West Virginia Weatherization Field Standards

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Low-Income Weatherization Assistance Program

State of West Virginia
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Introduction

The West Virginia Weatherization Field Standards provide guidelines to local administering agencies regarding the proper delivery of weatherization services for residential buildings. The purpose of the Standards is to ensure that high quality service is given at a reasonable cost and is delivered uniformly throughout the State. The success of this program depends upon agencies having a full understanding of the State's Weatherization Field Standards.

The objective of this document is two-fold. First, it serves to define the appropriate application of weatherization measures for each residence served. The document delineates material specifications as well as the steps that should be followed to complete each measure. Alternative methods will continue to be allowed, but whatever method is used must meet or exceed the standard described in the relevant section of this document.

Second, these Weatherization Field Standards set guides for the expectation of quality of the installed product. Procedures are included for evaluating the quality of each installed conservation measure and the overall quality of the completed job.

Additionally, it is anticipated that these Standards will help ensure that weatherization program funds are used in the most cost-effective manner possible.

This document is intended to represent the best thinking at the time of writing. It is also intended to be a dynamic document, changing as necessary to reflect advances in best practices for weatherization and the health and safety of clients and weatherization personnel.

All testing procedures, inspections, and safety checks performed by agency personnel will be done with the attempt to follow the tone and spirit of these Standards. No testing is to be performed by persons not holding appropriate licenses for doing so. It is understood by the Governor’s Office of Economic Opportunity that audit results constitute an opinion of observable conditions at the time of the audit/inspection. It is also understood that sometimes other deficiencies may exist beyond those observed.

The Weatherization Assistance Program has changed substantially, both technically and administratively, since its inception over three decades ago. The weatherization process continues to evolve in response to changes in funding, weatherization technology, program rules, and administrative personnel. The West Virginia Weatherization Field Standards will be used to implement and document these changes as they occur.

From time to time, these Standards may be amended and/or revised to reflect changes in state or federal regulations, advances in technology, and/or innovative approaches to weatherization. These Standards are organized to easily accommodate changes. In this sense, they will never be complete. In preparing this edition, some topics were almost certainly overlooked. The Standards will become more complete and comprehensive with use as omissions are identified and new topics are addressed with new policy or guidance.

1000 Administrative, Scope, and General Requirements

1100 Effective Date

1. All weatherization measures performed or completed on or after the date specified in the Subgrantee Weatherization contract shall comply with these Standards.
2. All dwelling units completed after the effective date shall comply with these Standards.

1200 Scope

The goal for the West Virginia Weatherization Assistance Program (WAP) is: "To reduce heating and cooling costs for low-income families, particularly for the elderly, people with disabilities, and children, by improving the energy efficiency of their homes and ensuring their health and safety."

1. The Weatherization Field Standards shall apply to all local administering agencies providing Weatherization Assistance Program (WAP) services.
2. The Weatherization Field Standards provide guidelines for the installation of energy conservation measures and repairs. Materials and measures that are allowed or not allowed will be specifically designated.
3. Items designated as “preferred approaches” are not required, nor are they mandatory. Agencies will be in compliance with the Weatherization Field Standards if they choose not to implement items listed as “preferred”, as long as the alternate method selected provides an equivalent or better result as measured by effectiveness and the Savings-to-Investment Ratio (SIR). However, the preferred approaches are provided as allowable options that will help to maximize the effectiveness of WAP services, protect the health and safety of clients and crews, and contribute to increased energy savings.
4. These Standards are not intended to abridge safety, health, environmental, or local codes or other ordinances. Such requirements, if more stringent than these, shall apply; if these Standards are more stringent, the Standards shall apply.
5. All questions concerning the content or implementation of the Standards should be directed to the West Virginia Governor’s Office of Economic Opportunity (GOEO).
6. These Standards are intended to be utilized in conjunction with 10 CFR Part 440, the DOE Weatherization Regulations, and the WV WAP Finance and Administration Manual.

1300 Enforcement

Continued agency inability and/or refusal to comply with these Standards are grounds for the Governor's Office of Economic Opportunity to suspend, terminate, or otherwise apply special condition(s) to the agency's current contract to provide weatherization services.

1400 Amendments to Weatherization Field Standards

1. From time to time, these Standards may be amended and/or revised by the West Virginia Governor's Office of Economic Opportunity to reflect changes in state or federal regulations, advances in technology, and/or innovative approaches to weatherization. The GOEO encourages agencies to submit suggested changes to these Standards that will result in the delivery of services in a more cost-effective manner while continuing to provide high quality work.
2. Amendments to these Standards will not become effective until thirty (30) calendar days from the date of GOEO approval and agency notification, except under the following conditions where amendments or revisions will become effective immediately:
    a. Changes in State or federal law or regulations mandate immediate implementation; or
    b. The GOEO determines that an emergency situation exists, such as a potential threat to life, limb, or personal property, and the proposed amendment and/or revision is necessary for the protection of the health and welfare of clients and workers.
3. Agency personnel may submit comments and suggested changes or revisions to these Standards to GOEO at any time. Suggested changes to the Standards must be accompanied by supporting documentation.
    a. The process for implementation of change will be either by recommendation of West Virginia GOEO technical staff and/or the Standards Committee to the State Weatherization Director.
4. All changes will be provided to the Weatherization Coordinators of all agencies at least thirty days prior to implementation to allow the opportunity for review and comment. The Weatherization Coordinators may then submit written comments regarding the changes to the State Weatherization Director for review and consideration. The State Weatherization Director will respond to all comments received prior to implementation of proposed changes.

1500 Weatherization Standards Waivers

1. Deviations from the Weatherization Field Standards require a waiver from the GOEO Weatherization Program Director prior to the expenditure of funds. Work may proceed after verbal authorization by the GOEO Weatherization Program Director. An electronic or hard copy documenting authorization will be forwarded and kept on file.

2. For example, waivers may be granted:
   b. If a client/occupant refuses to allow a certain measure to be completed and this measure has a higher priority or Savings-to-Investment Ratio (SIR) than the remaining measures. Agency personnel must document the reason the work was not performed.
   c. To convert water heaters or heating systems to a different fuel type.
      i. Gas water heaters may be replaced with electric water heaters if it is necessary to correct an unsafe or code compliance situation.
      ii. Clients have the option of declining or waiving a conversion for personal reasons. For example, if a conversion requires that a new venting system be run through finished space and the client does not like the appearance, the client may decline the conversion.
      iii. Agencies must first educate the client regarding the advantages and disadvantages of switching fuels. If the client declines the conversion, they must sign a statement in the client file waiving the conversion.
      iv. Fuel-switching costs should be analyzed for cost-effectiveness using the approved audit.
      v. Fuel conversions must be completed by qualified personnel in compliance with applicable building codes.
      vi. Fuel switching must be considered on a case-by-case basis.

1600 Deferral or Denial of Weatherization Based on Site Conditions

1. The primary goal of the Weatherization Assistance Program is to save energy. In some instances, a dwelling may be structurally unsound or otherwise unsuitable and not adaptable to weatherization without repairs beyond the scope of the program. While every effort should be made to secure resources to make those repairs so weatherization can be done, program services may have to be denied or deferred until repairs are made.
2. Conservation measures and associated repairs may be omitted if the work cannot be completed because of health, safety, local codes, or other technical reasons. The following are examples of acceptable grounds for a waiver:
   a. Risk to client or subgrantee staff due to health or safety risks such as fire, explosion, bodily harm, unruly pets, harmful combustion by-products, electric shock, friable asbestos, severe unsanitary conditions, severe structural damage, or height clearance.

3. Denials or deferrals do not require State approval, but a brief explanation must be documented in the client file. In addition, the client must be informed in writing if they are eligible for program services but the dwelling cannot be weatherized due to site conditions.
4. For further details on the policy regarding denial or deferral due to site conditions, please refer to Section 42100 on page 62.

1700 Monitoring by State

1710 General Procedure

Periodically, GOEO Weatherization staff will conduct subgrantee monitoring visits for the purpose of determining that all materials and services reported have been installed or completed according to the West Virginia Weatherization Field Standards.

The effectiveness, safety, workmanship, overall appearance, and compliance with the Standards will be evaluated during the monitoring visit. Please refer to Section 14000 on page 145 for monitoring procedures.

1720 Required Client File Documentation[1]

Documentation for each completed client file must contain:

1. Client Application Form which includes homeowner's permission to work on the dwelling, fuel bill release authorization, and disclaimer.
2. Income Verification Form with client's statement of income, agency verification of stated income, back-up documentation, and re-verification, if necessary.
3. Owner Agreement Form for rental unit (if applicable).
4. Work Plan detailing all aspects of the job concerning the actual weatherization of the home, including the job orders, actual material used and cost, and a home inspection.
5. Summary Sheet summarizing information on the client, home, and measures for statewide database.
6. Confirmation of Receipt of Lead Pamphlet (if applicable) certifying that the EPA booklet "Renovate Right: Important Lead Hazard Information for Families, Child Care Providers and Schools" was

[1] As of April 1, 2006, the Weatherization Application and Income Verification were to be integrated into the DBA FACS Pro software as instructed in Weatherization Network Memorandum Wx 2005-10, dated January 9, 2006. As described in the memorandum, there are some changed requirements if the client is in the FACS Pro system, including no longer needing a paper application form and paper income verification form. A full Weatherization component of DBA FACS Pro is currently being integrated into the statewide program. Agencies will be given additional training and instruction on the use of the FACS Pro and the Weatherization component for Weatherization applications, client tracking, reporting, and other functions during the course of this contract period. Furthermore, it is anticipated that integration of FACS Pro and the Weatherization component will affect the printed documentation required for the Client Files.

given to the client prior to the start of work in homes built before 1978. Clients must receive this booklet at least seven days before work begins.

7. The Energy Saver's Partnership Plan and Energy Education Certification Form documenting the energy education provided by the subgrantee to the client.
8. Mold and Moisture Assessment Findings Form to access existing moisture and/or mold problems in the dwelling.
9. Hold Harmless Statement (if applicable), to document existing or potential health and safety problems that the Weatherization Assistance Program will not be able to repair.
10. Carbon Monoxide Warning Statement (if applicable), to document high levels of carbon monoxide found when testing combustion appliances.

1730 General Requirements – Quality Control

1. Each job must have an accurate estimation and work order generated by the auditor/estimator in the client file. See Section 3000 on page 21 for a complete description of estimates and work orders.
2. The agency must conduct a thorough inspection of each completed unit before it is reported to the State as a completed dwelling unit. Final inspections must be performed by certified post-work Inspectors who, except in rare cases, did not perform the actual work on the job.
3. All installations should be performed in a neat and professional manner.
4. At no time during the job shall the crew store any materials and tools in living areas of the dwelling. Tools and materials shall be placed in proper storage chests. Materials may not be left on the client's property.
5. Any exterior wood trim installed on the home shall have all four sides primed to match the existing finish on the home. Care shall be taken to assure that the new trim blends into the existing character of the home and is of equal or better quality.
6. Every attempt will be made to closely match the existing trim explaining to the client beforehand that an exact match may not be possible.
7. All materials being installed by the crew shall be installed with efforts to match the existing trim or finish material that is adjacent to the new installed trim.
8. Required building permits, electrical permits, plumbing permits and other permits required by local or State authorities shall be obtained by the agency. Permits must be obtained prior to commencement of work and copies of permits must be provided to the owner.

9. A copy of all manufacturers' warranties shall be included in the final client file.
10. All repair work shall conform to the local building codes when applicable.

2000 Weatherization Personnel

2100 Program Personnel Core Competencies[2]

The competencies or skills that a West Virginia weatherization worker should possess depend on their position. For example, an auditor/estimator needs to conduct diagnostic testing that may not be required of a weatherization technician. An installer must acquire additional skills to become a crew supervisor, and still more to become an auditor/estimator. A new auditor/estimator hired off the street must already possess auditor-level competencies as a condition of hire. These increasing levels of competency provide a professional development path for agency and personnel.

Definitions for Core Competencies

1. *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.
2. *Possess a working knowledge of* means to:
   a. Know how a particular topic effects the weatherization process;
   b. Have the relevant information committed to memory or be able to locate it in readily available sources; and
   c. Use this knowledge to make informed decisions and guide weatherization work.
3. *Demonstrate the ability to* means to:
   a. Physically conduct a test, procedure, or technique on an actual house, a prop, or in a training laboratory in the presence of someone qualified to assess the particular competency.

All weatherization staff must possess the following basic skills:

1. Ability to read and write legibly;
2. Basic verbal and written communication skills;
3. Basic construction knowledge; and
4. Basic math skills.

[2] This section is based on *Core Competencies for the Weatherization Assistance Program* developed by The Weatherization Trainers Consortium for the U.S. Department of Energy Weatherization Assistance Program, March 26, 2007, and the requirements of the West Virginia Weatherization Assistance Program.

2110 Safe Work Practices

All Weatherization Coordinators, Post-Work Inspectors, Auditor/Estimators, HVAC Technicians, Crew Supervisors, Weatherization Technicians, and Lead Renovators must exhibit safe work practices by possess the following competencies.

1. Possess a working knowledge of:
   a. U.S. Department of Energy (DOE) program regulations/policy and Environmental Protection Agency (EPA) guidelines for asbestos, lead, mold, and other health hazards;
   b. Material Safety Data Sheets; and
   c. Occupational Safety and Health Act (OSHA) standards:
      i. Ladder safety;
      ii. Fall protection;
      iii. Personal protective equipment;
      iv. Respiratory protection;
      v. Motor vehicles;
      vi. Power-operated hand tools;
      vii. Fire prevention;
      viii. Permit required confined spaces;
      ix. Other worker related OSHA standards.
   d. All other work related standards included in Section 4000 on page 33.
2. Demonstrate the ability to:
   a. Select, fit, and use the appropriate personal protection equipment for a particular task;
   b. Safely use basic hand and power tools;
   c. Use a basic first aid kit to treat common job-site injuries;
   d. Work lead safe;
   e. Identify serious mold conditions; and
   f. Assess work area safety hazards.

2120 Weatherization Coordinator

1. Prerequisites:
   a. Possess *Safe Work Practices, Weatherization Technician, Auditor/Estimator* and *Post-Work Inspector* competencies.
2. Possess a working knowledge of:
   a. DOE program regulations 10 C.F.R. 440;
   b. West Virginia Program Operations Manual;
   c. West Virginia Program Weatherization Standards;
   d. Weatherization agency contracts;

e. Applicable state and local agency procurement regulations;
f. State and local approaches to monitoring, training, and technical assistance;
g. Applicable computer databases, reporting forms and procedures, and production and expenditure 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

3. Demonstrate the ability to:
   a. Effectively communicate and manage weatherization staff;
   b. Act as a public relations spokesperson for the program to leverage resources for the Weatherization Assistance Program from both public and private sources;
   c. Prepare and track a budget for implementing a local weatherization program;
   d. Prepare a Management Plan and Production Schedule for implementing a local weatherization program;
   e. Ensure that weatherization work complies with state technical program standards;
   f. Ensure rigorous, unbiased, and accurate final inspection of all completed units;
   g. Coordinate all program resources, including materials, vehicles, tools and equipment, warehousing, and personnel;
   h. Comply with budget line item requirements;
   i. Maintain a purchase order system to track contracted services and materials and tool requisitions;
   j. Maintain a coding system to assure expenditures are charged to the correct budget category;
   k. Maintain inventory tracking system for materials, tools, and equipment;
   l. Submit accurate financial and production reports in a timely manner;
   m. Maintain client file documents as per state guidelines;
   n. Schedule crews and jobs to meet production goals and compliance with program priorities;
   o. Manage a small construction/production-focused operation;
   p. Provide adequate technical training for auditors, technicians, and inspectors directly employed by the local agency, and ensure that subcontractors receive appropriate technical training; and
   q. Develop and implement innovative leveraging strategies.

2130 Post-Work Inspector

1. Prerequisites:
   b. Inspectors should possess *Safe Work Practices, Weatherization Technician, and Auditor/Estimator* competencies.
2. Possess a working knowledge of:
   a. West Virginia Program Weatherization Standards;
   b. Building science principles; and
   c. Relevant local codes.
3. Demonstrate the ability to:
   a. Verify that the weatherized house is safe by conducting all appropriate combustion appliance safety tests;
   b. Evaluate the appropriateness of the installed weatherization measures taking into consideration appropriate program regulations, policy, energy audit results, and/or priority lists;
   c. Assess whether the measures were installed with good workmanship, proper materials, and in such a manner to comply with local codes and ensure long-term energy savings over the life of the measures;
   d. Ensure that all measures charged to the job were actually installed; and
   e. Verify the effectiveness of air sealing efforts by conducting a blower door test and zone pressure diagnostics.

2140 Auditor/Estimator

1. Prerequisites:
   a. Possess *Safe Work Practices, Weatherization Technician, and Crew Supervisor* competencies;
   b. Possess a working knowledge of building science principles; and
   c. Have a working knowledge of personal computers and general software applications.
2. Inspection and Measurement:
   a. Possess a working knowledge of:
      i. West Virginia Program Weatherization Standards;
      ii. Air and heat flow in buildings;
      iii. Factors that affect building heat loss;
      iv. Construction features and critical junction points of common housing types;
      v. Insulation R-values;
      vi. Different insulation materials and installation techniques;
      vii. Various air-sealing techniques and appropriate materials;
      viii. Causes of and remedies for existing and potential moisture problems;

ix. Causes of and remedies for other existing and potential indoor air quality problems;
x. Residential mechanical ventilation systems;
xi. Building Tightness Limits based on the appropriate ASHRAE 62 standard; and
xii. Electric and fossil fuel baseload usage.

b. Demonstrate the ability to:
i. Measure the dimensions of floors, walls, ceilings, windows, and doors, and compute surface areas;
ii. Compute the volume of conditioned space of a building;
iii. Define the thermal envelope of a building;
iv. Define the pressure boundaries of a building;
v. Assess the effectiveness of existing insulation and the effective R-values; and
vi. Analyze utility bills including breaking out baseload usage for heating and cooling usage.

3. Diagnostic Testing:
a. Blower door:
i. Possess a working knowledge of:
1. Principles of air movement and how they relate to building heat loss;
2. Typical air leakage problems in common housing types; and
3. Minimum ventilation rates.
ii. Demonstrate the ability to:
1. Set up a blower door;
2. Prepare a building for a blower door test; and
3. Take blower door reading and interpret results.

b. Zone pressure diagnostics:
i. Possess a working knowledge of:
1. The air barrier or pressure boundary of a building and the importance of aligning it with the thermal barrier; and
2. Primary and secondary zones of a house.
ii. Demonstrate the ability to:
1. Conduct zone pressure diagnostics and interpret results;
2. Determine the location and effectiveness of the air barrier of a house.

c. Duct testing:
    i. Possess a working knowledge of:
        1. Problems associated with different types of duct leakage.
    ii. Demonstrate the ability to:
        1. Determine dominant duct leakage;
        2. Conduct pressure pan tests: and
        3. Seal duct leaks with appropriate materials and good workmanship.
        4. Measure room pressure imbalances in houses with forced-air systems.

d. Steam and hot water distribution system testing:
    i. Possess a working knowledge of:
        1. The components of typical steam and hot water distribution systems and the characteristics of their proper operation.
    ii. Demonstrate the ability to:
        1. Test air vents, steam traps, thermostatic radiator valves, and hot water zone valves; and
        2. Estimate the energy impacts of existing overheating problems.

e. Baseload systems:
    i. Demonstrate the ability to:
        1. Meter electrical devices to determine their annual energy consumption.

4. Combustion Appliance Safety
    a. Possess a working knowledge of:
        i. CO action levels;
        ii. Common code requirements related to:
            1. Vent system sizing, materials, clearances, and installation;
            2. Safety shut-off devices;
            3. Gas line sizing; and
            4. Combustion air.
        iii. Causes of and remedies to common vent system problems.
    b. Demonstrate the ability to:
        i. Measure the CO level in ambient air;
        ii. Measure the CO level of vented and unvented combustion appliances;
        iii. Measure the CO levels of gas- or propane-fired cook stove oven bake burners;
        iv. Understand the difference between as-measured and air-free CO readings;
        v. Detect any natural gas, propane, and fuel oil leaks;

vi. Conduct a worst-case draft test of a combustion appliance zone;
vii. Measure the CAZ to assure sufficient volume for combustion air;
viii. Clock a gas meter to determine the actual input of a gas-fired combustion appliance;
ix. Conduct basic temperature-rise and static-pressure-drop tests on forced-air furnaces;
x. Measure the steady-state efficiency of a vented combustion appliance; and
xi. Assess the potential inadequacy of supply and return plenum and duct sizes for forced-air systems.

5. Energy-Saving Measures:
   a. Possess a working knowledge of:
      i. What materials are allowed to be installed based on DOE 10 CFR 440 Appendix A;
      ii. The regulatory and policy requirements for selecting weatherization measures using NEAT and MHEA software and/or West Virginia priority lists; and
      iii. The interaction between typical weatherization measures (e.g., the impact of air-sealing and insulation measures on the potential savings of heating efficiency improvements).
   b. Demonstrate the ability to:
      i. Use NEAT and MHEA energy audit to input accurate building data and recommend appropriate, cost-effective weatherization measures;
      ii. Use West Virginia priority lists to select appropriate, cost-effective weatherization measures;
      iii. Prioritize air-sealing efforts;
      iv. 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;
      v. Select the proper CFL to replace an incandescent lamp while maintaining or improving lighting levels; and
      vi. Meter an existing refrigerator or locate its DOE tested usage in a database to estimate annual energy consumption.
6. Work Scope Development:
   a. Demonstrate the ability to:
      i. Accurately estimate the type and quantity of materials required to cost-effectively weatherize an eligible dwelling unit; and
      ii. Prepare clearly written work orders for work crews or contractors.

2150 HVAC Technician

1. Heating and Cooling Equipment:
   a. Prerequisites:
      i. Possess *Safe Work Practices* and *Weatherization Technician* competencies; and
      ii. Complete required West Virginian Weatherization Assistance Program HVAC courses, including:
         1. Basic Wiring and Electrical Heating Systems;
         2. Gas Heating Systems;
         3. Oil and Solid Fuel Heating Systems;
         4. Basic Cooling, Residential Heat Pump and AC Inspection;
         5. AC and Heat Pump Maintenance and Diagnostics;
         6. EPA Section 608 Technician Certification; and
         7. HVAC Electrician License.
2. Possess a working knowledge of:
   a. The essential components and operation of typical residential electrical, gas, oil and solid fuel appliances;
   b. Weatherization Assistance Program Standards for maintenance, repair, and replacement of typical HVAC Systems;
   c. National, State, and local codes that apply the safe and proper installation residential HVAC systems; and
   d. All West Virginia Weatherization Assistance Program required documentation, procedures, standards and policies related to HVAC systems.
3. Demonstrate the ability to:
   a. Maintain quality control Weatherization work and ensure it meets WV WAP standards;
   b. Inspect, test, diagnose and document all pre- and post-test results according to West Virginia Weatherization Assistance Program standards;
   c. Perform required maintenance, repairs, safety and efficiency measures, replacements and required documentation according to West Virginia Weatherization Assistance Program standards and applicable codes;
   d. Recognize and correct deficiencies with existing HVAC installations;
   e. Calculate the heating and/or cooling load of a dwelling per *Manual J*, NEAT or MHEA to ensure proper sizing of replacement heating and cooling systems;
   f. Ensure proper sizing of wiring, piping and venting of HVAC equipment;

g. Ensure code compliance of minimum safe clearances of HVAC equipment and venting systems;
h. Ensure code compliance regarding sufficient combustion air for combustion appliances;
i. Repair or replace vent systems of combustion appliances in a code compliant manner;
j. Repair or replace a water heater in a code complaint manner;
k. Assess duct system performance and make necessary repairs, adjustments and modifications for optimum efficiency;
l. Perform combustion safety (CAZ and worst case draft) testing to ensure proper vent system functioning;
m. Perform combustible gas leak detection testing;
n. Perform *Manual D* when new duct systems are necessary; and
o. Ensure that all necessary information and tests (pre and post) are accurately performed and documented and in the client file once the job is completed.

2160 Crew Supervisor

1. Prerequisites:
   a. Possess *Safe Work Practices* and *Weatherization Technician* competencies.
2. Possess and working knowledge of:
   a. West Virginia Program Weatherization Standards; and
   b. Building science principles.
3. Project Management:
   a. Demonstrate the ability to:
      i. Manage a crew of Installers so weatherization work is conducted safely, effectively, and efficiently;
      ii. Ensure that the job site and installers comply with the *Safe Work Practices*;
      iii. Maintain quality control of weatherization work and ensure it meets program stands;
      iv. Understand a work order;
      v. Order and obtain materials, supplies, and equipment in time to avoid delays and wasted time on the job site; and
      vi. Warehouse materials as necessary to avoid delays in completing weatherization work.
4. Inspection and Measurement
   a. Possess a working knowledge of:
      i. Air and heat flow in buildings;
      ii. Factors that affect building heat loss;
      iii. Construction features and critical junction points of common housing types;

iv. Insulation R-values;
v. Different insulation materials and installation techniques;
vi. Various air-sealing techniques and appropriate materials;
vii. Causes of and remedies for existing and potential moisture problems;
viii. Causes of and remedies for other existing and potential indoor air quality problems;
ix. Residential mechanical ventilation systems;
x. Minimum ventilation rates/building tightness limits based on the appropriate ASHRAE 62 standard; and
xi. Electric base-load usage.

b. Demonstrate the ability to:
   i. Measure the dimensions of floors, walls, ceilings, windows, and doors, and compute surface areas;
   ii. Compute the volume of conditioned space of a building;
   iii. Define the thermal envelope of a building; and
   iv. Assess the effectiveness of existing insulation and the effective R-values.

5. Diagnostic Testing:
   a. Blower door:
      i. Possess a working knowledge of:
         1. Principles of air movement and how they relate to building heat loss;
         2. Typical air leakage problems in common housing types; and
         3. Minimum ventilation rates.
      ii. Demonstrate the ability to:
         1. Set up a blower door;
         2. Prepare a building for a blower door test; and
         3. Take blower door reading and interpret results.
   b. Zone pressure diagnostics:
      i. Possess a working knowledge of:
         1. The air barrier of a building and the importance of aligning it with the thermal barrier; and
         2. Primary and intermediate zones of a house.
      ii. Demonstrate the ability to:
         1. Conduct zone pressure diagnostics and interpret results; and
         2. Determine the location and effectiveness of the air barrier of a house.
   c. Duct testing:
      i. Possess a working knowledge of:
         1. Problems associated with different types of duct leakage.

ii. Demonstrate the ability to:
1. Determine the amount of duct leakage or least the existence of significant duct leakage by conducting pressure pan testing;
2. Measure room pressure imbalances in houses with forced-air systems; and
3. Resolve room pressure imbalances.

6. Combustion Appliance Safety:
   a. Possess a working knowledge of:
      i. CO action levels;
      ii. Common code requirements related to:
         1. Vent system sizing, materials, clearances, and installation;
         2. Safety shut-off devices;
         3. Gas line sizing; and
         4. Combustion air.
      iii. Causes of and remedies to common vent system problems.
   b. Demonstrate the ability to:
      i. Measure the CO level in ambient air;
      ii. Measure the CO level of vented and unvented combustion appliances;
      iii. Measure the CO levels of gas- or propane-fired cook stoves (oven and burners) and remedy high CO levels through basic cleaning and adjustments;
      iv. Understand the difference between as-measured and air-free CO readings;
      v. Detect gas, propane, and fuel oil leaks; and
      vi. Conduct a worst-case draft test of a combustion appliance zone; and
      vii. Measure the steady-state efficiency of a vented combustion appliance.
7. Insulation:
   a. In addition to the insulation-related Installer competencies, possess a working knowledge of:
      i. Local codes relating to attic ventilation.
8. Training:
   a. Possess a working knowledge of:
      i. Adult learning concepts; and
      ii. Benefits of cross training on-site personnel.
   b. Demonstrate the ability to:
      i. Provide on-site training to Installers in a positive environment to strengthen competency in existing skills and increase the number of skill areas.

2170 Weatherization Technician

1. Prerequisites
   a. Possess *Safe Work Practices* competencies;
   b. High school diploma or equivalent;
   c. Valid West Virginia drivers license; and
   d. Must have reliable transportation for travel to and from work.
2. Air Sealing
   a. Possess a working knowledge of:
      i. Proper materials selection based on location of leakage areas; and
      ii. Minimum ventilation rates.
   b. Demonstrate the ability to:
      i. Use the blower door to locate leakage sites within the building;
      ii. Seal attic and floor bypasses at penetrations for plumbing, electrical wiring, flue vents, ducts; dropped soffits, and balloon-framed walls;
      iii. Seal typical bypasses in knee walls and finished attic spaces;
      iv. Seal basement band joists;
      v. Properly apply caulk and spray foam insulation;
      vi. Identify, select, and install weatherstripping on doors, windows, and attic hatches;
      vii. Cut glass, replace broken window panes, and apply glazing compound;
      viii. Repair plaster and sheetrock (drywall); and
      ix. Modify or install mechanical ventilation to ensure acceptable indoor air quality for post-air-sealing conditions.
3. Duct Sealing
   a. Demonstrate the ability to:
      i. Properly seal duct connections with mastic and fiberglass mesh tape or other approved material; and
      ii. Repair or modify duct systems as specified in a work order.
4. Insulation
   a. Possess a working knowledge of:
      i. Properties and appropriate application of different insulation materials; and
      ii. Potential hazards of insulating around knob-and-tube wiring.

b. Demonstrate the ability to:
    i. Install blown and batt attic insulation;
    ii. Access closed wall cavities and properly install dense-packed cellulose wall insulation including removing and replacing siding;
    iii. Install blown insulation and batt insulation in a floor;
    iv. Install water heater installation blankets;
    v. Install insulation on ducts, hydronic distribution pipes, and domestic hot water pipes; and
    vi. Safely operate and properly maintain insulation blowing machines and generators.

5. Baseload Measures
    a. Demonstrate the ability to:
        i. Replace incandescent light bulbs with compact fluorescent lamps while maintaining or improving lighting levels; and
        ii. Install low-flow showerheads and faucet aerators;
            1. Assess the existing condition of plumbing pipes and faucets that may prohibit these measures.

2180 Lead Renovator

1. Prerequisites:
    a. Possess *Safe Work Practices* and *Weatherization Technicians* competencies.
    b. Lead-Safe Renovation training and certification.
2. Possess a working knowledge of:
    a. DOE Lead-Safe Weatherization (LSW) work practices;
    b. West Virginia Weatherization Field Standards;

2190 Energy Educator

1. Competency:
    a. Principles of adult education.
2. Possess a working knowledge of:
    a. West Virginia Weatherization Field Standards;
    b. The distinction between oral and print culture communication and when to use each to maximize the effects of client education;
    c. The four models of energy conservation behavior and which is the most effective;
    d. What actions can be taken to reduce energy use in the dwelling;
    e. The basic steps of the weatherization process, from auditing, testing, installation, inspection, and monitoring;

f. The purpose of the basic equipment involved in weatherizing a dwelling, including a blower door, pressure pan, combustion analyzer, gas leak detector, insulation blowing machine, etc.; and
g. What actions need to be taken to maintain a healthy and safe indoor environment?

3. Demonstrate the ability to:
   a. Act as a public relations spokesperson for the meetings outside the agency, such as civic groups, senior centers and schools;
   b. Develop a trusting and professional relationship or partnership with the client;
   c. Explain why client education is important to the weatherization process;
   d. Explain what client education strategies work and why;
   e. Estimate the economic impacts of suggested actions to bolster customer commitment to changing their energy-related habits;
   f. Utilize a variety of resources and communication skills to achieve effective client education results;
   g. Assess the client's expectations of the WAP and help the client understand the program in an effort to reduce client complaints;
   h. Complete the Energy Partnership Plan with the client; and
   i. Enhance a client's self-esteem with client education methods.

2200 Training and Certification of Program Personnel

[reserved]

3000 Pre-Weatherization Inspection, Priority Lists, and Energy Audits

3100 Introduction

The auditor/estimator plays a critical role in the success of the effectiveness of the weatherization measures conducted on the home by identifying the most effective measures for energy savings. The auditor/estimator must provide sufficient information for the crew to work on the home, such as materials needed for the job, measures to be taken, and any specific problems or conditions the crew may encounter.

Measures to be taken on the home are determined by visual inspections, diagnostic testing, practical considerations, measures priority lists, calculation of savings-to-investment ratios, and the Weatherization Field Standards.

3200 General Requirements

1. Each client file must have an accurate estimate/work order generated by the estimator responsible for the job. An acceptable work order is one for which all installed energy-saving weatherization measures are on the appropriate priority list or have a Savings-to-Investment Ratio (SIR) of 1.00 or greater.
    a. Measures not on the appropriate priority list or for which SIR values are less than 1.00 are ineligible.
    b. All energy-saving measures must be considered and ranked in order of descending priority list category or SIR. Installing a measure from a lower priority list category without first installing all measures from a higher priority list category, or installing a lower SIR measure without installing others with greater SIR is forbidden; in other words, measures may not be skipped.
    c. It is not permissible to omit measures vital to the success of the weatherization job. For example, it is not permissible to partially insulate a dwelling because of budget constraints. All mandatory measures must be performed.
2. The work order must clearly itemize the work to be completed by the agency crew. The work order must:
    a. Be well organized and legible.
    b. Include all appropriate dimensions and quantities.
    c. Include any appropriate special instructions for necessary inspections or unusual installations.
    d. The method of insulation installation with the proposed amount, type, and R-value of the insulation to be installed.

e. The type of vapor retarder and attic ventilation to be installed, if any.
f. Details of any warranties on materials used in the home.

3300 Auditing Tools and Equipment

1. Approved blower door.
2. Digital manometer.
3. Bacharach Monoxor II or other carbon monoxide detector.
4. Portable combustion analyzer such as Bacharach PCA or Fyrite Pro.
5. Electronic combustible gas detector.
6. Digital auto-ranging clamp multi-meter with milli-amp sensitivity.
7. NEAT software installed on a computer with current cost data (preferred in field but in office also acceptable).
8. Digital camera.
9. Flashlight and mirror.
10. OSHA-approved respirator.
11. Toolbox with miscellaneous tools.
12. Stepladder or telescoping ladder.
13. Extension cord.
14. Battery powered drill with appropriate bits.

3400 Estimation Requirements

1. The estimate must include as a minimum:
   a. Information about the existing condition of the dwelling and its mechanical systems;
   b. Diagnostic tests, including combustion appliance analysis and blower door testing;
   c. Health and safety problems, including possible lead-based paint, moisture and/or mold, electrical problems, signs of rust and corrosion on combustion appliances;
   d. Existing insulation levels;
   e. Conditions the work crew needs to know in advance;
   f. Dwelling evaluation, considering existing conditions for energy savings opportunities and related health and safety problems;
   g. Identification of appropriate air and thermal barriers;
   h. Assessment of priority lists and measures to be taken;
   i. Outline of health and safety considerations;
   j. Strategy for weatherizing the dwelling.
2. Work orders must effectively communicate to the crew sufficient information on the home and measures to be taken. The work order should include:

a. Particular problems or considerations crew needs to know in advance;
b. Total costs and for all proposed measures;
c. Estimate of the time to complete the work;
d. Analysis of warehouse inventory as it relates to the job; and
e. Analysis of whether utility funds will be used for certain measures.

3500 Recommended Estimation Procedure

Every estimator will develop their own style of conducting a weatherization audit. The following steps outline a basic approach and tips that an estimator may use as a guide to effectively assess a housing unit for weatherization.

3510 Preparation

1. Select the potential job estimates. If possible, try to keep them close together to reduce travel time between homes.
2. Make sure client file is up to date. You may need to pick up additional income verification or other forms, utility bills, etc.
3. Know your agency's partnership programs such as home repair, utility or others that might assist if additional funds are required for the job.
4. Call the client to make an appointment. Verify address and directions. If you are still unsure of the client's location, use internet directions. Be sure to ask the client not to operate their fireplace or other solid-fuel appliances the day of the estimate (if possible), so that the blower door test can be safely done.

3520 Estimation Process – Working with the Client

1. Don't get discouraged before you have even knocked on the door. That big old two-story frame in poor condition can dampen anyone's spirit.
2. Introduce yourself and smile. Explain to the client why you are there and what you will be doing. Give them a business card. You may be the first representative of the weatherization program the client has met.
3. Small talk, even about the weather, helps to break the ice. Ask about the family pictures on the wall.
4. Sell yourself and the program. This is a crucial element of the estimation process. The client is not well acquainted with you and has little, if any, idea what you and your crew are going to be doing to their home.
5. Act in a professional manner. Your behavior will influence how the client will prepare for the weatherization work, respond to the crew, respond to energy education, and view the agency and program. Tell

the client they are welcome to observe your audit/estimate if they choose. If they do, you have just accomplished two objectives. First, the client will be more at ease because of your openness. Second, you probably just generated another application.

6. Involve the client. Explain that you will need to be “poking around” the house in the basement, attic, closets, bedrooms, and bathrooms. If possible, take the client through the home with you while you gather your information. Nobody knows the house better than the client.
7. Don't rush your estimate. Take your time and think things through. The advice and decisions you make may have a huge impact on the client's life. You should have a cell phone in case you need to postpone or cancel the next scheduled estimate.
8. Know your crew’s strengths and keep them in mind. The job may require the special talents of certain individuals or crews.
9. Don't make promises you are not sure you can keep. If you are not sure of a measure, tell the client: "Let's let the crew take a look at it".
10. Perform an exit interview with the client. Explain what you found, what measures may be done, and an approximate date when they can expect work to begin. Communicate clearly anything that they may need to do before the crew can do their work, such as removing clutter from the attic. Ask them if they have any questions.
11. Tell the client that if they know of anyone else that needs help to get in touch with you.
12. Collect any missing paperwork or signatures from the client.

3530 Estimation Process – Gathering Necessary Information

1. If there is a basement, start there. If there are any major health or safety problems, this is a likely place to find them. Make a visual assessment of the heating unit – the type, make, venting, condition, fuel type, and safety switches.
2. Document any findings on the proper forms.
3. Depending on the season, decide when to conduct the heating system efficiency test. In summer, do this first and then operate the blower door to cool down the house. In winter, do the reverse. Be sure to check all health and safety devices and test the carbon monoxide level of all combustion appliances.
4. Inspect the rest of the house – bathrooms, attic, kitchen, bedrooms, closets, and crawl spaces. Be observant throughout this process. Look for obvious air leaks as well as health and safety issues. Check the ground fault circuit interruption (GFCI) outlets, venting equipment, look for moisture problems, etc.
5. The pressure boundaries and thermal boundaries of each dwelling must be determined during the inspection.

6. All building cavities that define the thermal enclosure between the conditioned space and outdoors must be inspected and measured for existing insulation R-values, structural integrity, and the need for repairs.
7. The field inspection must identify the most appropriate methods for:
   a. Reducing air leakage and convective bypasses; and
   b. Increasing the insulating value of thermal boundaries, when appropriate.
8. As you move through the dwelling, make sure it is set up for the blower door test. Close windows and exterior doors; deactivate vented combustion appliances, etc.
9. Conduct a blower door test unless there are problems such as friable asbestos or an operating solid-fuel appliance.
10. Walk around the house with the blower door running and check for air leakage. Do not forget to check for leaks in basements that are within the thermal enclosure of the dwelling.
11. Perform other appropriate tests, such as zone pressure diagnostics.
12. Measure the perimeter of the house from the inside or outside. If it is a complicated house, you may want to do this at the beginning of your audit and make your sketch of the floor plan so that you are oriented when inspecting the interior of the house.
13. Use the digital camera to photograph the heating system and any areas of the house that may present a challenge. These can be a valuable reference when you're back in the office writing up the job. It is always a good idea to take photographs of moisture problems, date them, and include printed copies in the client file.
14. Put personal and household items back where you found them. Relight any pilot lights that may have been extinguished during the blower door test.
15. Look over your paperwork for a few minutes in the car before you drive away to be sure you have collected all the information you need. Organize your notes. Be sure you have done everything you need to on-site.

3600 Work Order Process

1. Write up a work order of the most cost-effective measures for the home. Write or type the job order legibly and describe the work requests clearly and specifically.
2. Analyze warehouse stock and whether any materials need to be ordered.
3. Work up the estimates as soon as possible. The longer they sit on your desk, the more you forget.
4. Give the crew the work orders for the job and discuss the work with them. Show the crew pictures of the job. Discuss your possible

solutions and encourage their comments. Let the crew members know you are open for suggestions.

5. If possible, visit the crew while the work is in progress and try to conduct the post-work inspection the last day of the job.

3700 Energy Audit Procedures

As allowed by DOE regulations, the West Virginia Weatherization Assistance Program utilizes priority lists for comparable dwelling units that do not have unusual energy-consuming characteristics. The priority lists are developed by conducting site-specific energy audits of a representative group of comparable dwelling units.

These priority lists will be periodically developed by the West Virginia GOEO, submitted to DOE for approval, and then distributed to the agencies.

WV WAP uses the Weatherization Assistant software as its energy audit tool. The Weatherization Assistant energy audit software was developed by Oak Ridge National Laboratory specifically for the use for the Weatherization Assistance Program. There are two components to the Weatherization Assistant software: the National Energy Audit Tool (NEAT) for single family houses and the Manufactured Home Energy Audit (MHEA) for mobile homes.

The use of NEAT or MHEA are required when an agency thinks needed measures for a particular house vary significantly from a priority list. NEAT and MHEA should also be used to analyze refrigerator replacements and to perform heating system replacement sizing calculations.

At least one person at each agency shall have good working knowledge of NEAT and MHEA.

3800 Priority List for Site-Built Homes

General Measures	Detailed Measures
1. Heating System Clean and Tune	Mandatory measure (unless system is being replaced). Include health and safety tests.
2. Air Sealing	Mandatory measures. Use blower door to guide air sealing. Ducts must be sealed as per blower door guided and duct diagnostic standards. Seal ducts only if they are outside thermal envelope. Home must be sealed at least to upper limit of the target range and any other significant or obvious air leaks. Seal all major bypasses and key junctures. Attics/ceilings must be sealed prior to installation of attic insulation.
3. Duct Insulation	Mandatory measure. After sealing ducts outside the thermal envelope, insulate the same ducts.
4. Attic Insulation	Mandatory measure: Insulate attics to R-38 if existing insulation is less than R-11. If there is even and consistent existing R-11 to R-19, attic insulation, go to priority #6, and priorities #5 and #6 move up to #4 and #5. If existing is consistent R-11, attic insulation to R-38 is a recommended measure. If existing is consistent R-19, attic insulation to R-38 is allowable. Mandatory measure: Insulate knee walls to maximum structurally allowable. Seal applicable key junctures in knee wall areas.
5. Sidewall Insulation	Mandatory measure: Dense-pack wall cavities to R-13 or maximum structurally allowable.
6. Floor Insulation	Mandatory measure if there is an open foundation and no existing insulation. Recommended measure otherwise. Insulate floors that define heating envelope to R-19 (if none existing).
7. Heating System Replacement	Case-by-case consideration. SIR is greater than 1 if SSE of existing unit is 76% or less. Cannot be justified on basis of cost-effectiveness over higher priority measures. Can be installed after higher priority measures if agency deems it affordable or utility program pays. Must replace with 90+ high efficiency forced-air unit or highest efficiency possible space heater.

General Measures	Detailed Measures
Baseload Measures	
Water Heater Insulation	Mandatory measure. Insulate tanks with less than R-11 existing insulation (unless added insulation will void manufacturer's warranty).
Refrigerator Replacement	Mandatory measure for DOE/DHHR if SIR is equal to or greater than 2. Mandatory measure if paid by electric utility EEP and SIR greater than 1.5 Optional measure if affordable for DOE/DHHR if SIR greater than 1.
CFLs	Mandatory measure if bulb is on more than 2 hours per day. Optional measure if affordable for DOE/DHHR if bulb is on more than 2 hours per day.
Shower Heads	Mandatory measure if paid by electric utility EEP and existing flow is greater than 3 gallons per minute.
Health and Safety	
Heating System Replacement	Case-by-case analysis. Heating systems with non-repairable health and safety hazards can be replaced if warranted. Utility funds will pay for new system in some cases.
Water Heater Replacement	Case-by-case analysis. Non-repairable gas and electric water heaters can be replaced if warranted and funds allow. Utility funds will assist in payment in some cases. Actively leaking water heaters can be replaced. Any replacement should be with highest efficiency or energy factor available and practical.
Combustion Appliance Measures	Mandatory testing and documentation of tests on HURMS. Eliminate hazards that pose imminent danger to health and safety of occupants.
Mechanical Ventilation	Mandatory when the dwelling is tighter than the BTL. Install properly sized mechanical ventilation when needed to insure indoor air quality.
Repair Measures	
	If repair materials are greater than $250 of DOE/DHHR funds, NEAT must be run to show cumulative SIR is greater than 1.
Replacement Doors and Windows	Individual NEAT must be run to show measure SIR is greater than 1. Door and window replacement cannot be done in lieu of any mandatory measures.

Notes

All mandatory measures are underlined.
General measures are listed in order of priority based on SIR.
Other measures (baseload, health and safety, repairs) are not listed in order of priority.
All mandatory measures have SIRs greater than 4 and are expected to be done on all jobs. Thorough documentation must be provided if a mandatory measure is not performed.

Recommended measures should be performed unless they are cost prohibitive. The reason for not performing the measure must be documented.
Allowable measures or case-by-case measures are at the discretion of the agency and should be based on costs and professional opinion. They cannot supplant mandatory measures without individual NEAT being run to justify.
Any variation from the priority list must be based on individual NEAT analysis.

3900 Priority List for Mobile Homes

General Measures	Detailed Measures
1. Heating System Clean and Tune*	Mandatory measure (unless system is being replaced). Includes health and safety tests.
2. Air Sealing	Mandatory measure. Use blower door to guide air sealing. Ducts must be sealed according to blower door guided and duct diagnostic standards. Home must be sealed at least to upper limit of the target range and any other significant or obvious air leaks.
3. Ceiling Insulation for pre-1976 Mobile Home	Mandatory measure if existing insulation is less than 3 inches or if existing insulation has light spots or voids (flat or bow string roof). Recommended measure if existing insulation is 3 inches and there is 8 inch bow string roof. Not cost-effective if there is 3 inches existing insulation without voids and there is a 6 inch or less bow string roof.
3. Ceiling Insulation for 1976-1994 Mobile Home	Mandatory measure if existing insulation is less than R-11 or if existing insulation has light spots or voids (natural gas and electric). Mandatory measure with oil or propane heat (regardless of existing R-value). Recommended measure if existing insulation is R-11 and there is at least an 8 inch bow (in center) string roof (natural gas and electric). Not cost-effective if there is R-11 existing insulation without voids and there is a bow string roof with a center of 6 inch or less (natural gas and electric).
3. Floor Insulation for post-1994 Mobile Home	Mandatory measure when there is R-11 existing insulation or less or insulation with voids. Not cost-effective on floors with existing R-19 insulation.
4. Floor Insulation for pre-1994 Mobile Home	Mandatory measure when there is a rounded (sag) belly. Mandatory measure on flat belly with 3.5 inch cavity if existing insulation is less than 3 inches or if existing insulation has light spots or voids. Not cost-effective with 3.5 inch flat belly with 3 inches existing insulation with no voids.

General Measures	Detailed Measures
Ceiling Insulation for post-1994 Mobile Home	Recommended measure if less than consistent R-14 or R-19 or if voids, but should not be the case because of HUD manufacturing mandates.
Heating System Replacement	Can be installed after higher priority measures, if agency deems it affordable and/or utility program pays. If replacing, must replace with 90+ high efficiency forced air unit or highest efficiency possible for direct vent space heater.
Baseload Measures	
Water Heater Insulation	Mandatory measure on tanks with less than R-11existing insulation (unless added insulation will void manufacturer's warranty).
Refrigerator Replacement	Mandatory measure for DOE/DHHR if SIR is equal to or greater than 2. Mandatory measure if paid by electric utility EEP and SIR greater than 1.5. Optional measure if affordable for DOE/DHHR if SIR greater than 1.
CFLs	Mandatory measure if paid by electric utility EEP and bulb is on more than 2 hours per day.
Shower Heads	Mandatory measure if paid by electric utility EEP and existing flow is greater than 3 gallons per minute. Optional measure if affordable for DOE/DHHR and existing flow is greater than 3 gallons per minute.
Health and Safety Measures	
Heating System Replacement	Case-by case analysis. Heating systems with non-repairable health and safety hazards can be replaced if warranted. Utility funds will pay for new system in some cases.
Water Heater Replacement	Case-by case analysis. Non-repairable gas and electric water heaters can be replaced if warranted and funds allow. Utility funds will assist in payment in some cases. Actively leaking water heaters can be replaced. Any replacement should be with highest efficiency or energy factor available and practical.
Combustion Appliance Measures	Mandatory testing and documentation of tests. Eliminate hazards that pose imminent danger to health and safety of occupants.
Mechanical Ventilation	Mandatory when the dwelling is tighter than the BTL. Install properly sized mechanical ventilation when needed to ensure indoor air quality.
Repair Measures	
	If repair materials are greater than $250 of DOE/DHHR funds, MHEA must be run to show cumulative SIR is greater than 1.

General Measures	Detailed Measures
Heating System Replacement	Electric furnace can be replaced if beyond reasonable repair using electric utility EEP funds. Combustion furnace replacements are allowable to replace if repairs are not feasible or repairs cost more than 2/3 the cost of a replacement. (Not subject to individual MHEA run when over $300.)
Replacement Doors and Windows	Jalousie windows can be replaced when not repairable and when there is significant air leakage discovered by blower door tests. Door and window replacement cannot be done in lieu of any mandatory measures.

Notes

All MHEA test runs called for clean and tune rather than replacement.

All mandatory measures are underlined.

Under "General Measures" some of the items are specific to the year the mobile home was manufactures.

General measures numbers 1 – 4 are listed in order of priority based on SIR.

Other Measures (baseload, health and safety, repairs) are not listed in order of priority.

All mandatory measures are expected to be done on all jobs. Thorough documentation must be provided if a mandatory measure is not performed.

Recommended measures should be performed unless they are cost prohibitive. The reason for not performing the measure must be documented.

Allowable measures or case-by-case measures are at the discretion of the agency and should be based on costs and professional opinion. They cannot supplant mandatory measures without individual NEAT being run to justify.

Any variation form the priority list must be based on individual MHEA analysis.

4000 Health and Safety Requirements

4100 Introduction

The primary goal for West Virginia's Weatherization Assistance Program is to implement cost-effective weatherization procedures to conserve energy and to assess and correct related health and safety hazards for the well being of clients, their dwellings, and weatherization personnel.

With more advanced diagnostics and installation techniques utilized in the West Virginia Weatherization Assistance Program, it is increasingly necessary to take steps to insure that program measures do not cause or exacerbate health and safety problems for workers or clients. Repairs are limited to those related to energy efficiency and conservation.

4200 Expenditures

It is estimated that health and safety measures will account for an average of 15 percent of the program operation’s costs, with an absolute maximum of 20 percent allowed by any agency. Since these measures are performed by subgrantee direct-hire crews, and are usually installed simultaneously with energy efficiency materials, only material costs are directly tracked. The ratio percentage of health and safety materials to all materials is applied to personnel and program support to determine those costs.

4300 Reporting

Subgrantee agencies report health and safety material costs on page two, Completed Dwelling Units, of the Monthly Progress Report. Total health and safety costs and percentages are tracked on the agency statistical tracking spreadsheet, maintained at both the state and local levels.

4400 Grantee Health and Safety Costs

All costs related to subgrantee health and safety are charged to either state administrative funds or Training and Technical Assistance (T&TA), as applicable. Most of these charges are for personal safety equipment and combustion testing equipment used by training and monitoring staff.

4500 Crew Health and Safety

4510 OSHA Requirements

Local agencies must comply with applicable Occupational Safety and Health Administration (OSHA) requirements.

4520 Agency Safety Officer

1. A Safety Officer is to be designated at each agency. The safety officer coordinates the safety program and maintains all safety personnel records. Responsibilities of the safety officer include:
   a. Insuring all program field personnel have access to and demonstrate the proper use, maintenance, and storage of all tools, equipment, and safety equipment;
   b. Conducting scheduled safety meetings, documenting subject matter, keeping attendance records, and maintaining all required forms; and
   c. Enforcing all safety regulations to insure worker safety. Personnel who are not following safety practices or not properly using safety equipment must be removed from the job site until training or correction of the violation can be provided. A report must be included in the worker's safety file.

4530 Safety Meetings

Safety meetings should be held at a minimum of every other month. The safety officer should determine the content of the meetings based on issues of current importance. It is recommended to limit each meeting to one topic, such as ladder safety or Material Safety Data Sheets, to help the worker retain and understand the information covered. Content of meetings and attendance should be documented. It is recommended to give brief post tests on the addressed safety issue so employees can demonstrate their knowledge and understanding of the topic.

4540 Respirators Fit Tests

Each Weatherization Assistance Program field employee is required to have a respirator fitted in accordance with a qualitative respirator fit test using an approved vapor gas test agent, as described by the manufacturer of the fit test kit and OSHA/NIOSH regulations. Qualitative fit tests will be given to each employee every 12 months. The test should be documented on the Qualitative Respirator Fit Test form.

4550 Spirometry Tests

It is recommended that all field workers have a spirometry test at least every 18 months performed by a physician or respiratory therapist to determine the worker's physical ability to wear a respirator and perform tasks while wearing it.

4560 MSDS Station

A copy of a product's Material Safety Data Sheet (MSDS) shall be maintained in each warehouse at a designated "Right to Know Station," MSDS books should also be maintained in each program vehicle. Each employee must have access to the information in the MSDS books.

4570 Employee Information Sheet

The warehouse and each program vehicle must contain at all times a list of emergency phone numbers, and a list of all employees with their emergency contact information. The Health Insurance Portability and Accountability Act of 1996 (HIPAA), will not allow employers to keep medical information such as employee's allergies or medications.[3]

4580 Personal Protective Equipment

1. Head Protection
   a. Hard hats or bump caps are required to protect the worker from accidental head injury.
2. Respirators
   a. Respirators are necessary when blowing cellulose or fiberglass insulation and when installing fiberglass batt insulation. Dust from insulation is likely the most serious potential health hazard facing crew workers, and using the correct respirator is mandated whenever handling or installing insulation.
   b. Each field employee shall be provided with a fitted respirator. The employee will receive training on how to select, maintain, clean, and store their respirator. They are responsible for its routine maintenance. Any problems or malfunctions must be reported to the safety officer.
   c. When installing any type of insulation, a full-face respirator is required. Filters should meet specifications N 7500-8, approved by National Institute of Occupational Safety and Health (NIOSH) and Mine Safety and Health Administration (MSHA).
   d. Disposable dust mask respirators can also be used when full-face respirators cannot be worn. Use a NIOSH/MSHA approved respirator, such as a 3M model #8710 or #9900 or equivalent. Proper fitting is a necessity.
3. Eye Protection
   a. Goggles, plastic shields or safety glasses with side shields, are to be worn whenever there is a chance of particles flying into the

[3] The Health Insurance Portability and Accountability Act of 1996 (HIPAA), Public Law 104-191, was enacted on August 21, 1996. To view the entire Rule, and for other additional helpful information about how it applies, see the Office for Civil rights website: http://www.hhs.gov/ocr/hipaa.

eyes. Use the proper eye protection whenever drilling, blowing insulation, cutting glass or Plexiglas, working with fiberglass and sawing. Glasses and sunglasses are not approved eye protection.

4. Gloves
    a. Each worker should have good quality work gloves. These will protect the hands while handling glass, fiberglass, aluminum, wood, and cellulose. Gloves with cuffs are recommended since they also protect the wrist.
5. Shoes
    a. Good quality work boots are recommended. Good quality means boots (or shoes) with a heavy, treaded sole that offers support, traction and protection. The uppers should be made of leather to protect the ankles and lower leg from scrapes and punctures. Tennis or other athletic shoes do not give proper protection.
6. Clothing
    a. Work clothes should be worn instead of old dress clothes. Long sleeved shirts offer better protection than T-shirts. Long pants offer more protection than short pants or dresses/skirts. Layers of clothing are recommended so that the worker can adjust to the temperature. Loose clothing helps prevent insulation fibers or dust from rubbing against the skin.
    b. While working in winter temperatures, several layers of lighter clothing will keep a worker warmer and afford easier movement than heavy and bulky clothes.
7. Personal Protection Rules
    a. Confine long hair so that it is not exposed to machinery and does not interfere with vision.
    b. Require the wearing of safety goggles, glasses or other eye protection when there is danger of eye injury.
    c. Enforce the use of respirators where harmful dusts or fumes exist.
    d. Require workers to remove rings and other jewelry while working on-the-job or in the shop area.
    e. Where noise levels are excessive over long periods of time, ear protection must be worn.
    f. Protective apparel must be worn as required by the nature of the task.
    g. Dresses/skirts must not be worn on the job site.
    h. Determine the physical defects and limitations of all those on the job so that they will not be assigned tasks detrimental to their health or physical condition.
    i. Prohibit the wearing of clothing that could be loose enough that it could get caught on protruding objects or caught in machinery or power tools.

4590 Crew Safety Equipment

1. The following is a list of mandated safety equipment that each crew must have on the job in accordance with the tasks scheduled to be performed.
   a. Water jug.
   b. Exhaust fan for the attic.
   c. Ladder levelers.
   d. Ladder stabilizers.
   e. Ground Fault Circuit Interrupters (GFCI).
   f. Proper type and gauge extension cords for the task, but at least 12 gauge with ground (12-3).
   g. Double insulated power tools.
   h. Trouble light, three-wire including ground.
   i. Bee spray.
   j. Industrial size first aid kit.
   k. Fire extinguisher.
   l. Flares or warning lights.
   m. Flashlight.
   n. Ground cable for generator.
2. Body Mechanics
   a. Use as many muscles as possible to distribute the work load.
   b. Both hands are used to pick up heavier objects.
   c. Lifting heavy objects alone is to be avoided. Help should be requested.
   d. Pushing is preferred to pulling.
   e. Leg muscles are used to lift heavy objects rather than back muscles.
   f. Bending and unnecessary twisting of the body for any length of time is to be avoided.
   g. Work is done at the proper level.
   h. Long pieces of material are carried by two people.
3. Ground Fault Circuit Interrupters (GFCI)
   a. Whenever power tools or electrical equipment are used, it is mandated that a GFCI be used.
   b. Since GFCIs merely sense differences in current flow between one side of a circuit and another; they protect people, not wires. If a short circuit should develop, the GFCI will probably open, but it may not before the fuse blows. The practical message then is: 1) avoid hazardous situations that could cause short circuits, and 2) bring along extra fuses just in case.

c. GFCIs cannot protect you from all possible kinds of shock. If you cut through the extension cord feeding the GFCI you will get shocked. Or, if you cut through another wire in the attic not connected to a GFCI, you will get shocked. A GFCI only protects you from shock that could occur between you and the GFCI.
d. Sometimes the GFCI opens the circuit for no apparent reason. These are called "nuisance faults". Though the GFCI can be reset quickly, such faults are indeed a nuisance. When the GFCI opens the circuit, however, it may be telling you something important! A tool may have an intermittent ground fault. This can be the most dangerous kind of electrical problem of all, for it may occur when you least expect it. If a GFCI continually needs resetting for all tools, check the GFCI. If a particular tool frequently causes the GFCI to open, check the tool.
e. Read the directions on the GFCI you purchase and brief your crews carefully before sending them out. Portable units are sturdy, but like all good equipment, they should be treated with care and kept away from dirt and moisture. Each unit should be tested frequently.

4. Electrical Safety
   a. All of the following practices and procedures are generally accepted safety practices and should be observed at all times.
      i. Equipment shall be properly grounded.
      ii. All switch boxes, junction boxes, wires, and conduits must be properly covered or closed.
      iii. Wire and cords that are defective, inadequate, worn, frayed, wet, oily, or have deteriorated insulation, must be replaced.
      iv. Defective switches, receptacles, extension cords, lamp sockets, tools, or equipment must be repaired immediately or properly marked and made inoperable.
      v. All stationary and portable electrical tools must be properly connected and grounded according to manufacturer's specifications (except double insulated tools).
      vi. Ground Fault Circuit Interrupters (GFCI) must be used.
      vii. Broken housing and loose or vibrating machine parts must be replaced before equipment is used.
      viii. Electrical panels, switch boxes, motors and other electrical equipment must never be cleaned with water or dangerous solvents.
      ix. Never overload circuits or overuse circuits by using the wrong size or type of fuse.
      x. All equipment or circuits being worked on or repaired must be locked out or otherwise de-energized and tagged.
      xi. All installation or extension of electrical facilities must comply with the National Electrical Code.

xii. Heavy duty, grounded extension cords designed for industrial services only must be used.
xiii. Extension cords must never be used to operate stationary equipment or other permanent operations.
xiv. Clearance of 30 inches and clear access must be maintained around all electrical panels.
xv. Work practices, which overload motors, insulation, wires, or electrical accessories, must be avoided.
xvi. Electrical cords must be disconnected by pulling on the plug, not the cord.
xvii. All switch panels, circuits, outlets and boxes at the warehouse and office must be utilized for all electrical installations.

5. Generator Safety
   a. Generators rather than the client's home electrical supply should be used on the job site.
   b. Generators should be grounded with a ground rod driven into the ground.
   c. Generators must not be used in any enclosed area, including the back of the weatherization truck.
   d. Exhaust from the generator must always be released to the outdoors and away from the home.

45100 Hot Weather Precautions

1. If proper precautions are taken, the vast majority of heat problems can be avoided. When working in high temperatures, drink large quantities of cool water (10-15 glasses a day). Eat light, easily digestible foods.
   a. Whenever possible, take turns when blowing insulation in the attic. Do not spend more than 15 to 20 minutes at a time in the attic. If dizziness occurs, get out of the attic immediately.
   b. Plenty of cool water and salt tablets (for those permitted to take them - be sure you know if any worker has high blood pressure) are the best prevention against heat related problems.
   c. Attic work should be started and finished early. Predetermine the temperature at which the work in the attic will stop.
   d. Be sure that work in an unvented attic does not begin until the vent openings are cut. It is mandated that each crew have an electric fan to aid in the ventilation of the attic.
   e. Familiarize yourself and fellow workers with the symptoms of heat stroke, heat exhaustion, and heat cramps. (Discussed below).
   f. Mandated protective equipment such as hard hats, goggles, respirators, and long sleeve shirts, although uncomfortable, must be worn while insulating work is being done to prevent short-term

and possible long-term problems to the eyes, skin and lungs. When insulating in hot weather, limit time in the attic and drink plenty of water.

2. Heat stroke is a life threatening condition. Someone suffering from heat stroke becomes dizzy and then quickly loses consciousness. They may have a severe headache before they lose consciousness. Their face will be red and the skin will be hot and dry. There will be no perspiration. The pulse will be strong and rapid and breathing will be labored and the pupils of the eyes will be dilated.
   a. Get medical help at once!
   b. Treatment: lower the body temperature as soon as possible. Get the person to a cool place and elevate their head to reduce the flow of blood to the brain.
   c. Remove most of the person's clothing and cool the body using a wet sheet, water, or whatever is on hand. Rub the body and head with ice if it is available.
   d. Continue the treatment until consciousness returns or the temperature returns to normal. Watch for signs of shock and treat accordingly.
   e. Give the patient all the cool water he wants, but no stimulants.
   f. If the person becomes hot and dry again, renew the cold application.
3. Heat Exhaustion: Heat exhaustion is a state of collapse from the effects of heat. It happens more often when the humidity is high. The person feels very weak and will probably vomit. They may feel chilly. The pulse is rapid and weak and breathing is shallow.
   a. Get medical help at once!
   b. The treatment is the same as for shock. Place the person with their head lower than the rest of their body. The mouth should be cleaned and the body covered. Apply cold compresses.
   c. Give salt in the form of a tablet or a pinch of salt in a glass of water. If the person vomits, do not give any more fluids.
   d. A person that has suffered from heat exhaustion should not work for a few days.
4. Heat Cramps: Heat cramps are painful muscle spasms that happen most often in the abdomen, arms, and legs. Heat cramps occur while doing hard work in high temperatures without taking any precautions. They may be slight or convulsive and may last a few minutes to 24 hours. After being relieved, the spasms may be renewed by exposure to a cold draft or exertion. Loss of salt from muscle tissue is the main cause of heat cramps.

45110 Cold Weather Safety Precautions

1. The following are recommended cold weather practices and precautions.
   a. Agency personnel should pay particular attention to weather forecasts in the winter season. This enables work to be scheduled according to changes in the weather and to alter clothing accordingly.
   b. Proper clothing is extremely important in the winter. Crew members should be supplied hard hat liners and two sets of warm winter gloves. They should also be encouraged to use insulated boots with a non-slip tread.
   c. For warmth, several layers of light clothing are recommended instead of thick bulky clothing, to allow for freer movement. A pair of insulated coveralls is a good idea.
   d. All crew members should be made aware that strenuous work for long periods of time is dangerous because the body does not think it is as tired as it really is. Work should be done in short intervals to prevent exposure and overtiring.
   e. Trips in and out of the house should be kept to a minimum to prevent cooling of the dwelling unit, exposing the client to the cold, and tracking snow and mud into the dwelling.
   f. Power tools should be used with extreme caution due to the possibility of electrical shock caused by wet feet, wet ground, and bad footing.
   g. Blower machines should be protected from the weather by elevating them on blocks, placing them on dry plywood or lumber, or placing them in a dry covered area (porch, step van, garage, etc.).
   h. All tools and equipment with motors should be warmed up prior to use.
   i. Care should be taken in the placement of extension and power cords.
   j. Exercise extreme caution and sound judgment concerning ladder work on extremely windy days.
   k. Ladders should be dug into the ground to provide a non-slip footing.
   l. Taking frequent breaks and drinking plenty of warm liquids will keep you warm and help prevent sickness.
   m. Be especially aware of the symptoms of frostbite and hypothermia.

45120 Fire Safety – Office, Warehouse, and Vehicles

1. The following safety practices are critical to prevent the risk of fire in the office, warehouse, and vehicles.
   a. Provide and properly mount approved fire extinguishers in vehicles, warehouses and offices. Multi-purpose dry chemical units are most effective for general use. Multi-purpose dry chemicals can damage delicate electrical equipment. Gas type extinguishers eliminate that problem. Halon 1211 is more effective and less costly than CO_2 for extinguishing electrical fires.
   b. Inspect and test fire extinguishers at regular intervals to ascertain that they are fully charged and in proper working condition.
   c. When storing flammable liquids, observe the following:
      i. Limit supply to small amounts. Keep flammable liquids on hand only if absolutely necessary.
      ii. Store flammables properly in airtight metal cans and in well ventilated areas. Make sure all containers are labeled.
      iii. Dispose of them safely in metal containers with tight lids. Discard them as soon as possible.
      iv. Clean up spills or leaks promptly.
   d. Never smoke around flammable liquids. Even a tiny spark or ash can cause a fire or explosion.
   e. Provide instruction to agency personnel in the location and the proper use of fire extinguishers and other fire fighting equipment.
   f. Segregate oxidizers and oily materials in storage.
   g. Provide Underwriters Laboratories Listed or oily waste containers for oily and paint soaked rags. It is a good policy to place waste with spontaneous combustion potential in water filled containers.
   h. Post fire alarm and evacuation procedures.
   i. When possible, prohibit use of flammable liquids for cleaning purposes.
   j. Provide for bulk storage of flammable materials in an area removed from agency facilities.
   k. Agency personnel should be aware of the location of emergency shutoff valves and switches in the event of a fire.
   l. Do not stack materials within 30 inches of sprinkler heads.

45130 Power Tool Safety

1. Be aware that improper handling and operation of power tools can cause very serious injuries and possibly death. See also the Electrical Safety and Equipment Safety subsection.
   a. Always use a properly grounded Ground Fault Circuit Interrupter.
   b. Remove jewelry, eliminate loose clothing, and confine long hair.

c. Be sure there is enough light to do the job safely.
d. Keep all safety guards in position and wear protective equipment. Eye protection is always in order.
e. Be sure to use grounded plugs or double insulated power tools.
f. When cords become damaged, they must be replaced.
g. Never operate power tools with an unclear head.
h. Never operate power tools unless you are thoroughly familiar with the controls and operations. When in doubt, consult someone who is familiar with them.
i. All power tools should be carefully inspected regularly. Look for frayed or bare wires, dirt and dust in the tool, and a tight connection of the cord.
j. Make sure that the blade or bit is tightly clamped to the chuck.
k. Make sure that the power switch on the tool is off before connecting it to the power sources.
l. While operating a power tool, give it your undivided attention.
m. Keep cutting pressure constant and do not force the blade or bit into the material.
n. Do not operate power tools with dull blades and bits. This can result in serious injury or lessen the life of the power tool.
o. Do not distract or in any other way disturb a person using a power tool.
p. Never try to clear jammed power tools until you disconnect the power source.
q. After using a power tool, turn the power off and remove the plug from the power source. After tool movement has stopped, clean the tool before putting it away.
r. When using an extension cord, always plug the tool into the extension cord before the extension cord is connected to the power source. Break the connection between the extension cord and the power source before disconnecting the tool from the extension cord. The tool cord and extension cord should generally not be longer than 25 feet each to guard against overheating.
s. Be sure that power cords do not come in contact with sharp objects.
t. Tool cords and extension cords should be long enough so that they do not need to be pulled tight.
u. Cords should be checked often to detect overheating. If a cord is uncomfortably warm, then something is not right and warrants inspection by a qualified person.
v. Make sure that cords are lying so that they do not interfere with other workers.

w. Electricity must be regarded with respect and handled properly. If there is water in the area extreme caution must be observed. Water will greatly increase the chance of grounding and shock.
x. Workers must always report any shock received from electrical equipment no matter how minor the shock might be. Minor shocks can lead to fatal shocks.

45140 Hand Tool Safety

1. Hand tools are sometimes taken for granted but are used more often than other tools and equipment. The following are safety practices concerning the use of hand tools on the job.
   a. Establish regular tool inspection procedures to ensure that hand tools are maintained in a safe condition. Dull blades, broken screwdriver blades, cracked handles or loose heads can cause injuries.
   b. Use good quality tools instead of cheap ones.
   c. Keep hand tools in a safe place. Tools left lying around can get stepped on and broken or become a tripping hazard.
   d. Do not lay a tool near power tools in use.
   e. Do no put sharp objects or tools in pockets of clothes. This could result in being stabbed or cut.
   f. Use the proper tool for the job.

45150 Ladder Safety

1. The following safety practices for using ladders are particularly critical due to the potential of serious injury when working with ladders.
   a. Ladder levelers and stabilizers are to be used on all straight and extension ladders.
   b. Regular inspection of ladders is required in order to find bends and cracks that could weaken the ladder.
   c. Regularly check the shoes at the bottom of the ladder to see that they are intact and secure.
   d. Ladders must not be placed on boxes, barrels, or other unsuitable bases to obtain additional height.
   e. Ladders are to be stored horizontally on the floor or on supports to prevent sagging.
   f. The rungs are to be kept in a non-slippery condition.
   g. Follow the "Rule of Ten": Keep ladders at least ten feet from power lines running into the house.
   h. Brace the ladder when you are raising it. Walk forward under the ladder, grasping each rung until it is upright. Use part of the

house or have another person brace the ladder. Make sure the ladder will clear wires and trees.

i. Special precautions should be taken when erecting and climbing a ladder on a windy day.
j. Set the base of the ladder out one foot from the house for every four feet up.
k. No ladder should be used to gain access to a roof or any other elevated position unless the top of the ladder shall extend at least three feet above the point of support.
l. Make sure the parts of the extension ladders overlap enough.
m. Have another worker hold the ladder if the ladder is extended over half of its closed length or there is a question as to its stability.
n. Be sure that your shoes are not greasy, muddy or slippery before climbing.
o. Always face the ladder when climbing up or climbing down.
p. Keep your belt buckle between the ladder rails. Do not overreach. Moving the ladder is more sensible than a possible serious injury.
q. If materials are to be carried up and down a ladder, carry them with the front end elevated.
r. Carry tools in a tool belt. Use both hands for climbing up and down.
s. Do not climb higher than the third rung from the top on straight or extension ladders.
t. Do not climb higher than the second tread from the top on stepladders.
u. Block and guard ladders when they must be placed in driveways or on walkways.
v. Never drop a ladder; the stress can weaken the ladder.

45160 Pests in the Attic and Crawl space

1. If you encounter bees, wasps, and other flying insects:
   a. Find out if anyone in your program is allergic to bee stings. If so, have them obtain an anti-venom kit from a local drug store and instruct them to have it with them at all times while on the job.
   b. If a person on your crew is allergic to bee stings, it is important that this person is alerted if an unseen nest is disturbed so that they can move to a safe distance from the swarm.
   c. It is possible that a person may not know that they are allergic to bee stings. The symptoms of an allergic reaction are faintness, nausea, and/or shortness of breath. If a person is experiencing these symptoms - GET MEDICAL HELP AT ONCE.

d. If a dwelling is known to have a bee problem, plan ahead of time to exterminate the bees. This will allow the attic or crawl space to air out and prevent unnecessary inhalation of the insecticides used. Late in the evening or early in the morning while the bees are in their nest is the best time to exterminate.
e. For nests in the ground, pour oil, gasoline, or kerosene in and around the nest. Important: Do not ignite the fuel - the fumes are enough to kill the bees.

2. Rats and Mice
   a. Rats and mice are usually found where you find food scraps at open garbage bins.
   b. The client or landlord should be told to remove any harborage within 100 feet of the dwelling unit.
   c. The droppings are of major concern since contact with them can create infectious diseases. Soap will not cleanse harmful bacteria from the skin. A disinfectant towelette should be used.
   d. If a rat or mouse bites someone, medical attention should be sought immediately.
   e. If the infestation is particularly serious, notify the local Health Department.
3. Bats
   a. To remove bats from a dwelling, first tightly close any large openings and then caulk, pack, or cover with galvanized mesh all but the opening they use most; then wait until all the bats have left the attic and close the hole.
   b. Dried droppings are the major source of contamination from bats. When working around the droppings an aseptic mask should be worn and skin contact with droppings should be avoided by wearing rubber gloves. Wearing goggles can prevent contact through the eyes. If bats are present, gloves and heavy clothes should be worn to prevent possible bites.
   c. Bat bites are rare; however, if a crew member is bitten, a physician should treat them. An effort should also be made to obtain the particular bat.
   d. If the infestation is particularly serious, notify the local health department.
4. Snakes
   a. To eliminate snakes, eliminate harborage such as lumber piles, rock piles, and debris under porches and house.
   b. When working where the presence of snakes is a possibility, wear protective leg and foot covering and heavy gloves.

e. If a poisonous snake bites a person they should be transported to a medical facility at once, particularly, if that person was bitten by a rattlesnake. First aid should be administered immediately.
f. Poison control hotline telephone number is 800-222-1222.

45170 Safety in the Attic

1. The following considerations should be noted on the Weatherization Work Plan so that a worker can be aware of what he will be dealing with when preparing to do attic work.
   a. Is there a chimney or flue? If so, does it need a collar or dam?
   b. Are there exposed wires? If so, the client should be informed to have them replaced before insulating work can be done.
   c. Are there open electrical junction boxes? These will have to be covered with junction box covers.
   d. Are the ceiling joists strong enough to support a worker's weight?
   e. Are there recessed light fixtures? Never insulate over a recessed light fixture unless it is labeled “Type IC” (these double-housed fixtures are rated to be in contact with insulation).
   f. What type of pests might be encountered in the attic? Bees are usually encountered in an attic especially in the summer months. All programs should have an adequate supply of bee spray. Bats may be encountered and this constitutes a health problem. A person can still be infected by rabies from contaminated air. If bats are present the local Health Department should be contacted.
   g. Be aware of children and large animals such as dogs. You must remember that you are liable for the client's family safety as well as your own. Children may be injured by tools or by climbing on ladders. Advise the client to keep children out of the work area. If animals become a problem have the client remove them accordingly.
2. The following equipment should be used when working in the attic:
   a. Hard Hat.
   b. Goggles.
   c. Respirator.
   d. Gloves.
   e. Long pants.
   f. Lighting.
   g. Walking board(s).
   h. Fan(s) for ventilation.

3. Other attic precautions:
   a. Be aware of what you are doing at all time. Be aware of what is above you, behind you, to the sides of you, and below you.
   b. Be sure there is sufficient lighting and ventilation for the job you are doing.
   c. Be especially cautious in hot weather.
   d. Be aware of electrical service wires at all times.

4600 Client Health and Safety

The primary health and safety problems encountered by clients are related to combustion appliances, poor indoor air quality resulting from excess moisture, and electrical hazards that lead to injury and fire.

4610 Health Concerns of the Occupants

1. Crews need to take all reasonable precautions to consider the health concerns of each occupant in the home, the condition of the dwelling, and the possible effect of work to be performed on any particular health or medical conditions of the occupants. A person allergic to dust, for instance, should not remain in the home while insulation is being blown.
2. Smoke Alarms.
   a. Smoke alarms are to be installed whenever the crew works on any combustion appliance in the home. Smoke alarms should be installed on the same floor as the heating unit, and at least one on each floor of the unit near bedrooms.
3. Carbon Monoxide Alarms.
   a. Carbon monoxide (CO) alarms should be installed near any heating system where there has been a detected CO problem. A combination CO/smoke alarm is also an option to install when appropriate.
   b. All CO alarms installed shall comply with the latest Underwriters Laboratory standards (ANSI/UL 2034) or alarm at lower level.
4. Duct Cleaning and Sealing.
   a. All supply and return ducts must be sealed for energy efficiency and to prevent foreign particulates from entering and being blown into the conditioned space. Leaky ductwork can also create positive or negative pressures (depending on location of leaks in supply and return ducts) that can have an effect on the draft of combustion appliances.
   b. During weatherization work, ducts should be kept as clean as possible. Crews should clean the ducts around registers and replace furnace filters.

4700 Potential Hazard Conditions

4710 Biologicals

The detection and remediation of mold, odors, viruses, bacteria, unsanitary conditions, and rotting wood is often beyond the scope of the Weatherization Assistance Program, and may be a reason for delaying work. Since workers often encounter these conditions, they try to remedy the situation if possible and take precaution to not exacerbate any potential problem. Factors such as cleaning agents, paints and turpentine, gasoline, sewage, animal waste, and excessive dust can sometimes be addressed to allow weatherization work to occur.

4800 Moisture Remediation, Assessment, and Repair

4810 Mold and Mildew Problems

The use of DOE funds for the removal of mold and other related biological substances is not an allowable weatherization expense. Generally, DOE funds should not be used to test, abate, remediate, purchase insurance, or alleviate existing mold conditions identified during the audit/estimate, the work performance period, or the quality control inspection. Other funding sources should be sought to cover the cost of cleaning or cleaning moldy surfaces.

All homes shall be inspected for previous and existing moisture problems using the Mold Procedure/Checklist Form to assist in identifying mold and moisture related problems in homes.

In West Virginia, excessive moisture is often a problem. Common measures for dealing with potential moisture problems include:

1. Repair or installation of bathroom and kitchen exhaust fans;
2. Installation of ground moisture barriers of six mil black plastic under enclosed foundation mobile homes, houses receiving sidewall insulation, or any house with excessive dampness in the crawl space;
3. Repair or installation of dryer vents to be properly vented to beyond the perimeter of the crawl space or basement;
4. Installation of attic ventilation and crawl space ventilation, but only when appropriate;
5. Establishment of a Building Tightness Limit to ensure air sealing measures do not tighten the home beyond acceptable levels;
6. Installation of continually operating exhaust fans in extremely tight homes; and
7. Replacement of downspouts and/or gutter sections to divert moisture away from the dwelling.

4820 Energy Related Mold and Moisture

Moisture, mold, and mildew can seriously affect the health and safety of the client and crew. Steps must be taken to alleviate moisture problems. The West Virginia Weatherization Assistance Program shall ensure that regular weatherization work is performed in a manner that doesn't contribute to the increase of any mold problems, and when the work is performed properly, can alleviate many mold conditions.

The Weatherization Assistance Program is not a mold remediation program. The use of DOE funds for the removal of mold and other related biological substances is not an allowable weatherization expense. If necessary, Weatherization Assistance Program services may need to be delayed until the existing mold problem can be corrected or referred to another agency for funding of remedial action.

The most common sources of moisture are leaky roofs and damp foundations from ground water. Other moisture sources include unvented dryers; unvented gas appliances such as ranges or decorative fireplaces; and showers in bathrooms without exhaust fans. One of the largest sources of household water vapor is the occupants themselves, through respiration and perspiration. Therefore, the number of people in the home is an important factor. The type of climate in the region is also important. A region that has a lot of rain and humidity, like West Virginia, or extreme temperatures is more likely to have a moisture problem.

The following steps are recommended in addressing moisture problems within the West Virginia Weatherization Assistance Program:

1. Assessment of Moisture Conditions.
    a. All homes prior to weatherization shall be inspected for previous or existing moisture problems. Identifying and eliminating the sources of the moisture should be the first priority when a moisture problem is found.
    b. The Mold and Moisture Assessment Findings form shall be completed and given to the client and placed in the client file. Give special attention to the following areas:
        i. Look for evidence of condensation on windows and walls indicated by stains or mold. Inspect closets, especially those that are connected to outside walls. Clothes may need to be moved or removed in order to inspect the walls.
        ii. Check for any standing water, open sumps, open wells, or "wet weather springs", dirt floors, water stains, etc. in basements. Also, check to see if firewood is stored in any conditioned space or the basement and, with the client's permission, remove the wood to a sheltered space outside.

Ask the client if laundry is hung to dry indoors during the winter months.

iii. Check for leaking water supply lines or waste pipes.
iv. If there is a high efficiency furnace present, the condensate drain line should be installed in accordance with the HVAC installation standards.
v. Inspect to determine if attic roof sheathing shows signs of mold or mildew.
vi. Inspect the top plates of all walls and chase-ways while in the attic. Balloon frame type walls, or bypasses, if left untreated can move moisture from the basement or crawlspace directly to the attic.
vii. Inspect the structure for the possibility of a “roof over”. If a newer roof has been installed over an existing older roof, then the crew must extend plumbing or exhaust any vents to the outside pipes through the new roof and properly seal the penetrations.

2. Existing Moisture, Mold or Mildew - Denial of Service.
   a. If an existing moisture, mold or mildew problem is found, the agency must determine if the moisture problem can be fixed under the scope of weatherization or if there should be a Denial of Service because of the severity of the problem (typically 10 square feet or more of affected surface).
      i. If it is determined that the problems are too severe under the scope of weatherization, a Denial of Service form shall be signed at the time of inspection and left with the client and a copy placed in the client file.
      ii. Client education must be given to the client to inform them of the health and safety problems associated with mold or mildew and the possible self-help solutions they can perform at a later date.
      iii. The agency should try to refer the client to other programs or agencies that may be able to assist in resolution of the problem.
3. Existing Moisture, Mold or Mildew – Elimination under Weatherization.
   a. If an existing moisture, mold, or mildew problem is found and the agency determines that the job can be completed or cleaned under the scope of the Weatherization Assistance Program, then:
      i. The agency will have the client sign the Hold Harmless Statement informing the client of the existing problem(s), leaving a copy with the client and a copy in the client file.
      ii. Because air tightening may cause an increase in relative humidity, client education should include information about any adverse health effects if moisture problems are left untreated and also include possible solutions.

iii. A dwelling that has a CFM_{50} greater than the Building Tightness Limit is no guarantee that moisture will not be a problem in that home.
iv. The agency will repair or eliminate the moisture problem and weatherize the dwelling in accordance with program regulations.
v. Containment of the work area is not necessary if the affected area is less than 10 square feet of surface area. Vacating people from spaces adjacent to the work area is not necessary, but is recommended when children less than 12 months old are in the house. People suffering from any health conditions should be kept away from the area being cleaned.

4. Repair or Elimination of Moisture Sources.
   a. In the course of weatherization, measures that help reduce the humidity levels in the house may be installed. Examples of these measures are venting dryers to the outside, venting existing bath or kitchen exhaust fans or installing moisture barriers on dirt floors. Repair of moisture problems that might 1) result in health problems for the client 2) damage the structure over the short- or long-term, or 3) diminish the effectiveness of the weatherization measures, must be done before the weatherization job is completed.
   b. Moisture problems can be reduced or eliminated by controlling the source of the moisture. This can involve:
      i. Installing a ground vapor barrier of six mil black plastic on a crawlspace floor.
      ii. Venting dryers to the outside of the dwelling.
      iii. Sealing the foundation.
      iv. Providing positive drainage away from the foundation.
      v. Repairing the roof, flashing, gutter, and downspouts.
      vi. Educating the client about the sources of moisture that they are able to control.
      vii. Removal of unvented space heaters.
   c. Moisture problems can be reduced or eliminated by ventilating areas where excessive moisture is produced, such as bathrooms and kitchens. This should include installation of a high quality properly sized exhaust fan in the subject area and informing the client of the related moisture issues and the proper operation and use of the fan.

4830 Dryer Vents

1. Electric and gas dryers must always be vented to the outdoors.
2. Mobile home dryer vents must be extended through the skirting to the outdoors.

3. Dryer venting must be of rigid or flexible metal vent pipe. No more than two 90^{o} elbows may be used in the vent system. Flexible metal vent pipe may be used if it does not exceed six feet in length.
4. Gas dryer vent pipe should not be installed with sheet metal screws or other intrusive fasteners that will collect lint (according to NFPA 54).

4900 Building Tightness Limit (BTL)

The building BTL value shall be recorded on the cover page of the Work Plan. The calculated BTL value for the dwelling must be based on the ASHRAE 62-1989 requirements of 15 CFM per person and at least 0.35 air changes per hour. Refer to Section 6200 page 70 for Building Tightness Limit calculation.

41000 Ventilation Systems for Acceptable Indoor Air Quality

Acceptable indoor air quality is a high priority for the West Virginia Weatherization Assistance Program. Whenever a dwelling is tighter than the Building Tightness Limit (BTL), the installation and operation of continuous ventilation should be considered in order to comply with national indoor air quality guidelines. Additionally, even if a dwelling is looser than the BTL, ventilation installed to ensure acceptable indoor air quality is sometimes warranted. Examples of such unusual cases include houses suffering from sever moisture problems and houses with many cigarette smokers.

41010 Bathroom and Kitchen Exhaust Fans

1. Bathrooms should have a 50 CFM exhaust fan to remove moisture and odors from the room. This fan should be operated by an on-off switch or a timer switch.
2. Kitchens should have a 100 CFM exhaust fan to remove odors and cooking gases to the outdoors; a range hood fan is preferred. This fan should be operated by an on-off switch.

41020 New Systems, Intermittent Operation

1. Exhaust fans that are intended for on-demand operation include kitchen and bathroom exhaust fans in dwellings that may or may not be tighter than the calculated Building Tightness Limit. These fans are intended for occasional use during cooking, baking, showering, and other times when moisture and odors are created by household activities.
2. High quality exhaust fans should be used with appropriate consideration for noise levels (recommend 2.5 sones or less) and CFM rating for square footage being vented. Exhaust fans should be operated with a light switch when possible so they are in constant operation with minimum involvement from the client.

3. Exhaust system ductwork shall consist of galvanized metal, rigid aluminum, PVC, or aluminum flex duct. It is recommended that flex duct not be used in runs over 6 feet in length.
4. Exhaust system ductwork shall be extended through the roof or sidewall to the outside and be insulated.
5. Controls should be installed in the same room as the fan.

41030 New Systems, Continuous Operation

1. Ventilation systems are recommended in dwellings that are tighter than the calculated Building Tightness Limit (see Refer to Section 6200 page 70) or have a pre-existing moisture problem or other indoor air quality problem that cannot be corrected by any other means.
2. Ventilation systems are allowed in units that will receive substantial reductions in air leakage and, as a result, may develop moisture problems. Exhaust fans installed for these reasons should be operated continuously when the dwelling is closed up to the outdoor air during winter mechanical heating or summer mechanical cooling.
3. To properly size fans for dwellings that are tighter than the calculated Building Tightness Limits, refer to Section 6200 page 70.
4. Exhaust system ductwork shall consist of galvanized metal, rigid aluminum, PVC, or aluminum flex duct. It is recommended that flex duct not be used in runs over 6 feet in length.
5. Exhaust system ductwork shall be extended through the roof or sidewall to the outside and be insulated.
6. For continuously operated exhaust fans, controls may be by a push button switch, a separate on/off wall switch, or hard wiring with a remotely located switch. Controls may be installed in the same room as the fan. The exhaust fans should be located as close as possible to the center of the house.
7. When installing a continuously operating exhaust fan, educating the client about its use is extremely important. The client should be informed about:
   a. The purpose(s) of the exhaust fan installation.
   b. The importance of operating the fan whenever the house is closed up, such as during the heating season.
   c. The disadvantages of not operating the exhaust fan.

41040 Existing Exhaust Fans

1. Existing mechanical exhaust ventilation systems should be made operable or replaced if not working.

2. Existing mechanical exhaust ventilation systems should be made to terminate outside the dwelling by extending the ventilation duct through the roof or sidewall.
3. Replacement exhaust system ductwork shall consist of galvanized metal, rigid aluminum, PVC, or aluminum flex duct. It is recommended that flex duct not be used in runs over 6 feet in length.

41050 ASHRAE Standard 62.2

Ventilation and other indoor air quality measures may be based on *Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings* (ASHRAE Standard 62.2-2007) instead of *Standard for Acceptable Indoor Air Quality* (ASHRAE Standard 62-1989).

41100 Unsanitary Conditions

Unsanitary conditions, including raw sewage, are sometimes encountered. Traditionally, crews have done their best under the circumstances to proceed with weatherization work. If the conditions would endanger either the crew or client if work were performed, the job may be deferred until such conditions can be corrected.

41200 Combustion Appliances and Combustion Gases

1. Combustion Safety Tests.
   a. With the integration of blower door technology and dense-pack sidewall insulation, houses are being sealed tighter than ever before. In accordance with the "house-as-a-system" approach to weatherization, we recognize that there can be existing indoor air quality conditions that may be intensified by current air sealing techniques. Therefore, the following health and safety measures must be performed on all combustion appliances of homes to be weatherized:
      i. A CO test of undiluted flue gases must be done on all vented combustion appliances. If a CO level above 100 ppm as-measured is found in the undiluted flue gas sample, corrective action must be taken to reduce the CO to acceptable levels. If readings are detected above the minimum levels, no weatherization work is to be done until the problem is corrected.
      ii. An ambient air test for CO must be taken on coal, wood, unvented heaters and gas cook stoves. If any ambient level of CO above 9 ppm is found, the source must be identified and the problem corrected.
      iii. A gas leak detection test must be taken on all natural and LP gas appliances and supply lines. All gas leaks must be

repaired before any work is done. Oil supply lines and components must also be checked for leaks.

iv. A draft test on all vented natural gas, LP gas and oil appliances must be performed to ensure an adequate draft.

v. An inspection of the vent system must be completed to ensure that the proper size and type of pipe is used, the condition of the vent pipe is satisfactory, the clearance meets applicable codes, and the vent system is unobstructed.

vi. Test for backdraft and the potential for flue gasses to spill into the living space.

vii. Identify the combustion air source and make sure it is unobstructed and sufficient, as defined by NFPA code.

b. A detailed description of these tests and the methods and techniques for resolving them appears in the Installation Standards section of the Program Operations Manual.

c. The local agency is responsible for any potential health and safety problems that will be compounded if prescribed conservation measures are installed. For example, if a furnace is emitting unacceptable levels of CO, it is likely that tightening the home would increase the problem. Therefore, this problem must be fixed before any air sealing is done.

2. Hold Harmless Statements.

   a. If some measures are too costly for the program to absorb, or outside the realm of normal Weatherization Assistance Program practices, they must be identified and explained to the client. A Hold Harmless statement can be signed to allow weatherization work to begin. An example of such a case is a single wall vent that is drafting correctly, but the code calls for a double wall vent. In summary, the Weatherization Assistance Program may not be able to afford complete renovations of the heating system to ensure the entire system is up to code. Any installations made by the Weatherization Assistance Program, however, will be made according to NFPA and NEC codes.

3. Unvented Space Heaters.

   a. A dwelling utilizing an unvented space heater as the primary heating source cannot be weatherized.

   b. In such cases, the Letter of Program Services Denial or Delay Due to Site Conditions must be signed by the client.

   c. The estimator must explain the consequences of using an unvented space heater to the client.

   d. When the client has agreed in writing that they understand the policy and will not use the unvented space heater, weatherization may commence. A completed Hold Harmless Statement must be in the file stating that the client understands the dangers of using

the space heater and agrees to use it only if there is a power outage and that they understand that they must provide combustion air to the heater.

41300 Fire Hazards

1. Combustion Appliance Clearances.
   a. Crews must check for adequate clearance of space heaters, furnaces, and vents from combustible materials. If the clearance is not sufficient, corrective action must be taken insuring all applicable NFPA codes are followed.
2. Solid-Fuel Appliance Checklist.
   a. The Solid-Fuel Appliance Checklist addresses safety issues, including fire hazards, from wood and coal stoves. Issues relating to the stove, stove pipe, and chimney are addressed.
3. Carbon Monoxide and Smoke Alarms.
   a. Carbon monoxide and smoke alarms are to be installed on every floor of the dwelling, preferably close to the heating source and outside of bedrooms. Client education must be included to ensure they clearly understand how and when to change batteries and safely maintain the alarms(s).

41400 Existing Occupant Health Problems

Agencies should attempt to identify any health problems and allergies of a dwelling's occupants prior to weatherization work, with an objective to ensure that work will not exacerbate any problems.

41500 Existing Indoor Air Quality Problems

1. Asbestos pipes.
   a. In the West Virginia Weatherization Assistance Program, asbestos on pipes is relatively rare because there are few boiler systems in the program housing stock. Dealing with asbestos pipes is beyond the responsibilities of program crews, and they are instructed to avoid contact with the pipes. If the condition of the asbestos is deteriorated enough to pose an immediate safety problem in the area, the agency can defer services until the problem is rectified.
2. Asbestos siding.
   a. When house siding is expected of containing asbestos, crews shall not drill through the siding. In this case, the crew will attempt to blow the sidewalls from the inside.
3. Radon.
   a. There are few instances of previously identified radon problems in the housing stock of the West Virginia Weatherization Assistance Program. Program crews do not test for radon. Common

practices such as installing 6-mil plastic ground vapor barriers and installing crawl space venting may help mitigate any existing radon problems.

4. Formaldehyde and Volatile Organic Compounds (VOCs).
    a. Crew awareness of potential problems with formaldehyde and volatile organic compounds is important when addressing air sealing. Crews are instructed to remove any VOCs when possible and to give client education regarding the potential dangers. Crew supervisors are given the flexibility to raise air tightness limits if warranted. If air tightness standards are increased, the reason for the increase must be included in the client file.

41600 Lead-Safe Weatherization (LSW)

Each subgrantee must give notification to the occupants of homes to be weatherized regarding the potential hazards of lead-based paint and lead-based paint dust if the home was built prior to 1978. For homes weatherized after December 22, 2008, EPA's new publication "Renovate Right: Important Lead Hazard Information for Families, Child Care Providers and Schools" must be given to an adult occupant of the affected home. For occupied homes, the Weatherization staff, crew, or contractor must have an adult tenant or homeowner sign an acknowledgement after receiving the pamphlet. The pamphlet can also be sent by certified mail with receipt to be placed in the client file.

Lead-Safe Weatherization (LSW) includes weatherization worker protection, general LSW work practice standards, and lead dust containment standards. Please refer to the latest weatherization program standard for details.

1. Level 1 Containment.
    a. Level 1 containment is required in pre-1978 homes when less than 6 ft^2 of interior painted surface per room or 20 ft^2 of exterior painted surface will be disturbed.
    b. Level 1 containment consists of methods that prevent dust generation and contains all debris generated during the work process. The containment establishes the work area which must be kept secure.
    c. Measures that may fall within this guideline include:
        i. Installing or replacing a thermostat.
        ii. Drilling and patching test holes.
        iii. Replacing HEPA filters and cleaning HEPA vacuums.
        iv. Changing furnace filter(s).
        v. Removing caulk or window putty (interior).
        vi. Removing caulk or window putty (exterior).
        vii. Removing weatherstripping.
2. Level 2 Containment.

a. Level 2 containment is required when weatherization activities will disturb more than 6 ft^2 of interior surface per room or 20 ft^2 of exterior surfaces in homes built prior to 1978. Level 2 containment consists of methods that define a work area that will not allow any dust or debris from work area to spread. Level 2 containment requires the covering of all horizontal surfaces, constructing barrier walls, sealing doorways, covering HVAC registers with approved materials, and closing windows to prevent the spread of dust and debris.
b. Measures requiring level 2 containment may include:
    i. Drilling holes in interior walls.
    ii. Drilling holes in exterior walls, removing painted siding.
    iii. Cutting attic access into ceiling or knee walls.
    iv. Planning a door in place.
    v. Replacing door jambs and thresholds.
    vi. Replacing windows or doors.
    vii. Furnace replacements.
c. Exemptions:
    i. If there is documentation that the dwelling has been certified as lead-free. This documentation must be:
        1. A written determination by a certified lead inspector or risk assessor; or
        2. Test results from an EPA-recognized test kit; or
        3. Documentation of a State-approved lead-based paint test protocol, e.g., XRF scans.
    ii. Pre-1978 mobile homes with paneling that was not painted by the manufacturer, occupant, landlord, or past owner of the unit before 1978. For an exemption to apply, it must be verified that areas receiving weatherization have never been painted or were painted for the first time after 1978.
    iii. If the owner signs a statement that ALL of the following apply:
        1. No pregnant woman resides the dwelling; and
        2. The dwelling is not a child-occupied building.[4]
    iv. Housing for the elderly or persons with disabilities.
    v. Any dwelling with no bedrooms.
    vi. Work is performed by the client (do-it-yourself work).
d. Level 2 containment must ALWAYS (<u>above exemptions do NOT apply</u>) be used where any of the following is conducted (even if

[4] ". . . occupied" includes being the child's primary residence or a home that is visited regularly by the same child, under age 6, on at least two different days within any week (Sunday through Saturday period), provided that each day's visit lasts at least 3 hours and the combined weekly visits last at least 6 hours, and the combined annual visits last at least 60 hours. (Lead Safe Weatherization (LSW) – Additional Materials and Information, Weatherization Program Notice 09-6, Effective date: January 7, 2009, page 2).

the activities will disturb less than the hazard levels within the Level 1 category):

i. Window replacement.
ii. Demolition of painted surface areas.
iii. Using any of the following: Open-flame burning or torching; machines to remove paint through high-speed operation without HEPA exhaust control; or operating a heat gun at temperatures at or above 1100 F^{O}.

3. There must be adequate documentation in the client file to demonstrate that lead-safe weatherization measures were performed when necessary. Documentation should include photos of the site and containment set up, as well as a listing of materials used and measures taken. Post work inspector must also certify that LSW procedures were used and properly implemented.
4. West Virginia WAP will adhere to EPA lead-safe rules as written in the "Lead; Renovation, Repair, and Painting Program" Final Rule (LRRPP Final Rule), as directed by DOE. Details of the rule are in the process of being finalized at the release of these Weatherization Standards, but are expected to be fully implemented by April 2010.
5. Weatherization of HUD program housing stock, including HUD Section 8, is infrequent in West Virginia. These units will only be weatherized if HUD will provide certification that abatement or control of any lead-based paint hazard has been addressed, and will agree that the local agency will not be liable for any lead hazards, provided the safe work practices generally outlined above are employed.
6. Subgrantees are not to weatherize homes where there are suspected or known lead-based paint hazards and there are any cases of documented or suspected lead poisoning. Additionally, they shall not weatherize homes where there is an extraordinary lead-based paint hazard and there are no means to abate the hazard, including insufficient funds or insufficient training to properly address the hazard.

41700 Building Structure

1. West Virginia Weatherization Assistance Program crews often encounter homes in poor structural condition. In some cases, Weatherization Assistance Program services have to be postponed until the dwelling is made safe and able to weatherize. Sometimes agencies coordinate their efforts with other programs to enable and enhance services. Too often, there is no other recourse for the home, and Weatherization providers are forced to do the best they can under the circumstances. Often the Weatherization Assistance Program is the referred agency for homes in dire need of repair. Incidental repairs up to $250 materials can be provided. Sometimes air sealing and health and safety measures can also be considered

building structure repairs; examples include patching a floor or wall and repairing a chimney.

2. Typical structure repairs performed by Weatherization crews include:
   a. Sealing minor roof leaks;
   b. Minor floor, wall, and ceiling repair;
   c. Window and door casings; and
   d. Minor chimney repair.

41800 Electrical Issues

1. Knob-and-tube wiring.
   a. Where live knob-and-tube wiring exists, the following conditions must be met in order to install attic insulation:
      i. Wiring insulation must be intact and complete with no exposed areas and connections.
      ii. S-type fuses that match the size of the wiring must be installed if they do not already exist. Any modification of the electrical panel must have prior written permission from the client. The agency may wish to contract with a licensed electrician where questionable safety conditions exist.
      iii. When installing cellulose or fiberglass, there must be a minimum of 1-inch clearance from the wiring. With cellulose precaution must be taken to prevent the possible drifting of the product, which could result in contact with the wiring.
   b. The presence of knob-and-tube wiring, overloaded circuits, live bare wires, asbestos siding, or untreatable moisture in the wall cavities will be allowable reasons for not insulating exterior walls. If the problems can be corrected within reasonable means, the walls may be insulated.
2. Other standards related to electrical safety include:
   a. Junction boxes must be covered and their locations indicated on the rafters above before insulation is installed.
   b. Inspect the electrical wiring to determine type(s) of wiring present, its condition, routing, and circuit protection.
   c. Over-fused circuits should be corrected by installing the appropriate size circuit protector matched to the wire gauge. The following protection is required:
      i. Not more than 15 amps for #14 wire.
      ii. Not more than 20 amps for #12 wire.
   d. If the circuits continue to trip the breakers or blow fuses, work should be deferred until the problems can be corrected.

41900 Refrigerants

Most, but not all agencies have at least one crew worker with EPA-approved section 608 type 1 certification. Several agencies have workers who are type 2

certified to work on heat pumps and add-on air conditioners. No work involving any refrigerant recovery will be done by anyone not having the appropriate EPA certification. EPA certification courses are offered periodically at the Training and Energy Services Center.

42000 Other Code Compliance Issues

All installations involving combustion appliances must be done according to applicable NFPA codes. The Weatherization Assistance Program is not always able to bring all combustion appliances up to code. If this is the case, explain the situation to the client.

The National Electric Code is also applicable for the West Virginia Weatherization Assistance Program in appropriate situations and installations.

42100 Deferral or Denial of Service

There are some health and safety conditions that, until ameliorated, make weatherization of some dwellings unfeasible. In such cases, work for qualified applicants must be deferred, or even denied. Weatherization agencies must attempt to resolve such issues, as well as pursue reasonable options on behalf of the client, including referrals.

While program workers have been historically reluctant to defer or deny services, it should be remembered that most agencies have a very long waiting list of approved applicants, and there are typically many homes on the waiting list that are suitable, adaptable, and in dire need. This statement being made, it must be the goal of weatherization agencies to do all that is reasonable within their means to overcome problems and provide program services.

The West Virginia GOEO has devised a standardized form for deferral or denial of services. Agencies should modify the form as needed for their particular circumstances. A significant part of this deferral or denial policy is based on health and safety considerations.

42200 Exceptions

1. Diagnostic equipment or test procedures should not be used in or on dwellings where such equipment or testing could exacerbate existing problems or pose a threat to the health of occupants.
2. In all cases, it is the estimator’s responsibility to determine if a condition exists that could cause any diagnostic equipment or test procedure to be potentially harmful to clients or weatherization personnel.
3. If the potential exposure can be eliminated by varying the test procedure while still achieving reliable results, doing so is permissible and encouraged. For example, in a home with possible airborne pathogens, pressurizing as opposed to depressurizing during the

blower door test should garner the necessary data safely. If no viable alternate test procedure exists, elimination of the test in question is allowable in the subject home.

4. All required testing shall be done to the extent allowed by law.
5. Documentation in the client file is required regarding any of the above exceptions.

5000 Client Education

5100 Client Education Recommendations

1. Client education should be provided during all phases of the weatherization process. This includes, but is not limited to:
   a. During client intake and scheduling, education should cover:
      i. What the client should expect.
      ii. How the weatherization process will proceed.
      iii. Who will call next and/or what will happen next.
   b. During the initial field inspection, education efforts should cover:
      i. What the client should expect during the inspection.
      ii. Air leaks discovered with the blower door.
      iii. An explanation of any appropriate health and safety issues, such as:
         1. Lead-based paint.
         2. Asbestos.
         3. Combustion venting.
         4. Carbon monoxide.
         5. Mold and mildew.
         6. Plumbing leaks.
         7. Animal hazards such as rodent feces or insect infestations.
         8. Other possible hazards.
      iv. An explanation of energy conserving measures that will be installed, including:
         1. Air sealing.
         2. Addition of insulation.
         3. Heating and cooling system improvements.
         4. Water heater improvements.
         5. Baseload measures.
      v. Improvements in thermal comfort in the dwelling as a result of the weatherization.
      vi. Explanation of gas range safety and use.
         1. The holes in the oven bottom must never be blocked with aluminum foil or anything else. Storing too much in the broiler or drawer area under the bake oven can also block the vent holes. This blockage can result in unacceptable carbon monoxide emissions.
         2. Do not use the range-top burners or the oven burner(s) as a space heater. Manufacturers recommend against such use; gas ranges are not designed for this.

3. An existing CO alarm should be maintained properly. If a new CO alarm will be installed as part of the weatherization services, explain the proper use and maintenance.
4. Have the range checked and tuned once every four years by a technician with an instrument capable of measuring carbon monoxide. This checkup and tuning should include: Testing of the range's gas pressure and making all necessary adjustments for the acceptable operation of all burners. The level of carbon monoxide emissions from a burner can only be determined with an instrument that measures CO; it cannot be determined by visual inspection of the flames.
5. The oven should be kept clean at all times. There is evidence that dirty ovens emit more CO than clean ovens.
6. The flames from gas burners – both natural gas and propane – should burn steadily with a clear, blue flame. The flame normally makes a slight hissing sound, but it should not sound like a blowtorch. If the flames burn yellow and/or burn loudly or irregularly, the gas range should be serviced as soon as possible. Avoid using a bad burner until it is properly adjusted or repaired.

vii. An explanation of required maintenance for existing equipment, added equipment, or energy-saving measures.
1. All oil-fired heating units should be cleaned and tuned once every year.
2. All gas-fired heating units should be cleaned and tuned once every three years.
3. Inform client how to replace filter in heating and/or cooling air handler.

viii. What will take place after the initial inspection:
1. Order of events and when they will take place.
2. Who will contact client next.
3. When the work will be complete.

ix. What the client must do to prepare for the weatherization work.
1. Movement of stored items to make room for the weatherization work.
2. Other client participation that must take place before the weatherization work begins.

c. The installation and repair of conservation measures.
    i. Those installing weatherization measures should always take advantage of client education opportunities, if feasible. Such opportunities may include explaining how and why a measure is being installed and how the measure will reduce the client's energy bill and enhance thermal comfort.

d. The final job inspection.
    ii. The inspection personnel should reinforce the advantages of the energy-saving measures installed.
    iii. The client should always be asked if they have any remaining questions regarding the weatherization or health and safety work that was done.
    iv. The inspection personnel should explain to the client how the dwelling will perform differently as a result of the installed weatherization measures.

2. Whenever possible, demonstrate to educate. Get the client involved in the educational process, if possible. Work to establish the trust and respect of the client; this will make educational efforts more effective.
3. The use of up-to-date written materials is encouraged for client education, but demonstration has proven to work better in most cases.

5200 Certified Energy Educator

1. Each subgrantee will identify at least one Energy Educator, who attends a day long training utilizing role-playing, participation, and discussions to acquire the skills to establish an effective means of communication between the Energy Educator and the client. After passing a certification test, the Energy Educator will work with clients to affect change in bad energy conservation habits.
2. The Energy Educator will utilize a tabletop easel with energy saving tips and maintenance tips for weatherization measures. The process is intended to be interactive between the Energy Educator and client.
3. A key element of the process is a "contract" called the Energy Saver's Partnership Plan, where the client agrees to do certain actions to conserve energy in their home. The Energy Educator will follow up in two months to help ensure the "contract" is being heeded.

5210 Energy Education Certification Form

The first section of the Energy Education Certification Form is used to document that an energy educator reviewed energy saving issues with the client. The second part of the form is a checklist to record the energy saving information and tips discussed with the client, and to review measures that were performed on the dwelling.

5220 Energy Savers Partnership Plan

The Energy Saver's Partnership Plan is an agreement between the local agency and the client outlining what the Weatherization Assistance Program will do/did to save energy in the dwelling, and in turn, what the household agrees to do in regards to energy saving tips and preserving the weatherization measures. The form is intended to encourage the household to be more concerned with energy efficiency and understand why it will benefit them.

5230 Certified Energy Educator Activities with the Client

1. The certified energy educator from the agency should make an appointment to visit the client.
   a. It is strongly recommended that the educator visit the client just before the weatherization work is completed. This is the most effective time for client education.
   b. If it is not possible to schedule the education visit before the weatherization work is completed, the visit should be scheduled within three days after the work is completed.
2. The educator should spend time developing a trusting relationship with the client. Other important activities with the client include:
   a. Discussion of the weatherization and health and safety work done on the client's home.
   b. Demonstration, if possible, of any of the work done or of energy-saving measures in which the client can engage.
   c. Presentation using the Energy Education flip chart.
   d. With the client discuss, fill out, and sign the Energy Saver's Partnership Plan, suggesting two or three ways the client can commit to saving additional energy in their home. Leave a copy of this Plan with the client and make sure a copy is put in the client's file.
   e. Complete the Energy Education Certification and make sure it is put in the client's file.
   f. Discuss Client Education brochure and leave with the client. This brochure is a brief summary of the Energy Education flip chart.
3. It is recommended that the educator visit the client again in two to three months to check on the client's progress on the partnership agreement and reinforce the client education.
   a. Discuss with the client the Energy Saver's Partnership Plan agreement and their progress.
   b. Complete the Client Education Follow-Up Report and make sure it is put in the client's file.

6000 Air Sealing

6100 Air Sealing Requirements

Before air leakage reduction measures are installed, the air barrier and thermal boundaries of the building enclosure must be defined and existing health and safety problems must be corrected.

During the air sealing process, a blower door should be set up so that the effectiveness of air sealing can be determined by measuring the reduction in the dwelling CFM_{50} value. This should be done at least two or three times during air sealing; at a minimum of once daily. Readings should be recorded on the Work Plan.

Usually, as air sealing work progresses, it becomes less cost-effective because the large leaks are sealed first. When it seems that the effectiveness of air sealing has diminished to a point below that which is cost-effective, the sealing work should stop. Refer to section 6200 on page 70 for further guidance on air sealing guidelines.

Prior to any work done on the dwelling, an “as-is” blower door test should be performed as a means of determining the initial CFM_{50} and locating air leaks.

Air sealing work on dwellings is of two types:

1. Primary air sealing. This includes:
   a. Any obvious air sealing. Examples include replacing window glass where glass is missing, and sealing large holes in the building envelope. There is little question that sealing or repairing these obvious leaks in the dwelling envelope will be cost-effective.
   b. Air sealing that must be done prior to other high priority measures, such as air sealing the attic floor before insulation is added.
2. Secondary air sealing. This is air sealing completed with the guidance of the blower door after all primary air sealing activities have been completed, and typically after attic insulation and dense-pack sidewall insulation have been installed. Further description is provided in Section 6600 on page 76.

6110 Blower Door Use Requirements

1. Pre- and post-weatherization CFM_{50} measurements must be completed on each dwelling unit and documented in each client file on the Work Plan. A one-point CFM_{50} blower door measurement is preferred over the multi-point computer-derived method.
   a. Pre- and post-weatherization blower door tests may be waived due to the following circumstances:
      i. Problems may be created in the unit due to a lack of structural integrity.
      ii. Solid-fuel combustion appliances are operating. Attempts must be made to have the client shut down a solid-fuel burning appliance approximately twenty-four hours before the pre-weatherization energy audit is conducted. Similar attempts must be made before the post-weatherization inspection if a blower door test will be required.
      iii. Suspected friable asbestos-containing material may be significantly disturbed. Friable asbestos is defined as material that easily crumbles into very small particles with very little force such as finger or hand pressure. Friable asbestos is more dangerous than hard asbestos because of its ability to release very fine fibers into air which lodge into nose, windpipe, and lung tissue.
      iv. Other documented extenuating circumstances.
2. Blower door testing should continue during air-leakage reduction work as part of blower-door-guided air sealing.

6200 Determination of Building Tightness Limit (BTL)

Using a blower door to detect air leaks, it is entirely possible to tighten a home to a level that creates a potential for indoor air quality or moisture problems. In order to decrease this likelihood, a Building Tightness Limit (BTL) needs to be determined for each home. Crews must take caution to avoid sealing the home below this limit. The BTL standards are found in this section.

The BTL standards are based on the ASHRAE Standard 62-1989, recommending a minimum of 15 CFM per person under natural conditions and at least 0.35 air changes per hour (ACH).

Other considerations for determining the BTL are:

1. All appropriate supply and return duct leaks must be cleaned and sealed if the pre-test CFM_{50} is below the established BTL. Duct leaks are sealed first to help ensure air sealing does not exceed the standard.

2. Likewise, if there are moisture or other indoor air quality problems that cannot be corrected during weatherization work, the crew supervisor must use caution and judgment to ensure that the dwelling is not sealed too tightly.
3. The BTL standards are intended to insure acceptable indoor air quality. In some cases, it is possible that a home will still be tightened beyond the BTL. This problem is more likely to happen in mobile homes. By installing the mandated ceiling and floor insulation, and sealing the plenum and duct work, mobile homes are sometimes sealed below the BTL. In these situations, installing mechanical ventilation to ensure acceptable indoor air quality may be necessary.
4. Crews have questioned the logic of air sealing a home, and then installing mechanical ventilation. The simple justification is that the overall energy savings derived from duct sealing, and the increased R-value and air sealing properties of ceiling, floor, and dense-pack sidewall insulation is significantly greater than the additional costs of running (electricity plus added space heat) a continuously operating exhaust fan. Mechanical ventilation should only be installed because the top priority measures of duct sealing and ceiling, floor (in mobile homes), and dense-pack sidewall insulation (in site built homes) have caused CFM_{50} to fall below the BTL. No home should be tightened below the BTL due to other air leakage measures.
5. Count each smoker as an additional occupant. For example, if there are four people in the household and two are smokers, count six occupants for the purpose of determining the BTL.
6. Use of the BTL does not guarantee satisfactory indoor air quality. Health and safety issues, pollutants, and moisture problems should always be considered before sealing the house.
7. All combustion analysis tests must be done to ensure it is safe to perform air sealing measures in the home. Combustion safety tests must be done on homes with combustion heating systems or other combustion appliances after air sealing to insure there is adequate combustion air and that backdrafting will not be a problem.

Determine the BTL value for each house by using Table 6.1 below. If the house is larger than the square footages listing in Table 6.2, calculate the BTL value for the house by using the formula

$$BTL = \frac{0.35 \times Volume \times N\ value}{60}$$

For the equation above, the N value can be found in Table 6.3.

Table 6.1
Building Tightness Limits

Occupants	Exposure	1 story	1.5 story	2 story	3 story
5 or less	Shielded	1,935	1,740	1,550	1,355
	Normal	1,615	1,450	1,290	1,130
	Exposed	1,450	1,305	1,160	1,015
6	Shielded	2,320	2,090	1,860	1,625
	Normal	1,935	1,935	1,550	1,355
	Exposed	1,740	1,740	1,395	1,220
7	Shielded	2,710	2,710	2,165	1,895
	Normal	2,260	2,260	1,805	1,580
	Exposed	2,030	2,030	1,625	1,420
8	Shielded	3,095	3,095	2,485	2,165
	Normal	2,580	2,580	2,065	1,805
	Exposed	2,320	2,320	1,860	1,625

Shielded – urban areas with high buildings or sheltered areas
Normal – dwellings in a residential neighborhood with yard space between buildings. 80-90% of homes will fall in this category.
Exposed – dwellings in an open setting with few buildings or trees around, and dwellings on top of a high hill or mountain that is exposed to high winds.

Table 6.2
Chart for maximum area of dwelling for use of BTL chart

Occupants	Max. sq. ft. area	Occupants	Max. sq. ft. area
5	1,610	7	2,250
6	1,930	8	2,570

Table 6.3
N values

	1 story	1.5 story	2 story	3 story
Shielded	29.4	26.5	23.5	20.6
Normal	24.5	22.1	19.6	17.2
Exposed	22.1	19.8	17.6	15.4

6300 Air Infiltration Reduction Standards

1. The West Virginia Weatherization Assistance Program uses an air tightness target range for air sealing activities. The target range for each dwelling must be entered into the Work Plan after the blower door pre-test.
   a. The upper limit of the target range is the minimum acceptable CFM_{50} reduction based on percentage reductions from the pre-weatherization CFM_{50}. These reductions should be easily attainable in most cases. Greater leakage reductions should be sought, especially when the pre-test CFM_{50} is high. This reduction guideline is specified in CFM_{50} Reduction Guidelines for Upper Limit of Air Sealing Target Range, found in Table 6.4 below.
   b. If the initial blower door test reading is equal to or less than the Building Tightness Limit, then that reading is to be considered the upper limit of the target range. If the initial blower door reading is lower than the calculated BTL, then the upper limit of the target range is the initial blower door reading.

Table 6.4
CFM_{50} Reduction Guidelines for Upper Limit of Air Sealing Target Range (continued on next page)

Pre-Wx CFM_{50}	Upper Limit of Target Range	Pre-Wx CFM_{50}	Upper Limit of Target Range
1,600	1,500	5,100	2,933
1,700	1,500	5,200	2,990
1,800	1,530	5,300	3,048
1,900	1,615	5,400	3,080
2,000	1,640	5,500	3,100
2,100	1,680	5,600	3,125
2,200	1,760	5,700	3,150
2,300	1,800	5,800	3,190
2,400	1,840	5,900	3,245
2,500	1,850	6,000	3,280
2,600	1,885	6,100	3,300
2,700	1,925	6,200	3,333
2,800	1,960	6,300	3,386
2,900	2,030	6,400	3,440
3,000	2,080	6,500	3,470
3,100	2,130	6,600	3,500
3,200	2,160	6,700	3,518
3,300	2,228	6,800	3,570
3,400	2,295	6,900	3,623
3,500	2,318	7,000	3,650
3,600	2,340	7,100	3,675
3,700	2,405	7,200	3,690
3,800	2,440	7,300	3,725
3,900	2,470	7,400	3,740
4,000	2,500	7,500	3,750
4,100	2,563	7,600	3,800
4,200	2,600	7,700	3,850
4,300	2,640	7,800	3,900

Table 6.4
CFM_{50} Reduction Guidelines for Upper Limit of Air Sealing Target Range (continued on next page)

4,400	2,670	7,900	3,950
4,500	2,700	8,000	4,000
4,600	2,760	8,100	4,050
4,700	2,820	8,200	4,100
4,800	2,880	8,300	4,150
4,900	2,818	8,400	4,200
5,000	2,875	8,500	4,250

c. The initial lower limit for the air tightness range is the Building Tightness Limit (BTL). Determining the BTL is intended to ensure acceptable indoor air quality.

2. In performing mandated measures of air sealing, attic insulation, wall insulation, duct sealing, and mobile home floor insulation, some dwellings may become more airtight than the BTL. In these cases, installing continuously operating ventilation may be necessary to ensure acceptable indoor air quality (refer to Section 6200 on page 70).
3. If any unvented space heaters or kerosene heaters are to remain in the dwelling after weatherization (only unvented heaters that are a secondary source of heat may remain), the auditor/estimator and/or crew supervisor must use caution when air sealing. Clients should be informed of potential hazards of using unvented secondary heating sources. Please refer to Section 10340 on page 121 for space heater policy.
4. The auditor /estimator and/or the crew supervisor must use caution and judgment to assess moisture or other indoor air quality problems that cannot be corrected during weatherization work, and consider reducing air sealing measures to help ensure acceptable indoor air quality.

6400 Guidelines for Installing Mechanical Ventilation to Ensure Acceptable Indoor Air Quality

If a home is tightened beyond the BTL, it should be analyzed to determine whether adding mechanical ventilation is necessary. The following are guidelines to assist in this analysis:

1. All combustion appliance health and safety tests plus all commonly performed moisture control measures, such as plastic ground covers and dryer vents, must be done. Every effort should be taken to identify and correct potential indoor pollutants and moisture problems.
2. If there is evidence of moisture or indoor air quality problems (excessive moisture on windows, stench, mold, rot, etc.) that cannot

be alleviated as part of the weatherization process, then install mechanical ventilation if the post-weatherization CFM_{50} is below the BTL.

6500 Air Sealing Guidelines

Since energy audits normally do not prioritize measures within the general heat waste (infiltration) category, use the following guidelines for prioritizing air leakage measures. The technician should define the conditioned space of the home, and then try to establish an effective air barrier between the conditioned and unconditioned space. Measures are generally performed in this order until the BTL is reached, or until it is no longer cost-effective to install additional materials.

1. Air leaks are to be sealed from the largest openings first and progressively working to the smaller leaks. Due to the stack effect, the most critical leaks are often those in the top part and lowest parts of the house. Always check:
   a. Chase ways around chimneys.
   b. Plumbing and wiring penetrations.
   c. Interior wall cavities.
   d. Dropped ceilings.
   e. Junctures between floors.
   f. Electrical service entry.
   g. Rim joist leaks.
   h. Basement wall leaks.
   i. Knee wall bypasses
2. Ensure all attic sealing is complete. Often the best method for detecting air leaks between the living space and the attic is by reversing the blower door fan to pressurize the house while the attic floor is inspected.
3. In mobile homes seal the plumbing chase behind washer and dryer, water heater closet, under/behind bath tub, and around the electric panel box.
4. Seal all large openings in the envelope (e.g., holes in the walls, floors, or ceilings, missing sheetrock, missing or broken glass, missing windows, etc.).
5. Seal all duct leaks, both supply and return lines if the ducts are located in unconditioned spaces such as attics or crawl spaces.
6. Seal or install dampers in other openings such as dryer vents, kitchen and bathroom exhaust fans, window air conditioners, unused fireplaces and flues, etc.
7. Install dense-pack sidewall insulation in all walls separating conditioned living space from exterior or unheated spaces, using the standards described in these Standards. Attic and wall insulation

should be installed before other air leakage measures are done to reduce the possibility of sealing the home below the BTL. A blower door test should be done to assess the status of the air sealing work. Continue air sealing if the BTL has not been reached and it is cost-effective to do so. **NOTE: Always seal the attic properly before installing attic insulation.**

8. Continue "secondary" measures air sealing such as general caulking, weatherstripping, outlet seals, glazing, etc., as detected by the blower door. Secondary air sealing refers to those smaller leaks that receive a lower priority due to their relatively low air leakage reduction level reduction potential and/or high material/labor costs. Further description is found below.
9. Openings in recessed light fixtures must not be sealed unless the fixture is rated as a “Type IC” (zero clearance) fixture.

6600 Secondary Air Sealing

Secondary air sealing measures are to be performed only after previously listed air sealing and insulation measures, and only when a need for this additional air sealing is detected by the blower door. If the CFM_{50} value is still not within the target range for the dwelling, these measures are normally performed by sealing the largest leaks first and then working down to the smaller leaks. If the target range has been met, these measures can still be performed if adequate CFM reductions are obtained. Following is a list of commonly performed secondary air sealing measures:

1. Tighten windows by weatherstripping or installing window channels. Re-glaze windows if there is noticeable air leakage, or if the window will likely deteriorate without re-glazing.
2. Seal doors with weatherstripping, sweeps, and thresholds. Make doors operate properly and replacement of entry locks as necessary.
3. Replace existing primary windows or doors if they are deteriorated beyond common repair methods. Any door, window, or sash replacement not yielding an SIR greater than 1 should be considered a repair material, and is subject to the $250 Incidental Repair limit.

6700 Air Sealing and Damming Around Chimneys and Vents

Special requirements are necessary for air sealing around chimneys and vent because of fire hazard. Follow the requirements below for such sealing.

1. Fire stopping around masonry chimneys “shall be of galvanized steel not less than 26 gauge thick or of noncombustible sheet material not

more than ½-inch thick."[5] Such material must be used to seal gaps or chases greater than ¼ inch wide around masonry or metal chimneys. Aluminum flashing may not be used for this purpose. This fire-rated material must be sealed to the chimney and the surrounding framing and finish materials with high temperature caulking. Gaps of ¼ inch or less are to be sealed with high temperature caulking only. This treatment is intended to stop the flow of air and water vapor into the attic from these gaps or chases.

2. In addition to stopping the flow or air around a chimney, a block must be installed to keep insulation at least 2 inches from the masonry or metal chimney. This is to be accomplished with a block of a rigid material. If this material is not fire-rated, it must be at least two inches from the masonry or metal chimney.
   a. If an existing chimney or flue is treated incorrectly, correct it to comply with these standards. If it is not reasonable to bring a chimney up to these standards, document this fact in the client file and include photographs

6800 Window Air Conditioners

1. Window air conditioners should be removed and stored when not needed. When it is found that the client does not remove a window air conditioner for the heating season, client education should address the advantages of:
   a. Removing and closing the window, or
   b. Installing an airtight cover on the exterior of the air conditioner unit, or
   c. Sealing the air conditioner unit from the interior.
2. If the client does not remove the window unit, an air conditioner cover – interior or exterior – should be left with the client along with instructions of how to install and remove the cover.

6900 Incidental Repairs

Incidental repairs must not exceed the $250 repair materials limit for any home. Repair materials are those that protect or enable the installation of "energy conservation" materials. Common repair materials include, but are not limited to, roll roofing, flashing, roof coating, and lumber for doors and window casings.

61000 Room-to-Room Pressures

Room-to-room pressure(s) should be measured, with the air handler operating, in all rooms with forced air heating return or supply ducts and operable doors, after all weatherization installations have been completed, but before post-weatherization combustion safety testing (worst-case draft test) is performed.

[5] NFPA 211 *Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances*, 2006 ed., 7.1.6.3.

61100 Penetrations in Basement Ceilings

1. If the basement is defined as outside of the thermal enclosure, seal all significant leaks in the basement ceiling. If the basement ceiling will be insulated, make sure the penetrations are sealed before insulating.
   a. Use the blower door to help find leaks in the ceiling by pressurizing the house, closing the door to the basement, and opening a basement window or door to the outside.
   b. Sealing penetrations between a conditioned space (the first-floor area) and a space outside of the thermal enclosure (the basement) is allowable and saves energy.
2. If the basement is defined as within the thermal enclosure, leaks that are not connected to the outdoors should not be sealed. Sealing leaks between conditioned zones is not allowable. However, some penetrations in a basement ceiling, while initially appearing to be between two conditioned zones, might be connected to the outdoors through attics, open interior walls, exterior walls, or unconditioned attached structures. These circuitous leaks are more likely found in a balloon-framed house. Leaks of this type must be sealed. Follow this procedure to identify leaks that are connected to the outdoors:
   a. First, carefully complete all attic bypass air sealing.
   b. Insulate the attic after completing the attic bypass air sealing.
   c. Insulate the house walls. The walls must be dense-packed with cellulose unless conditions will not permit (examples that would prevent installation are asbestos siding or live knob-and-tube wiring).
   d. After completing the attic air sealing and the attic and wall insulation installation, depressurize the dwelling with the blower door.
   e. With the blower door running, the door to the basement open, and the basement closed to the outdoors, search for leaks in the basement ceiling. If air is flowing through penetrations in the basement ceiling, this air is leaking in from the outdoors. Possible examples of these leaks include:
      i. Chimney chases.
      ii. Plumbing stacks.
      iii. Interior walls open to the basement.
   f. If basement ceiling penetrations are leaking air from the outdoors, seal them. Note: It is always best to stop these types of leaks by sealing attic bypasses or dense-packing exterior walls with cellulose. However, in some cases, difficult air leaks remain after this work.
   g. If penetrations are not leaking, do not seal them.

61200 Zone Pressure Diagnostics

Zone Pressure Diagnostics (ZPD) testing is highly recommended in some dwellings. ZPD testing is helpful in the determination of the location pressure boundaries and the effectiveness of air sealing measures.

61300 Duct Leakage

Duct leaks can lead to many problems in a dwelling, the most common one being wasted energy. Other problems can include thermal discomfort, substandard indoor air quality, and hazardous combustion venting.

Duct leaks can be 1) within the confines of the thermal boundaries of the building or 2) outside of the thermal boundaries, perhaps leaking to the outdoors. Mobile home ducts and site-built homes with ductwork in crawl spaces or attics are susceptible to leakage to and from the outdoors.

Although duct leakage within the thermal enclosure usually does not have a significant energy impact, it might impose a hazard to occupant health by causing poor indoor air quality or backdrafting of combustion appliances. These potential problems are addressed by performing the appropriate combustion safety testing.

Pressure pan testing must be performed in mobile homes and manufactured double-wide dwellings to determine if the ducts are leaking to a significant degree to or from the outdoors.

61310 Duct Leakage Standards

61310.1 Site-Built Homes

1. West Virginia Weatherization recommends combustion safety testing before weatherizing to determine whether the furnace air handler significantly influences the pressure in the combustion appliance zone (CAZ). To conduct this test, measure the pressure in the CAZ with reference to the outdoors with the furnace air handler off and then on.
   a. If the air handler significantly affects the pressure in the CAZ, call for the appropriate duct sealing on the job work order.
2. For ducts located in a crawlspace, basement, or other area that is outside of the thermal enclosure:
   a. If possible, alter the thermal/air envelope so that the ducts are within this envelope.
   b. If it is impossible or impractical to bring the duct space within the thermal/air envelope (examples of these types of spaces include crawl spaces, basements, attics, and attached or tuck-under garages):

   i. Make all necessary ductwork repairs, seal all ductwork joints with mastic, and thermally insulate ducts in unconditioned spaces to at least R-6. Only vinyl-backed, reinforced foil duct wrap, or two-part foam is to be used on ducts.
   ii. Use a pressure pan test to check ducts before and after repairs and sealing.

3. For ducts located within the thermal enclosure, such as a conditioned basement or crawl space:
   a. Always repair disconnected ducts or ducts that are leaking significantly.
   b. Seal the thermal enclosure of the space rather than the duct joints, if possible.
4. There are a number of techniques that can be used to help find leaks in ductwork. These methods include:
   a. Careful visual inspection.
   b. Operating the air handler while searching for leaks. Existing leaks often become leakier if the conditioned basement or crawl space is opened to the outdoors.
   c. Pressure pan testing at registers and grilles while the blower door is operating and the basement or crawl space is opened to the outdoors.
5. Supply registers and return grilles may not be located in an attached garage.

61310.2 Mobile Homes and Double-Wides

1. If there is a belly return system in the mobile home or double-wide, convert it to a living-space-system (refer to Section 9800 on page 108, Belly Return Conversions).
2. For a central return (living space return) system, the preferred duct leakage rate is zero.
3. For a central return system, a sum of 3 Pascals for the pressure pan readings is acceptable if:
   a. The floor boots are sealed with mastic, fiber tape, and metal, as necessary; and
   b. The end of the supply trunk ducts is sealed.

   Goal: Attempt to reduce the sum of the pressure pan readings to 0 Pascals.
4. For a central return system, a sum of 5 Pascals for the pressure pan readings is acceptable if:
   a. The floor boots are sealed with mastic, as necessary;
   b. The end of the supply trunk ducts are sealed;

c. Any crossover ducts are visually inspected, repaired and sealed, as necessary (make sure these ducts are supported properly); and
d. The furnace plenum is sealed with mastic, fiber tape, and metal, as necessary.

Goal: Attempt to reduce the sum of the pressure pan readings to between 0 and 3 Pascals.

5. If difficulty is experienced meeting the goals, a “pillow” (fiberglass insulation inside of a plastic bag) can be used to block and segment sections of the ducted system to assist in finding leaks.

7000 Insulation Requirements

Adding insulation to the building shell is often the most cost-effective measure performed in the Weatherization Assistance Program. Insulation reduces heat loss through the building shell. Combined with the home's air barrier, insulation forms the thermal boundary. The air barrier and insulation thermal boundary should always be aligned with each other. Insulation should be installed without voids or gaps and should be protected from moisture. The R-values of common insulation materials are listed below in Table 7.1.

Table 7.1
R-Values Per Inch For Common Insulating Materials

Insulating Material	Avg. R-Value Per Inch
Mineral wool	3.2
Fiberglass batt	3.2
Vermiculite	2.1
Perlite	2.7
Cellulose	3.4
Fiberglass (loose fill)	2.2
Rock Wool (loose fill)	2.2
Expanded polystyrene board (cut-cell surface)	4.0
Extruded polystyrene board (smooth cell surface)	5.0
Polyisocyanurate board, foil faced	6.0
Two-component polyurethane foam	6.0

7100 Attic and Roof Insulation

Attic insulation in older homes is often both insufficient and ineffective due to poor installation, settling, subsequent work related activity, or unaddressed thermal bypasses. Attic insulation produces the best energy savings of any typical weatherization measure and often is the most cost-effective measure in terms of Savings-to-Investment Ratio.

7110 Inspection, Preparation, and Repairs

1. Prior to installing insulation, a thorough inspection of the attic area must be performed.
   a. The inspection must include a determination of the R-value and integrity of existing insulation, the location of air leaks from the

conditioned spaces to the attic, and the suitability of the structure for receiving insulation.

b. The inspection should determine the necessity of any repair work associated with the installation of the attic insulation. Repairs should be completed before installing insulation. Additional descriptions of allowable and necessary repairs are noted below. Attic sealing needs to be performed before insulation installation.
c. Attics should be tested for air leakage between the ceiling and attic space either by pressurizing the house with the blower door or using zone pressure testing. These tests should be conducted prior to, and then after, performing air sealing and installing insulation in order to determine the quality and completeness of the air leakage and bypass sealing.
d. All bypasses, such as plumbing and electrical chase ways and balloon wall cavities, must be thoroughly sealed before insulating.

7120 Moisture Inspection and Repair

1. Roof leaks and all other attic moisture problems shall be repaired prior to the installation of attic or roof insulation.
2. All mechanical vents from exhausting and combustion appliances must be vented through the roof or sidewall. No exhaust fan vents, combustion appliance vents, or plumbing stacks may terminate in the attic.

7130 Attic Access

1. There must be access to the attic provided for post work inspection and potential future needs of the client.
2. A gable vent on a hinged plywood or OSB door is considered adequate access.
3. An adequately sized gable vent held in place with screws (no nails) is acceptable if building a hinged door is impractical.
4. When it is necessary to install an interior attic access in the ceiling, it must be:
   a. Sized to provide reasonable access for inspection.
   b. Shall be weatherstripped and insulated to the same level as the attic floor, or with at least 4 inches of extruded polystyrene (R-20).
5. In pre-1978 homes, installation of an attic access must be performed using lead-safe work practices, and all dust and debris caused by the installation shall be wet-cleaned.
6. An attic ceiling access shall have an insulation dam, made of rigid materials, that exceeds the height of the insulation to be installed. The dam must be strong enough to hold the weight of a person entering or exiting the attic. The use of fiberglass or other non-rigid

material as a dam around the attic access is not allowed, unless limited roof height restricts rigid material. In that case, thick fiberglass batts are allowable.

a. Examples of approved attic access insulation dam materials include:
    i. Plywood of at least ¾ inch thickness.
    ii. Wood board of at least ¾ inch thickness.
    iii. Plywood of at least ½ inch thickness with ¾ inch by 2-½ inch strapping securely fastened to the exterior face of the plywood box, with the edge of the strapping flush with the top edge of the fabricated plywood box.

7. If there are no interior accesses, at least one exterior access to each attic space shall be left for inspection purposes. When it is necessary to install an interior access in a knee wall, it must be at least the width of the knee wall stud cavity by 24 inches high, and shall be weatherstripped and insulated to the same R-value as the knee wall. At least one latch shall also be installed to ensure air tightness. If it is unreasonable to provide permanent access to all knee wall areas, the attic and/or knee wall area must be inspected by a certified Post-Work Inspector before the area is sealed off. The insulation in the sealed knee wall area must be adequately documented in the client file with photo documentation.

7140 Insulation Shielding and Blocking

1. All electrical fixtures shall be blocked with rigid material to ensure a minimum insulation clearance of 3 inches and a maximum clearance of 6 inches.
    a. Exceptions to this rule include Type IC (insulation contact) recessed lights, Type IC light/fan combinations and closed junction boxes.
2. No insulation, including fire-rated insulation, shall be installed above recessed light fixtures so as to trap heat or prevent free air circulation. However, insulation may be installed over Type IC (insulation contact) light fixtures.
3. Blocking must be installed so that it is effective in shielding the heat source from the insulation, and no insulation shall be left within the blocked area.
4. Metal blocking must be notched so that it does not contact electrical wiring.
5. Fire stopping around masonry chimneys “shall be of galvanized steel not less than 26 gauge thick or of noncombustible sheet material not more than ½-inch thick.”[6] Such material must be used to seal gaps or

[6] NFPA 211 *Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances*, 2006 ed., 7.1.6.3

chases greater than ¼ inch wide around masonry or metal chimneys. Aluminum flashing may not be used for this purpose. This fire-rated material must be sealed to the chimney and the surrounding framing and finish materials with high temperature caulking. Gaps of ¼ inch or less are to be sealed with high temperature caulking only. This treatment is intended to stop the flow of air and water vapor into the attic from these gaps or chases.

a. In addition to stopping the flow or air around a chimney, a block must be installed to keep insulation away from the masonry or metal chimney. This is to be done with a block of rigid material. If this material is not fire-rated, it must be at least two inches from the masonry or metal chimney.
b. If an existing chimney or flue is treated incorrectly, correct it to comply with these standards. If it is not reasonable to bring a chimney up to these standards, document this fact in the client file and include photographs.

7150 Installation Methods for Attic Insulation

1. Locate and seal attic thermal bypasses, chases, and open-topped partition walls. Remove enough of any existing flooring so that a thorough inspection for, and repair of, attic bypasses is possible. Properly treat ceiling height changes and stairwells as necessary to stop air leakage. Seal knee wall floor cavities. Make sure bypasses are completely sealed before installing any insulation.
2. Attic insulation must completely cover heated areas and must be installed at an even depth, except where physical constraints exist.
3. Insulation must be installed to the outside edge of the top plate of an exterior wall.
4. Insulation may not cover soffits vents or fill the eave/soffit area.
5. Insulation must be installed according to the manufacturer's specifications for coverage and R-value.
6. If the installation of cellulose insulation on top of existing batt or blanket insulation is warranted, cut or pull back existing fiberglass batts one to two feet from the soffit and blow the perimeter.
7. Cellulose is the preferred insulation to be installed in the attics of site-built homes. If another type of insulation is installed, there must be documentation as to why cellulose could not be used.

7150.1 Insulation Coverage and Density

1. Insulate uninsulated open-joist attics or any attic with R-11 existing insulation to at least R-38 in all dwellings that are heated and lived in year-round.

2. It is still recommended to increase insulation levels in attics with effective insulation levels between R-11 and R-19, as per the measures priority list.
3. If there is properly installed insulation of R-20 or greater, it might not be cost beneficial to further insulate the attic, depending on additional conservation needs of the home. Insulate enclosed areas (under floors and behind slopes and knee wall cavities, etc.) to the following density levels, as long as interior finish materials are able to withstand the pressure without damage:
   a. Blown cellulose at a density of 3.5 to 4.5 lb/ft^3.
4. Insulate knee wall cavities as follows:
   a. Blown cellulose at a density of 3.5 to 4.5 lb/ft^3.
   b. Fiberglass batts to an insulating value of R-19.
5. Where feasible, densely packing cellulose insulation with an appropriate hose or tube might help seal air leaks and bypasses in attics. However, dense-packing cellulose in an attic does not eliminate the need to remove enough attic flooring in order to find and seal leaks with caulking, foam, and other materials before cellulose in installed.
6. Calculating the number of bags, as per manufacturer's specifications from product supplied, is the preferred method for determining the proper amount and density of material to be installed into an attic area at a given R-value.
7. When it is cost-effective, it is preferred that dropped soffits above cabinets and similar construction details be filled with cellulose insulation.
8. When a vapor retarder is installed with the insulation, the retarder should be installed toward the conditioned living space.
9. Add insulation as necessary to eliminate voids and areas of incomplete coverage.

7150.2 Vaulted or Sloped Ceiling/Roof Cavities

1. Vaulted ceiling or sloped ceiling/roof cavities shall be insulated to a value of at least R-19 whenever possible. If it is not possible to insulate to R-19, the reason must be documented in the client file.
2. If batt insulation is used, the vapor retarder should always face the conditioned living space. If this vapor retarder faces a habitable space, the vapor retarder must be covered with a 15-minute fire-rated material, such as ½ inch drywall mudded once (for an air barrier). An air barrier without penetrations must be installed on the warm side of this insulation.
3. If cellulose insulation is used, the cellulose shall be dense-packed in the vaulted or sloped ceiling/roof cavities.

7150.3 Knee Wall Areas

1. Knee walls shall be insulated in a manner similar to exterior walls when they separate conditioned from unconditioned spaces.
2. Whenever possible, knee walls should be insulated with dense-pack cellulose insulation.

7150.4 Enclosed Ceiling/Floor Cavities

When insulating enclosed ceiling cavities, it is preferred that insulation be installed in the rafter cavities from the attic, through the eave or from the interior of the home, rather than through the roofing materials.

7150.5 Storage Space

Where attic space is being used for storage before the attic is weatherized, agencies should request the client remove storage items from the area before the crew begins the job. If storage cannot be removed or if the attic will be used for storage after insulation is installed, the agency can evaluate whether a storage platform should be built that will be supported at least 12 inches above the attic floor near the attic access, so insulation can be installed under the platform and storage items can be accessed without compromising the insulation.

7150.6 Attic Ductwork Insulation

1. Ductwork in attics must be sealed appropriately with the proper materials (duct mastic) before insulation is installed. Refer to Sections 61300 on page 79 and 11100 on page 125 for instructions.
2. When working ducts are located outside of the thermal enclosure, install a minimum of R-6 on ducts and plenums.
3. A minimum of 6 inches of clearance between duct insulation and heat sources must be maintained, unless the insulation material is rated for closer proximity.
4. If ductwork outside of the thermal enclosure is serving a cooling system, the duct insulation must have a vinyl or foil vapor barrier installed on the outer surface of the insulation unless two-part foam is used to prevent condensation on the ductwork.

7150.7 Floored Attic Insulation

If a drill-and-blow method is used for insulation in a floored attic, holes must be properly plugged, secured with adhesives, and sealed. Floor planks can also be removed to allow for access to blow cavities, and then reinstalled.

7150.8 Attic Ventilation

Attic ventilation should be installed when needed, but no attic should be over-ventilated because this increases the overall leakage rate of the dwelling and can increase air leakage caused by the stack-effect. Sealing attic bypasses, controlling indoor humidity levels, properly sealing attic bypasses, and insuring exhaust fans are extended to the outside should be the primary means in controlling moisture in attics.

1. General Installation:
    a. Ensure that existing vents are not blocked, crushed, or otherwise obstructed. Correct problems as necessary, or replace.
    b. When attic insulation is installed, a reasonable amount of attic ventilation should be in place, unless local codes supersede.
    c. All ventilation openings should have suitable louvers and screens to prevent snow, rain, and insects from entering the attic.
2. High-Low Vents:
    a. Attic ventilation is most effective when there are equal amounts of low intake vents through soffits and eaves and higher exhaust vents on the roof.
    b. Roof vents should be installed close to the peak.
    c. Install high gable vents at least three feet above the soffit or a gable vent used for low venting.
3. Gable Vents:
    a. Gable-end vents should be installed as high in the gable as possible and positioned to provide cross ventilation.
    b. Precautions shall be taken to prevent the wind from "washing" insulation near the attic vents.
4. Roof Vents:
    a. When roof vents are installed, they should be nailed and well sealed to the roof to prevent water leakage. If possible, roof vents should be located on the areas of the roof least visible from the ground.
    b. If possible, roof vents should not be installed on a roof that is in poor condition.
    c. Roof vents are not to be installed over rafters.
    d. Roof vents should be tucked under shingles as much as possible. Surface mounted roof vents are not allowed.
5. Knee Wall Ventilation:
    a. Knee walls or attic spaces that are sealed from other attic spaces may need to be ventilated as if they are separate attics.
6. Attic Vent Area Guideline:
    a. When attic ventilation is installed, use the following guideline:

b. If the attic floor and bypasses are air-sealed and exhaust vent terminations extended to the outside, then one square foot of net-free ventilation may be installed for every 300 square feet of attic floor area.

7200 Sidewall Insulation

Installing dense-pack sidewall insulation with uniform coverage and density is a proven energy efficiency measure because it maximizes the insulating value, minimizes insulation settling, and effectively reduces air leakage though the walls. Dense-pack sidewall insulation must be completed where uninsulated wall sections exist, including walls that separate conditioned spaces from unconditioned spaces, such as garages or unheated porches. There must be complete documentation in the client file giving adequate rationale whenever walls are not insulated.

7210 Inspection, Preparation, and Repairs

Perform an inspection of the home from the interior and exterior prior to installing insulation. This inspection should identify all potential hazards and needed repairs and then note them in the estimation form and/or Work Plan.

7210.1 Moisture Inspection and Repair

Any leaks or other moisture problems must be repaired prior to the installation of wall insulation. Make reasonable repairs to walls. Use lead-safe work practices in all pre-1978 dwellings.

7210.2 Interior Inspection and Repairs

1. Make reasonable repairs to interior walls as needed. In pre-1978 homes, repairs to these surfaces can generate a lot of lead-based paint dust and debris, so lead-safe work and clean-up practices must be employed. Locate any areas of the interior wall surface that are weak or not securely fastened. Holes drilled for insulation must be plugged, finished, and returned to a condition as close to the original as possible.
2. Locate the positions of all wall-mounted switches and outlets before beginning insulation work. Locate all chases, utility runs, duct runs, wall heaters, vent fan penetrations, etc. prior to insulating. Insulation should not be installed against chimneys and some electrical fixtures. Block around these areas before installing insulation. If it is not possible to block around an area, avoid that area when insulating. Make sure all appropriate code clearance requirements are considered.
3. Find any interior soffit areas, pocket doors, or other structural details that may need preparation prior to insulating, and prepare as

necessary. Locate critical framing junctures and ensure adequate insulation densities in these areas.

7210.3 Exterior Inspection and Repairs

1. Note all types of siding material. Note siding material that may contain asbestos and/or lead-based paint. If the home is pre-1978, lead-safe weatherization practices must be followed.
2. Determine the best drilling strategy. The preferred method is to lift the siding or temporarily remove it before drilling the sheathing.
3. Repair or replace severely deteriorated window or door components as directed by the estimate. Replace all missing glass.
4. Patch holes in exterior walls.
5. Determine the source of, and correct any problem that has led to, moisture in wall cavities prior to installing insulation. Repair or replace damaged, rotted, or deteriorated siding to ensure the integrity of the insulation. If any missing siding, flashing, etc. would allow disintegration of installed insulation, replace it with a comparable material.
6. Access structural additions and critical junctures to determine the ability of these areas to contain high-density insulation. Correct any openings or gaps prior to installing insulation.

7220 Installation Methods for Wall Insulation

1. Wall areas above windows and doors (except in mobile homes), and the area below windows must be insulated, whenever possible.
2. Uninsulated exterior walls without drywall, paneling, or other interior finish material must be insulated by adding interior finish material and insulating wherever possible, unless it can be proven not cost-effective to do so.
    a. If faced fiberglass batt insulation is used, the vapor retarder must face indoors.
        i. All vapor retarders must be covered with site appropriate permanent material such as ½ inch drywall.
        ii. If drywall is used to cover the insulation, it must be taped and mudded with one coat.
3. For all enclosed walls (where there is both exterior and interior surface finish materials), insulation must be installed using the tubing method rather than the nozzle method.
4. As an exception, a nozzle may be used in small cavities such as above windows and doors, or in other spaces that are less than two feet in height.
5. The tubing method may be used to install insulation in the sidewall by drilling one hole per story.

6. Walls must be dense-packed whenever the interior wall surface material allows. Dense-packing requires:
   a. The proper machine settings. For dense-packing, the air-to-material ratio must be high enough for a cellulose density of at least 3.5 pounds per cubic foot. On the other hand, if this ratio is too high, the job of insulating will take much longer. A balance must be found for each machine, delivery system, and wall.
   b. Effective delivery of the insulation material from the machine to the end of the wall tube. This includes:
      i. No air leaks in the hose or at the joints.
      ii. A hose that is as short as possible for the job, but at least 50 feet long.
      iii. Gradual reductions or transitions in the delivery system to minimize clogging.
      iv. A tube that is cut at a 45 degree angle at the end to facilitate insertion into the wall cavity.
   c. A technician that uses an effective technique characterized by:
      i. Inserting the tube all the way up to the top plate and then pulling down just less than one foot before the machine is turned on.
      ii. Pulling the tube out of the fill hole by just less than one foot at a time as the flow in the hose and tube slows and stops due to increasing resistance in the cavity. If the tube is pulled out too soon, the density will decrease.
      iii. Inserting the tube downward through the fill hole after the wall cavity is filled upward from the fill hole. Inserting the tube with only the air running will help “drill” through the cellulose that has fallen from the upward fill. This will help achieve a higher density in the downward fill.

7220.1 Blocking

Construction details that allow insulation to escape from sidewall cavities (such as balloon framed walls) must be blocked or packed with insulation or other material in a manner that effectively retains the insulation.

7220.2 Insulating Floor Cavities Between Exterior Wall Cavities and Other Key Junctures

1. Open floor cavities between exterior wall cavities shall be insulated in balloon-framed buildings.
2. Only those parts of these floor cavities that border the exterior must be insulated. These cavities are usually open to the walls, allowing access from the rim or band joists and also from the wall cavities above or below these floor cavities.

3. It is recommended that these cavities be insulated using the bag method. This method uses an empty 100 pound grain bag or other appropriate material. The empty grain bag is pushed through the drilled hole at the rim joist area with the fill tube, filled with cellulose, and then the remainder of the bag opening is pushed into the hole with the fill tube.
   a. Joist cavities that are perpendicular to the band joists (usually on the eave sides of a dwelling) should be treated with the bag method or another acceptable method.
   b. Joist cavities that are parallel to the band joists (usually on the gable-end sides of a dwelling) should be completely filled with insulation.
4. All key junction points must be properly dense-packed and/or air sealed including wall-ceiling intersections; cabinet insets; ceilings over tuck-under garages; and knee wall and floored attic intersections.

7220.3 Insulation Coverage, Density, and Voids

1. Sidewall insulation must be installed according to the manufacturers' recommended density, and in a manner that does not allow the material to settle.
2. When insulating sidewalls with cellulose, install the insulation to a density of 3.5 – 4.5 lbs/ft^3 using the tubing method, unless there is good reason not to dense-pack. If the insulation is not installed to at least 3.5 lbs/ft^3, documented reasons must be included in the client file.
3. When using blown fiberglass, install at a density of 1.6 lb/ft^3. Cellulose is the preferred material for dense-pack sidewall insulation. Blown fiberglass would only be rarely used in a case where cellulose would not be an acceptable material.
4. Total voids of more than five percent will not be allowed by the West Virginia Weatherization Assistance Program.
5. It is usually not cost beneficial or practical to re-insulate stud cavities with existing fiberglass insulation. However all walls with existing insulation should be inspected in at least three stud bays to check for complete coverage. Do not assume all walls or stud bays are insulated just because some are.

7220.4 Plugs and Patching

1. Where possible, remove the exterior lap siding and drill the sheathing and/or sub-siding for the installation of insulation. Holes in the sub-siding must be patched. Various materials may be used for this

patching, including wood plugs, plastic plugs, or spray foam insulation.

2. Holes drilled for an interior blow are to be covered by wooden chair rail and do not need to be sealed if dense-pack of the cellulose insulation (3.5 to 4.5 lbs/ft^3) is achieved.
3. Installing wall insulation by drilling and plugging exposed drill holes is an acceptable method when methods 1 and 2 above are not practical.
4. Plugs that are compatible with the siding or wall type must be used to fill and cover the exposed surface that has been drilled.
5. Exposed plugs must be caulked and primed.
6. Any wood that is replaced as a result of the weatherization work and that is exposed to the weather must be primed.
7. Stucco-sided dwellings may be insulated from the exterior or the interior. If insulated from the exterior, the stucco patch must match the existing stucco in texture and color.
8. Interior drill and blow techniques are preferred for homes with brick veneer siding.

7220.5 Quality Control

A final inspection to assess quality and quantity of wall insulation must be performed. This inspection can be performed by using a bore scope, removing interior outlet and switch plates, using an infrared camera, or other acceptable inspection techniques. The amount of installed insulation can also be checked by using the calculation methods based on square footage and cavity depth in the Work Plan.

7300 Foundation and Crawlspace Insulation

This section addresses rim joist insulation, basement insulation, and crawl space insulation. It has been found that insulating foundation walls in West Virginia is not cost-effective in most cases.

7310 Moisture Inspection and Repair

1. All dwellings must be inspected for problems associated with excess moisture.
2. Identification of potential moisture problems shall be documented in the client file.
3. Repair any moisture problems that will degrade or diminish the effectiveness of weatherization measures.
4. In crawl spaces, install a moisture barrier on the floor. This barrier should overlap at least six inches at the joints, and extend six inches up the crawl space wall. Note: If the entire dirt floor is not accessible, cover as much as possible.

a. If the crawl space area has 18 inches of clearance or more between the crawl space floor and ceiling, a moisture barrier must be installed unless there are substantial reasons not to. If a moisture barrier is not installed, the reasons must be included in the client file.

5. In unfinished basements that have potential safety problems due to slope, a non-skid moisture barrier should be considered for the client's safety such as roll roofing.

7320 Wall Moisture Barrier

If there is evidence of water leaks or moisture coming through the foundation wall from the exterior, a moisture barrier must be attached to the sill plate in a manner that drains the moisture to the outdoor surface of insulation placed on the interior surface of the foundation wall, and covers the insulated section of the foundation or crawl space wall. Inspect guttering and downspouts and repair where appropriate.

7330 Treatment of Other Hazards

Use appropriate personal protective equipment and work practices in the presence of animal or insect hazards. Ensure personal safety during work.

7340 Defining the Thermal Boundary

The estimator must decide whether the first floor or the foundation wall will serve as the air and thermal boundary. A lived-in basement would always be considered within the boundary, but unused basements and crawl spaces can be within or outside of the boundary. In some cases making this decision will be difficult. The information below is intended to set guidelines for defining the air and thermal boundary for an unoccupied basement or crawl space.

1. The foundation walls are the preferred air and thermal boundary when:
   a. There is good ground drainage and no existing moisture problems;
   b. There is an interior stairway between the house and basement;
   c. There are ducts and the furnace in the basement;
   d. Foundation walls test tighter than the floor;
   e. Basement may be occupied some day;
   f. Laundry facilities are in the basement;
   g. Heating equipment is located in the basement;
   h. Floor air sealing and insulation would be very difficult; or
   i. There is a concrete basement floor.

2. The floor is the preferred air and thermal boundary when:
   a. There is moisture or excessive dampness in the basement with no practical solution for mitigation;
   b. No furnace or ducts are present in the basement;
   c. Exterior entrance only;
   d. Rubble masonry foundation;
   e. Dirt floor or deteriorating concrete floor;
   f. Badly cracked foundation walls; or
   g. Excessive door and/or window repair is required in the basement.
3. Basements and crawl spaces should be tested using zone pressure testing when the housing construction type or the air leakage rate indicates that there may be hidden air leakage into or from the basement or crawl space, or air quality problems are resulting from air leakage from a basement or crawl space. This test should be conducted prior to, and then after, installing insulation in order to determine the quality and completeness of the sealing. In addition, this test can help determine the appropriate location of the pressure and thermal boundaries.

7350 Storage Space

The client needs to be advised to remove any items so that the floors can be insulated effectively. The agency can work with the client in the event the client is incapable of moving the items as needed. The agency has the right to defer service until issue is resolved.

7360 Rim or Band Joist Insulation

1. Insulation must be a minimum of R-10.
2. Fiberglass, rigid foam board, two-part foam, or other appropriate insulation may be used for this application.
3. If there is significant air leakage, the band or rim joist area must be properly sealed before the insulation is installed.
4. The insulation must be secured in a permanent manner.

7400 Floor Insulation

7410 Inspection, Preparation, and Repairs

Precautions must be taken to ensure adequate combustion air is being supplied, through non-operable vents, for combustion appliances in crawl spaces or basements.

1. All units must be inspected for problems associated with excess moisture.

2. If floor insulation is installed over a crawl space area, the crawl space floor shall be covered with a moisture barrier of six mil black plastic when conditions warrant. This polyethylene must be lapped at least 6 inches at the joints and extended up the crawl space wall 6 inches.
3. Identification of potential moisture problems shall be documented in the client file.
4. Repair any moisture problems that will degrade or diminish the effectiveness of weatherization measures.
5. Repair any rotted, broken, or damaged structural components when appropriate.

7420 Installation Methods for Floor Insulation

1. All appropriate air sealing of the floor should be done before insulation is installed.
2. Install R-19 insulation between floor joists that define a thermal boundary.
3. The insulation should be installed without voids or gaps. Fit insulation tightly around cross bracing and any obstructions.
4. Floor insulation must be fastened securely in place with wire fasteners, nylon mesh, or another appropriate method. Friction fitting or stapling floor insulation is not considered an appropriate method for securing the material.
5. Do not support insulation with Tyvek, Typar, or other house wrap stapled to the bottom edges of the joists.
6. Do not use chicken wire or other metal mesh to support floor insulation.
7. Install insulation so that it is in contact with the underside of the sub floor above.
8. Faced fiberglass insulation must have the facing upward toward the heated area.
9. Ensure that floor insulation is in direct contact with the rim or band joints. If the dwelling is balloon framed, air seal the bottom of the stud cavities prior to installing the insulation.
10. A crawl space clearance of less than 18 inches from the bottom of the floor joists to the ground is considered inaccessible.
11. Combustible material must be kept a minimum clearance of six inches from any combustion appliance or flue.

7420.1 Dryer Vents

Dryers must be vented to outside the perimeter of the crawl space or foundation. The vent hose must be metal or PVC material, not vinyl. Ensure that there are no traps (sags) in the vent hose so that condensation does not

occur, blocking the air flow to the outside. The outside end of the vent hose must be capped with a self-closing vent cover.

7420.2 Materials

Fiberglass insulation, faced or unfaced, is the preferred insulation material for perimeter and floor. Vinyl faced insulation should not be used for floor insulation.

7420.3 Insulation Coverage

1. Floor insulation must be installed in a manner that provides as continuous a thermal boundary as possible.
2. Floor insulation must not be installed in a manner that excessively compresses the material.

7420.4 Ducts and Pipes

1. When floor insulation is installed, ductwork below the floor insulation must be appropriately sealed and insulated. Refer to Section 61300 on page 79 for instructions.
2. When floor insulation is installed, water pipes and all furnace supply and return ducts below the insulation must be insulated as part of the floor insulation measure. Please refer to Sections 7400 on page 96.
3. Do not insulate over pumps, valves, pressure relief devices, or vents; do not insulate over heat tape unless the manufacturer's specification indicates that such installation is safe.

7430 Crawl space Ventilation

1. Refer to Section 7300 on page 94 for more information regarding crawl space treatment.
2. Crawl space venting is generally not needed if the following conditions are met:
   a. The crawl space is dry with no evidence of standing water or moisture problems;
   b. There is proper surface drainage;
   c. There is a properly installed moisture barrier covering the entire crawl space floor.
3. If the above conditions cannot be met, the crawl space must be vented. If a moisture barrier cannot be installed, the reason shall be documented in the client file.
   a. If crawl space vents are provided, they must provide one square foot of free vent area for every 1500 square feet of crawl space ground area if there is a moisture barrier, or one square foot of

free vent area for every 300 square feet of crawl space ground area if a moisture barrier cannot be installed.

b. Crawl space vents shall be louvered and screened or otherwise designed to prevent the entry of snow, rain, animals, and insects into the building.

c. If operable crawl space vents are installed, the client must be informed of the benefits of closing the vents in winter and opening the vents in summer.

4. If there are more vents than are needed, it is preferred that surplus vents be closed off with removable rigid insulation. Where possible, close off vents on the windward side of the crawl space. Do not close off or restrict combustion air vents.

7500 Electrical Safeguards

1. Correct electrical problems such as unsafe wiring, open junction boxes, or other electrical code violations prior to performing any insulation work.
2. In attics, all visible electrical junction boxes shall be covered with an appropriate junction box cover and their location must be noted on the rafter above the box.
   a. All electrical fixtures shall be blocked with rigid material to ensure a minimum insulation clearance of three inches and a maximum clearance of six inches. Exceptions to this rule include Type IC (insulation contact) recessed lights and light/fan combinations, and closed junction boxes.
   b. It is permissible to remove recessed light fixtures with client permission if this is the most practical method of air sealing. Be certain to observe all appropriate codes.
3. Knob-and-tube wiring:
   a. If knob-and-tube wiring has been deactivated and the dwelling has been rewired with BX, NM, or other approved electrical cable, the attic may be insulated over the inactive knob-and-tube wiring.
   b. Any insulation must be kept at least one inch from the live knob-and-tube wiring, unless the wiring has been approved or upgraded by a licensed electrician.
4. Under floor joists do not use any metal mesh material, such as chicken wire, to support floor insulation. This can cause an electrical hazard to the installers.

8000 Window and Door Replacements

8100 Primary Windows

8110 Window Assessment

1. All existing egress windows must remain operable.
2. Non-operable windows may be permanently sealed against air leakage if agreed to by the client.
3. Window work on pre-1978 houses must be performed using lead-safe weatherization procedures.

8120 Window Replacements

1. Window replacements must be based primarily on an energy-saving decision process rather than on client requests or aesthetics.
2. Replacement of windows must be justified by the NEAT or MHEA audit and cannot be installed in lieu of a mandatory measure.

8130 Window Air Leakage

Window tightening measures such as caulking and weatherstripping are considered general heat waste measures.

8140 Window Repairs

1. When feasible, windows must be repaired, rather than replaced.
2. Replace missing, broken and severely cracked panes.
3. Window glazing compound shall only be replaced if the existing glazing is deteriorated to the degree that the window glass is in jeopardy of falling out of the sash.
4. Jalousie windows in pre-1976 mobile homes can be replaced if they cannot reasonably be repaired and are significantly leaking air, such as a broken out glass or sash that does not seal to the frame and leaks badly. In this case, the replacements can be classified as air sealing measures rather than repairs. The replacement of jalousie windows can be done in addition to mandatory mobile home measures but cannot be done in lieu of those measures.

8200 Storm Windows

8210 Interior Storm Windows

1. With the relative low cost of mobile home replacement windows, and the unlikelihood that a storm panel would be cost-effective installed over a good quality primary window, replacement of a substandard window is generally preferred to the installation of a storm panel.
2. If interior storm panels are installed, they must be removable, the panels numbered, and the client educated to their removal, storage, and reinstallation. The supervisor must assess the ability of the client to comprehend this procedure and the likelihood that panels will be reinstalled correctly.
3. Self-storing insider storm windows can also be considered if MHEA justified.
4. Interior storm panels may be replaced or installed or primary windows may be replaced or installed, but both measures cannot be done to the same window unit.
5. A ½- to 2-inch air space between the prime window and the installed storm window is preferred.
6. Allowable storm windows include:
   a. Rigid-framed single- and double-strength glass.
   b. Rigid- and flexible-framed Plexiglas of at least 100 mils thickness.
7. Repairs to prime windows must be done to keep moisture out before an interior storm window may be installed over the prime window.
8. Storm windows must be securely fastened in place, installed straight, plumb, and level, and without distortion.
9. Storm windows must be installed with screws, placed at least every 16 inches, including one in each corner.
10. Metal storm windows should not come in contact with frames or fasteners constructed of dissimilar metals.
11. Installed storm windows in kitchens, baths, and other high moisture areas must be operable if they provide the only source of ventilation into the space.
12. Operable storm windows shall move freely.

8220 Exterior Storm Windows

1. Exterior storm windows can be installed as a last option when it is not cost beneficial to repair or replace the primary window and there is significant air leakage.
2. Storm windows are to be installed so that they function properly, and do not interfere with the operation of the primary window.

3. All storm windows over 32 inches in width and/or 63 inches in height must be installed with a brace bar for stability.
4. Storm windows must be installed with screws, placed at least every 16 inches, including one in each corner.
5. There must be a continuous bead of caulk sealing the storm window to the blind stop, or casing, without sealing the weep holes.
6. All exterior storm windows must have weep holes. If there are none, weep holes must be made.
7. A storm window should be installed so that there is less than a 2-inch dead air space between the glass of the primary and storm windows.
8. A double-hung storm window is not to be used as a horizontal slider.
9. A double-hung storm window is not to be installed over a dead light prime window.
10. Clips used in shipping storm windows are to be removed after the storm windows are installed.

8300 Doors

8310 Door Assessment

1. Doors must be assessed for needed repairs, air leaks and comfort-related problems.
2. If there are two or more existing egress doors on the first floor, at least two must remain operable. At least one egress door on the second floor, if existing, must remain operable. Other doors can be sealed, if reasonable, with the client's permission.
3. Door work on pre-1978 houses must be performed using lead-safe weatherization procedures.

8320 Exterior Door Replacements

1. Individual replacement doors may only be installed if the cost of the repair is justified by the NEAT or MHEA audit. Doors cannot be installed in lieu of mandatory measures.
2. Replacement doors may include one lite (pane of glass) if the replaced door had one or more lites.
3. Combination primary/storm doors can only be used if the door being replaced is a combo door. However, the same rules as number 1, above, still apply.

8330 Air Leaks in Doors

Air leak mitigation measures for doors such as jamb-up kits, sweeps, and thresholds must be based on detection of leaks using the blower door.

8340 Door Repairs

1. When feasible, a door must be repaired rather than replaced.
2. Stuck doors do not have to be made operable unless they are to function as egress doors.

9000 Mobile Home Requirements

The same general procedures described in all other sections of these Standards shall apply to mobile homes unless otherwise stated, or stated more specifically in this section.

9100 General Inspection

Structural problems affecting insulation measures must be corrected prior to installing insulation.

9200 Heating Systems

1. Perform a visual inspection.
2. Perform health and safety tests. Correct any hazardous situations and document. Try to insure there will be no unvented space heaters in operation in a mobile home.
3. Clean and tune the furnace to maximum steady state efficiency. Attach pre- and post-test tapes to HURMS page of Work Plan.
4. Replace filters and leave one additional reusable filter with the client. Filter should be cut to size. Instruct the client on how to replace the filters.
5. Inspect thermostat to insure it is mounted in a proper location and is not the mercury bulb type switch.
6. Make sure the HURMS page information is complete.

9300 Moisture Problems

1. If there are moisture problems in the ceiling or sidewalls, insulation should not be added until the moisture source and/or site of penetration, including leaks, is identified and eliminated.
2. Exhaust-fan ducts terminating in ceiling cavities, crawl spaces, or other areas, shall be extended to the outdoors and sealed to prevent exhaust air from re-entering the conditioned space.
3. Dryer vents shall be vented to the outdoors. If the mobile home is skirted, the dryer vent termination must be to the outdoor side of the skirting.
4. If the crawl space area has 18 inches of clearance or more between the crawl space floor and ceiling and the mobile home is skirted, install a moisture barrier on the ground in crawl spaces. This barrier should overlap at least six inches at the joints. Note: If the entire dirt floor is not accessible, cover as much as possible.
5. If the crawl space is a walk-under type, the agency has the option of not installing a moisture barrier, but only if there is evidence that the crawl space is used frequently by the client and is dry.

9400 Electrical Inspections

The electrical wiring in mobile homes is sometimes aluminum. This aluminum wire, when in contact with other metals that are normally part of an electrical system, can cause galvanic corrosion and shorting. As a result of this possibility, special care should be taken.

1. Before insulating mobile homes, inspect and assess the electrical wiring and the circuit breaker/fuse box as follows:
   a. #12 aluminum and #14 copper wiring must be protected with 15 amp fuses or breakers; and
   b. The client should be asked about any known existing electrical problems.
2. Care must be taken to ensure that electrical wiring was not damaged during insulation work. This can be done by testing electrical outlets and switches after completing the work.

9500 Air Leakage Reduction Requirements

1. Perform initial blower door test before any work is done to the mobile home. Repair any obvious, major leaks, utilizing the blower door to direct efforts.
2. Air sealing activities should comply with the Building Tightness Limit (BTL) procedure and calculation in Refer to Section 6200 page 70 of these standards.
3. Only the following air leakage reduction measures may be installed when the existing CFM_{50} measurement is below the calculated Building Tightness Limit:
   a. Ductwork sealing.
   b. Insulation preparation work and insulation installation.
   c. Major repairs to the air barrier and thermal boundary.
   d. Air sealing work that is necessary to block moisture migration into ceilings and walls.
4. In addition to the leakage areas noted in number 3 above, major air leaks should be addressed first, including the plumbing chase behind the washer and dryer, the water heater closet, under the bath tub, and around the electric service entrance conductor. Air leak mitigation measures that enhance client comfort (for example, installing a storm window near a reading chair, installing a jamb weatherstrip kit on a door near a reading chair, etc.) must be documented with a brief explanation in the client file on the Work Plan.
5. Snap fasteners, weatherstripping, and/or drip caps shall be used whenever possible to reduce air and/or water leaks around primary windows.

6. When accessible, the joint (marriage wall) between the two sections of a double-wide must be filled and sealed from underneath the structure.
7. Air leaks in water heater closets with an exterior wall must be sealed, with care taken not to seal off combustion air from the outside.
8. Continue air sealing until it is no longer cost-effective or the Building Tightness Limit is reached.

9600 General Insulation

Insulation shall be installed only in areas of the mobile home envelope that separate conditioned from unconditioned space.

9700 Roof/Ceiling Insulation

1. Recessed lighting fixtures and fan/light combinations that are Type IC (insulation contact) rated by UL may be covered with insulation.
2. Ventilation fan housings and ducts may be covered with insulation if all holes and penetrations are sealed with a nonflammable sealant. Fans must remain operational.
3. Thermal insulation shall not be installed within three inches of fan/light fixtures or recessed light fixtures that are not rated Type IC.
4. All mobile home flues and chimneys must be listed for use in mobile homes to assure adequate clearances are maintained.
5. The ceiling and roof condition must be inspected and assessed before installing insulation.
6. Blocking around combustion appliance vents is required when insulation is installed, except where combustion air is pulled through a pipe that surrounds the combustion appliance vent pipe (concentric pipe system). Follow the manufacturer's recommendation for clearances between vents and combustible insulation.
7. Ceiling insulation must be installed in a manner that ensures complete coverage over heated or cooled areas. Ceiling cavities should be blown to resistance, not dense-packed.
8. Mobile home ceilings shall not be insulated with cellulose or over-filled so as to create structural problems in the ceiling. However, if a framed and sloped roof is built over the original mobile home roof, cellulose may be used to insulate between the added framed roof and the original mobile home roof.
9. If cellulose is installed between the original roof and the added framed roof, ensure that there is no roof venting between the mobile home ceiling and the original mobile home roof. If such ventilation is left in place it effectively short circuits the added insulation between the original and added framed roofs.

10. If an interior drill-and-blow method is used for installing insulation, holes must be plugged and sealed properly. In addition, the hole pattern must be adequate to ensure complete coverage.
11. If an exterior or side-opening (edge lift) installation method is used, all roof penetrations and areas of potential leakage must be sealed with elastomeric sealant (when compatible with roof materials) or another equivalent sealant, as necessary. Areas that are to be patched must be cleaned first, down to the metal roof surface. After insulation, install new mobile home guttering. The edge lift method is the preferred method to insulate mobile home ceilings.
    a. If the roof requires a new coating after this insulation work, make sure the roof is strong enough to support workers. Temporary walking boards are recommended rather than walking on the roof itself.
12. If an end gable blow is utilized, steps must be taken to assure complete and adequate coverage is achieved. Attention to areas behind gussets, trusses, edges and corners is critical. Access to the gable end should be achieved by removing siding. Drilling and cutting is not an allowable method for access.

9800 Ductwork

1. General:
    a. Fiberglass (with the exception of duct board) shall not be left exposed on the inside of ductwork.
    b. Visually inspect registers and boots where there is any evidence of air leakage.
    c. Repair any missing, loose-fitting, disconnected, or blocked ductwork. Repair work is warranted if there is restriction or blockage of the duct that restricts air flow, even if there is no indication of air leakage.
    d. Properly seal all detectable air leaks in duct system.
    e. Inspect, test, and repair, if necessary, the connection between the furnace plenum and the main duct run.
    f. Trunk-end stops are only necessary if it is determined that the installation will reduce duct air leakage.
        i. End stops shall be made from sheet metal or aluminum valley flashing placed a minimum of 12 inches beyond the last register opening in order to retain balanced airflow. If 12 inches is not possible, the minimum must be four inches. Gaps between the stop and the duct must be sealed with mastic.
    g. Closable registers with vanes are not allowable. Existing closable registers must either be replaced with non-closable registers or have the operable part removed.

h. Flat non-reinforced registers are not allowed.
i. Floor registers must not be mechanically fastened to the floor except for situations where they may become a tripping hazard to the client.

2. Belly Return Conversions:
   a. Mobile home belly return air systems must be permanently sealed from the occupiable space. A living-space return air system must be created by:
      i. Either removing the furnace closet door, or installing an adequately sized return air grille(s) in the furnace closet door;
      ii. Sealing the return grilles in the floors of bedrooms, bathroom, kitchen, living area, etc.;
      iii. Sealing the return air grille in the furnace closet floor; and
      iv. Allowing for return airflow under closed bedroom and bathroom doors in a manner that reduces the room-to-room pressure difference – with the door closed and the air handler operating – to three Pascals or less.
   b. For a discussion of duct leakage measurements and standards, follow the instructions in Section 61300 on page 79.
   c. For ductwork sealing and insulation, follow the instructions in Section 11100 on page 125.
3. Crossover Duct Repair and Treatment:
   a. Crossover ducts shall be repaired or replaced in a manner that prevents compression or sharp bends, minimizes stress at connections, avoids standing water, and avoids long runs. When there is no skirting, the crossover duct shall be protected against rodents, pets, etc., and properly suspended above the ground. If replacement is needed, replace with hard line duct and insulate to R-6.
   b. Flexible crossover ducts shall have a minimum R-6 insulation. They shall be secured with mechanical fasteners (for example, stainless steel worm drive clamps, plastic/nylon straps applied with a tightening tool, etc.) and sealed with mastic or a comparable pressure-sensitive tape.
   c. Existing flexible crossover duct with an insulation R-value of four or less which has been damaged may be replaced with new foil-faced flexible duct with R-6 insulation.
   d. The crossover duct must be replaced if the inner lining is brittle or made of mesh. If in doubt, replace it. In many cases, a leaky crossover can be repaired by cutting out the section of duct containing the leak. A fabricated sheet metal sleeve can be inserted between the remaining pieces of crossover duct. The metal sleeve must be attached to the flex duct crossover using ratcheting plastic straps and insulated.

e. Crossover ductwork must be appropriately secured above the ground. It may be supported by strapping or blocking.
f. Flexible duct shall not be allowed to sag more than 12 inches over a span of eight feet.
g. Flexible duct must be foil faced since it is located in an unconditioned space.

9900 Floor (Belly) Insulation

1. Floor Insulation Requirements:
   a. Repair and seal ducts before insulating the floor.
   b. Belly rodent barriers must be inspected for general condition, structural strength, and major air leaks prior to installing insulation.
   c. Make necessary belly rodent barrier repairs if additional insulation will be added, or if holes in the belly allow significant air movement between the belly cavity and the outside.
   d. Belly cavities must be inspected to determine the location of the plumbing, any plumbing leaks, and the R-value of existing insulation. Leaks should be fixed prior to weatherization.
   e. Belly insulation shall be installed only after all repairs have been made, major holes in the rodent barrier and floor have been sealed, and all ductwork has been sealed according to Section 61300 on page 79.
   f. Belly insulation must be installed in a manner that ensures complete coverage of all heated areas. Holes that have been made in belly rodent barriers for the installation of insulation must be patched and sealed. One section of a three-tabbed shingle can be put into the cavity at the tube access point before insulating, and then moved into place to cover the slit in the belly after the insulation is installed.
   g. Bellies shall not be dense-packed with cellulose or over-filled so as to create undue stress on the belly rodent barrier. Belly cavities should be blown to resistance, not dense-packed.
   h. If for any reason parts of a mobile home belly cannot be insulated, all other parts must be insulated, unless the parts that cannot be insulated will allow airflow to short-circuit the effectiveness of the insulated sections.
2. Floor Insulation Methods:
   a. Loose fill fiberglass is the preferred insulation material for mobile home bellies.
   b. Bellies that hang up to eight inches below the floor in the center area should be filled entirely with insulation blown at the required densities.

c. Bellies that are greater than eight inches below the floor at the center area should be insulated but only after attempts have been made to bring the rodent barrier closer to the floor above. Furring strips or other rigid materials should be utilized. This must be done with care to avoid damaging the duct trunk line or water lines in the belly.
d. The underneath-belly blow method is the preferred method. When insulated from underneath, the use of the insulation hose or a large diameter fill tube is preferred; a 90º nozzle may not be used.
    i. When insulation is installed from underneath the belly, it is preferred that the first person to go underneath install a six mil vapor barrier on the ground in order to reduce health risks to the installers from animal feces.
e. If bellies cannot be insulated by the underneath-belly blow method, such as less than 18 inches access, then access through the rim joist and use of a fill tube should be used for installing the insulation.
f. Make belly patches durable and secure by using adhesives, clinch staples, screws, and lath strips whenever possible.
g. Insulated sheathing board, fiberboard, and nylon-reinforced belly bottom material specifically manufactured for mobile homes are the preferred patching materials for large holes in belly rodent barriers.
h. Ductwork must be inspected for insulation that might have accidentally been installed inside the ductwork during insulation work.
i. Upon completing insulation work, rim joists that have been drilled shall be plugged with an appropriate plug. The plug shall be sealed in the hole with an adhesive compound.
j. If a mobile home is fully skirted, a ground cover must be installed to prevent evaporation of ground moisture. If a mobile home is not fully skirted, a ground cover is not required.
    i. Installing mobile home skirting is not an allowable measure.
    ii. Low-cost repairs to existing skirting are allowed.

91000 Insulation of Water Supply Systems

1. Water pipes that have not been protected from freezing with under-floor insulation should be insulated to a minimum of R-3.
2. The piping shall be free from water leaks and properly secured to support the weight of the piping and insulation.
3. The insulation product may be either a) flat and capable of being molded to the outside of the pipes, or b) preformed to fit standard pipe diameters. If the product is preformed, dimensions shall be appropriate for the pipe size. Do not use fiberglass pipe wrap except

in situations where preformed foam pipe wrap will not conform to the existing plumbing.

4. If the insulation is exposed to the weather, it shall be resistant to degradation from moisture, ultraviolet light, and extremes in temperature, or a jacket or facing shall be installed that protects the insulation from these conditions.
5. To prevent freezing, box the individual water supply system pressure tank with two inches of extruded polystyrene insulation. Make sure the outer surface of this insulation is protected from direct sunlight.

91100 Water Heaters and Their Closets

1. At a minimum, water heaters in closets with an exterior wall must be treated as follows:
   a. The tank should be wrapped with an insulation blanket. Please refer to Section 12100 on page 131 for instructions.
      i. Large holes in the closet walls that allow air leakage into the interior must be sealed.
      ii. All plumbing within the closet that is susceptible to freezing must be insulated.
      iii. An adequate amount of combustion air must be provided to gas water heaters.
   b. If it is not possible to wrap the water heater with insulation, the exterior access door and adjacent exterior walls of closets containing electric or gas water heaters should be insulated, if possible. If the door and adjacent wall can be insulated, the water heater shall not be wrapped with insulation.
      i. Cover any air vents in the door or adjacent exterior wall.
      ii. Bring combustion air from underneath the belly or through any skirting by installing an appropriately sized metal or PVC chute with a rodent barrier when there is not a concentric flue.
2. When treating a water heater closet that houses a non direct-vent gas water heater, air seal and insulate the interior walls and provide adequate combustion air.
3. Insulate first three feet of cold water pipe from the hot water tank and all exposed hot water pipe. Insulate any other cold water pipe exposed to freezing temperatures. Maintain clearances from combustible pipe insulation with gas water heaters.
4. Set hot water temperature to 120^{o}F and educate client about how this will save energy, but might force shorter showers. If a dishwasher is present, set the temperature to 140^{o}F unless the dishwasher has a pre-heater.
5. Install low-flow showerheads when shower flow exceeds three gallons per minute (one gallon in 20 seconds).

91200 Combustion Systems

1. If interior combustion air is used for the furnace, replacement with a sealed combustion (direct-vent) furnace should be considered.
2. Always change the furnace filter.
3. If a furnace filter is replaced with a disposable filter, leave another washable filter behind with the client and instruct the client how to replace the filter.
4. All fuel-burning, heat-producing appliances in mobile homes, except ranges and ovens, must to be vented to outside. Further, all fuel-burning appliances in mobile homes, except ranges, ovens, illuminating appliances, clothes dryers, solid fuel-burning fireplaces and solid fuel-burning fireplace stoves, must be installed to provide for the complete separation of the combustion system from the interior atmosphere of the manufactured home (i.e., to draw their combustion air from outside). Therefore, if interior combustion supply air is used for a furnace or water heater, replacement with a sealed combustion (direct-vent) furnace or water heater is required.

Optional measures should be evaluated on a case-by-case basis on the guidance in the mobile home priority list. When these measures prove cost-effective, they may be installed.

91300 Inside Storm Window Installation

1. The MHEA should be used to justify installation.
2. Panels must be removable, the panels numbered, and the client educated to their removal, storage, and reinstallation. This measure should not be done unless the job supervisor is assured by the client that they will maintain and reinstall panels correctly.
3. Self-storing insider storm windows can also be considered if MHEA justified.

91400 Baseload Electricity Reduction

Electric baseload measures, as described in Section 12000 on page 131, are to be considered for mobile homes, including refrigerator replacements, compact fluorescent light bulbs, and low-flow showerheads.

10000 Space Conditioning Appliances

10100 General Requirements

The efficient operation of heating and cooling systems is a critical aspect of efficient energy use. Replacing or repairing heating and cooling systems is allowed from an energy efficiency or health and safety standpoint. This section provides standards on the maintenance, repair, safety, efficiency improvements, and replacement of existing heating appliances.

10110 Appliance Work Documentation

1. Each client file must include documentation of all efficiency work, adjustments, or replacements made to the water heating, space heating, and space cooling appliances. This documentation is normally completed on the Heating Unit Repair and Maintenance Sheet (HURMS) of the Work Plan.
2. Documentation must include information on the applicable combustion appliance efficiency tests (see Section 10120 on page 115).
3. Before the work on a combustion appliance is complete, a representative of the agency must have finished a review of all combustion appliance forms and determined that the combustion appliance(s) meets the appropriate specifications.

10120 Combustion Efficiency

1. The steady-state efficiency of all heating system should be checked to determine:
   a. If it needs cleaning and tuning.
2. Replace the heating system if the priority list or applicable conditions are met (see Section 10300 on page 120).

10200 Health and Safety Measures for Combustion Appliances

With the use of blower door technology and dense-pack sidewall insulation, houses are being sealed tighter than ever before. In accordance with the "house-as-a-system" approach to weatherization, there might be existing indoor air quality conditions and combustion venting problems that may be intensified by air sealing activities. As a result, the following health and safety tests and inspections apply to all homes to be weatherized.

10210 Vent System Inspection

An inspection of the vent system must be completed to ensure that the proper size and type of venting pipe is used, the condition of the vent pipe is satisfactory, and the clearances meet applicable codes. Ensure that the vent system is unobstructed. Use Table 10-1 below for guidance. Refer to appropriate codes and manufacturer's instructions, if appropriate.

Table 10-1
Required Vent Types and Clearances

Gas	Oil	Solid Fuel
24 gauge single-wall galvanized 6 inches from combustibles	24 gauge single-wall galvanized 18 inches from combustibles	24 gauge single-wall black pipe 18 inches from combustibles
B-vent and BW-vent 1 inch from combustibles	Smoke pipe Type L double-wall PMI from combustibles	Smoke pipe Type L double-wall PMI from combustibles
Approved thermo-plastic for 80+ and 90+, 0 to 5 inches from combustibles PMI	Metalbestos all-fuel pipe 2 inches from combustibles	Metalbestos all-fuel pipe 2 inches from combustibles
Schedule 40 for 90+ condensing 0 inches from combustibles PMI	Stainless steel flexible liner must be installed as a kit	Stainless steel flexible liner must be installed as a kit
Flexible flue liner kit, must be installed as a kit	Residential vents must have a single acting barometric damper -.04 inches WC	
All horizontal sections of vent must have a ¼ inch per foot slope down to the appliance.		

1. Mobile home vents:
   a. There are no approved gas atmospheric furnaces for mobile homes; however, there are some atmospheric water heaters. They will be clearly marked "Approved for Mobile Home Installation" and will have certain installation requirements.
   b. Prior to 1976, mobile home furnaces got combustion air from underneath the mobile home by a duct or hole in floor. These furnaces had a single wall flue pipe.
   c. Post-1976 mobile home furnaces must be sealed combustion. A sealed combustion mobile home flue is a double wall concentric vent stack that routes flue gasses out through the inner stack and draws combustion air from the roof down between the inner and outer vent pipes.
   d. Vent repairs or replacements should be done according to applicable codes.

10220 Appliance Clearances

Check for adequate clearance of space heaters, furnaces, and flues from combustion materials. If the clearance is not sufficient, corrective action must be taken to ensure all applicable codes are followed. Refer to appropriate codes and manufacturers' instructions, if appropriate.

10230 Combustion Supply Air for Heating Appliances

Identify the combustion air source and make sure it is unobstructed and sufficient, as defined by the appropriate NFPA code. Use the method below to meet code requirements for combustion supply air:

1. The minimum volume of the combustion appliance zone (CAZ) is 50 ft^3 per 1000 BTUh input rate of vented combustion appliances in the CAZ.
2. If combustion supply air is not adequate, correct the situation with the guidance of NFPA 31 (oil), 54 (gas), or 211 (solid fuel).

10240 Combustible Gas and Oil Leaks

Gas leaks can be dangerous and are literally a total waste of energy. Additionally, natural gas and LPG act as a greenhouse gas that is about twenty times more potent than carbon dioxide. Check for gas leaks on all natural gas and LPG gas appliances and supply lines. Check for natural gas leaks above fittings; check for LPG leaks below fittings. All gas leaks must be repaired before any work is done. Verify gas leaks with a soap solution (note: do not use soap solution of flexible CSST tubing). If a gas leak is found:

1. Severe gas leaks:
   a. Shut down the main gas valve at the gas meter, if it is outside.
      i. Inform the client and leave the dwelling.
      ii. Contact the fuel supplier and have the problem fixed.
2. Moderate gas leaks:
   a. Tighten the pipes and fittings (with gas supply off).
   b. Replace pipes that have holes or cracks, making sure all connections are properly sealed.
   c. Ensure that all materials and sizes comply with NFPA and local codes.
3. All gas leaks must be fixed before weatherization work begins. Document leaks and repairs in the Work Plan. Gas leaks on buried lines outside the house/thermal envelope are not the responsibility of the Weatherization Assistance Program, but can be repaired when feasible.

4. Oil supply lines and components must also be checked for leaks. If leaks are found, repair in accordance with NFPA and local codes.

10250 Venting System Spillage

Spillage testing must be done after the weatherization job is complete, since air sealing work can have an effect on draft. With the combustion appliance zone (CAZ) under worst-case conditions test for spillage after two minutes of burner operation on all vented combustion appliances that have a negative pressure in their vent connectors. If spillage occurs, determine the cause and mitigate the hazard.

Because approved mobile home furnaces are direct-vent, sealed combustion units, spillage testing is not required. Other direct-vent appliances in site-built homes do not require spillage testing.

10260 Carbon Monoxide Emissions, Ambient and Flue Gas

Carbon monoxide is a hazardous gas that is a common byproduct of both vented and unvented combustion. Testing for CO must be done to ensure the safety of clients and workers:

1. Ambient CO testing:
   a. Upon entering the job site living space, an ambient CO reading must be taken. If any level of CO above nine ppm is found, the source must be identified and the problem corrected. If a level of nine ppm or higher is found, a Carbon Monoxide Warning Statement must be filled out and discussed with the client. A copy is to be given to the client and a copy is to be inserted into the client file.
   b. An ambient air test for CO must be taken on solid-fuel appliances, unvented heaters, and gas cook stoves. If any level of CO above nine ppm is found, the source must be identified and the problem corrected.
   c. Post-weatherization CO readings must be taken and documented to ensure that weatherization measures did not exacerbate an existing CO problem.
2. In all vented combustion appliances, a CO test of undiluted flue gases must be done. If levels are above 100 ppm as-measured in the undiluted flue gas sample, corrective action must be taken to reduce the CO to lower acceptable levels. If a level of 100 ppm or higher is found, a Carbon Monoxide Warning Statement must be filled out and discussed with the client. A copy is to be given to the client and a copy is to be inserted into the client file.
3. For gas oven bake burners, CO must be checked at the oven vent termination in a sample of undiluted combustion gas. The reading must be less than 100 ppm as-measured or 400 ppm air-free. The

CO emissions increase and then peak just after burner start up, they then fall to a momentary plateau before the burner shuts down as part of the duty cycle. The reading CO ppm must be taken during this stable plateau. If readings are higher than those stated above, corrective action must be taken.

a. If readings are detected above the minimum levels:
    i. Immediately inform the client and fill out the Carbon Monoxide Warning Statement Form.
    ii. Determine the source(s) and cause(s) of the problem and document reading(s) in the Work Plan.
    iii. At this point no weatherization work is to begin.
    iv. A plan of action is to be determined based on the skill level of the crew and implemented to correct the problem before any weatherization work can continue. This may involve using a contractor.
    v. If for some reason the client refuses the corrective action, the job is to be terminated and a written explanation along with a completed Carbon Monoxide Warning Statement documenting the reason inserted in the client file.

10270 Draft for Vented Combustion Appliances

Perform a stack (breech) draft test on all vented natural gas, LPG gas and oil appliances to ensure an adequate draft. Draft readings are to be taken at steady-state conditions with the combustion appliance zone (CAZ) under worst-case depressurization. Overfire draft must be checked on all oil- and gas-fired power burners.

10280 Smoke and Carbon Monoxide Alarms

A CO alarm or combination CO and smoke alarm must be installed in all homes with combustion appliances, including forced air furnaces, space heaters, gas or oil hot water heaters, boilers, solid-fuel stoves and furnaces, gas ranges, and unvented space heaters. These alarms should be the plug-in type and have battery backup. At a minimum, one alarm is to be installed on each floor of the living space. Locate alarm according to manufacturer's recommendations.

The cost of the CO alarm or combination CO and smoke alarm is a health and safety material cost. Educate the client to ensure that they clearly understand how to change batteries and safely maintain the alarm.

10290 Combustion Safety Testing

All oil- and gas-fired furnaces, boilers, and water heaters – with the exception of direct-vent units – must be tested with worst-case draft test procedures.

102100 Hold Harmless Statement

There may be instances when health and safety problems might remain after weatherization has been completed on a dwelling. These can include:

1. Repairs relating to combustion appliances that are too extensive or costly for the West Virginia Weatherization Assistance Program to remedy. An example is an aged, asbestos covered boiler.
2. Existing conditions in a dwelling that are beyond the control of the weatherization agency. Examples include the client use of unvented kerosene or gas space heaters as a secondary heat source.

The Hold Harmless Statement is to be used to document existing potential health and safety problems that remain after the weatherization work is completed.

1. An agency representative must explain the problems to the owner, and in the case of a rental unit, the client.
2. The health and safety problem(s) and corrective measures the owner and/or client can take must be documented on the form with as much detail as possible.
3. The owner and agency representative must sign and date the statement.
4. A copy of the form must be given to the owner.

10300 Central and Space Heater Replacement

Every effort will be made to repair the existing heating unit before replacement is considered. Replacement will be allowed only when the unit cannot be cost-effectively repaired or made to operate safely. Every effort must be made to get the maximum efficiency possible with an existing installation. Inspections must be done to ensure that wiring and chimneys are in good condition and that there are no obvious building code violations. All efficiency measures must be performed and documented.

10310 Replacement of Heating Systems, General

Replacement of a heating system (furnace or space heater) is allowed when one of the following conditions exists:

1. The heat exchanger is cracked and a new one cannot be located or is cost prohibitive to install;
2. Major repairs total 2/3 or more of the cost to replace the unit;
3. The unit design is very inefficient or the unit is grossly oversized (justified by *Manual J*, NEAT, or MHEA), resulting in high heating bills or combustion air, venting, or clearances that cannot meet national, state, and local codes.

a. A grossly oversized unit can be replaced under two conditions:
    i. The existing unit is 40 percent or more oversized based on *Manual J*, NEAT or MHEA.
    ii. If an existing unit is suspected of being 40 percent or more oversized and/or has an input greater than 100,000 BTU/hr. Written sizing justification must be included in the client file before it can be replaced.

4. Weatherization work causes the existing heating unit to become grossly oversized based on *Manual J*, NEAT, or MHEA.

10320 Replacement Heating System Sizing

All gas, oil, and electric replacement units must be sized according to *Manual J*, NEAT, or MHEA.

1. Documentation of heating system sizing must be included in the client file.
2. Replacement primary heating equipment must not be sized less than 50,000 BTU/Hr input for residential applications and 40,000 BTU/Hr input for mobile home applications.
3. Heating systems should not be oversized by more than 25 percent.
4. If the calculated size is not locally available, using the next higher size appropriate for the job is permissible.

10330 Furnace Replacement

1. Furnace replacements must have a rated annual fuel utilization efficiency (AFUE) of greater than 80 percent. Higher efficiency units are preferred. 90-plus, high-efficiency furnaces are to be installed whenever possible unless this higher efficiency cannot be justified.
2. Contact the West Virginia GOEO before any boiler replacement.

10340 Space Heater Replacement, Excluding Solid-Fuel Appliances

1. Space heaters with steady-state efficiencies of 64 percent or less must be replaced. Space heaters with steady state efficiencies greater than 64 percent can be replaced if there are other conditions present that may justify replacement, such as health and safety considerations, multiple space heaters being replaced by one unit with significantly less BTU/hr input, or other factors listed below. The justification must be documented in the client file.
2. In homes where unvented space heaters are the primary heating source and there is no repairable existing vented heat source, the agency must install a vented heating system whenever reasonably

possible. If this is not possible, no weatherization work may be done. In most cases, this will mean the installation of a direct-vent wall heater(s). This policy is based on the fact that weatherization of the dwelling will result in the probability of increased moisture and indoor air quality issues resulting from an unvented space heater.

3. West Virginia strongly encourages removal of all unvented gas- and liquid-fueled space heaters and replacement with vented, code-compliant heating systems as a prerequisite to weatherization. However, unvented gas- or liquid-fueled space heaters may remain as secondary heat sources in single-family houses provided they comply with the International Residential Code and the International Fuel Gas Code. Funds may not be used to replace unvented secondary space heaters. Any unvented gas- or liquid-fueled space heaters that remain in a single-family house after weatherization:
   a. Shall not have an input rating in excess of 40,000 BTU/hour;
   b. Shall not be located in, or obtain combustion air from sleeping rooms, bathrooms, toilet rooms, or storage closets, unless:
      i. Where approved by the authority having jurisdiction, one listed wall-mounted space heater in a bathroom with an input rating that does not exceed 6,000 BTU/hour, is equipped with an oxygen-depletion sensing safety shut-off system, and the bathroom meets required volume criteria to provide adequate combustion air;
      ii. Where approved by the authority having jurisdiction, one listed wall-mounted space heater in a bedroom with an input rating that does not exceed 10,000 BTU/hour, is equipped with an oxygen-depletion sensing safety shut-off system, and the bedroom meets required volume criteria to provide adequate combustion air.
   c. If any unvented kerosene heater is left in the dwelling after weatherization, including a newly installed unit, a Hold Harmless Statement must be completed and put in the client file. Client education must be provided on the limited use of the unvented space heater.
4. Any space heater replacement or repair procedure should include inspection to ensure that working smoke and carbon monoxide detectors are installed on the same floor as the space heater. In instances where smoke and carbon monoxide detectors are not present or are not operating properly, new detectors may be purchased and installed with DOE funds. The purchase and installation cost of the smoke and carbon monoxide detectors may be charged to the health and safety category or to program operations at the State's discretion.
5. DOE policy does not allow fuel switching except on a limited case-by-case basis. An exception to this rule is with unvented kerosene

heaters, where fuel switching is allowed when practical. Specific replacement and fuel types are discussed below.

6. Electric space heaters: DOE does not allow WAP-funded work on electric space heaters other than incidental repairs.

10350 Solid-Fuel Appliance Replacement Policy

Solid-fuel appliances are defined as those that burn wood (cord or pellet) and coal. Solid-fuel appliances include heating stoves, ducted gravity furnaces, and forced air furnaces. The venting and clearances of existing installations must be made, when reasonably possible, to comply with the current edition of NFPA 211. Repairs are preferred to replacements.

1. Replacement of a solid fuel appliance is allowed only when there is a crack in the heat exchanger that can cause a carbon monoxide problem or a fire hazard. All replacements must comply with the current NFPA 211.
2. There may be situations where the costs of a new installation or the repair of an existing installation may be too expensive for the Weatherization Assistance Program to incur.
   a. In some cases, the owner may have to be responsible for some or all of the costs for making a solid fuel appliance installation safe.
   b. In situations where an owner is responsible for making any health and safety repairs; a Hold Harmless Statement must be completed with an addendum describing each problem to be corrected. A copy must be left with the owner and a copy becomes a part of the client file.
3. Cost of repair and replacement of solid fuel appliances are to be charged to health and safety.
4. Replacement of solid fuel gravity furnaces, forced air furnaces, and boilers will not be permitted and are considered beyond the scope of weatherization. However, repair of existing units will be permitted.
5. Solid-fuel appliances in mobile homes:
   a. Replacement of solid-fuel appliances in mobile homes must be mobile home approved direct-vent stoves. Mobile home solid-fuel stoves and approved venting systems are expensive. The material costs for these measures can easily exceed the targeted 15 percent of the total material cost for the job allotted for health and safety, so careful consideration must be given to the replacement of mobile home solid-fuel appliances.

10360 Subcontracting Heating System Work

Agencies who use contractors for any heating system replacement are responsible for verifying and documenting that the heating system needed replaced, was properly sized using *Manual J*, NEAT, or MHEA, that the installation complies with all national, state, and local codes, and that all West Virginia Weatherization heating system (including duct measures and standards) policies and procedures were followed. Agencies are responsible for ensuring that all mandatory health and safety testing and post-weatherization documentation is in the client file.

11000 Heating/Cooling System Distribution

11100 Ducted Distribution Requirements

Making the heating unit safe and efficient, while important, is only part of making the entire heating system as effective as possible. The condition of the delivery system will define the amount of heat that is actually delivered to the dwelling. A detailed inspection of supply and return ducts for air leaks or blockages must be made, and all problems corrected. Do not attempt to repair/seal ductwork on which asbestos is present.

Ductwork treatment is dependent on a number of factors, including its location, accessibility, its impact on dwelling pressures, and its condition.

11110 Ductwork Inspection, Cleaning, and Sealing

1. Ductwork must be tested and sealed according to Section 61300 on page 79.
2. Existing flex duct must be adequately supported without sags. Additional support is often needed.
3. Delivery and return ductwork must be cleaned as necessary to remove large objects and debris that may impede airflow through the heating system.
4. Uncover any blocked registers or grilles. Explain to the client the importance of maintaining the unrestricted airflow.
5. As necessary, supply registers and return air grilles must be removed and cleaned to remove excessive dirt and debris that may impede airflow. It may be necessary to use a cleaning solvent such as mineral spirits or denatured alcohol to eliminate any greasy buildup to ensure the duct sealing material will adhere properly.
6. When appropriate, remove and block off ducts, registers, and grilles located in unconditioned spaces.
7. Ductwork outside the thermal envelope of the dwelling must be sealed with mastic and insulated.
8. All accessible return air ductwork within a combustion appliance zone (CAZ), except gravity systems, must be sealed enough to eliminate the potential for backdrafting.
9. Ducts and registers into non-living areas of the structure may be sealed off with the owner’s permission as long as system efficiency is not compromised.
10. Existing crawl spaces used as plenums should be abandoned and replaced with a sealed duct system.
11. Cloth duct tape shall never be used for duct sealing.

   a. Ductwork sealing shall be done with mastic, fiber mesh tape, or sheet metal. Gaps of 1/8 inch or less may be sealed with duct mastic.
   b. Gaps between 1/8 inch and one inch shall be sealed with duct mastic embedded with fiber mesh tape.
   c. Gaps larger than one inch shall be covered with sheet metal or valley flashing, fastened with screws, and sealed with mastic.
12. New ductwork installations may not include panned joists or stud cavities for ducts. All passageways for distribution air must be hard ducted; panned floor joists may not be used.
13. If the boot is loose to the floor, it shall be reattached to the subfloor with roofing nails or staples. Wood screws may also be used. Ensure that the heads of the screws do not prevent the register or grille from fitting properly into the boot.
   a. If gaps exist between the boot and the floor and the space below the floor is unconditioned, fill the gaps with mastic or other appropriate materials.

11120 Ductwork Sealing Materials

1. Cloth duct tape shall never be used for duct sealing.
2. Existing duct tape must be removed before installing duct mastic or other approved sealing materials
3. Mastic shall meet the following requirements:
   a. Non-toxic and water-resistant.
   b. UL listed and labeled per UL 181A or 181B standards.
   c. Shall be compatible with the duct material to which it is applied.
4. Fiber mesh tape used to reinforce duct mastic shall meet the following requirements:
   a. Comply with the mastic manufacturer's specifications.
   b. Made of fiberglass.
   c. Have at least a 9 x 9 weave per inch.
   d. Be at least 0.006 inches in thickness.
5. Draw bands used to support or seal ductwork shall meet the following requirements:
   a. Comply with the manufacturer's installation instructions.
   b. Weather- and UV-resistant duct ties or stainless steel worm drive clamps
   c. Loop tensile strength must be at least 150 pounds.
   d. Service temperature rating must be at least 165^{o}F.
6. Duct supports shall conform to the duct manufacturers' installation instructions and must be corrosion resistant.

11130 Ductwork Insulation

1. Active ductwork outside the thermal enclosure must be repaired if damaged, then sealed and insulated.
    a. Prior to installing insulation, ductwork must be sealed according to these Standards.
        i. Exception: Inaccessible parts of the distribution system do not require thermal insulation. Inaccessible means nearly impossible to insulate because of location or obstructions.
2. Supply and return ducts and plenums located within the thermal enclosure do not require thermal insulation.
    a. Exception: There might be cases where duct insulation is appropriate if within the thermal enclosure, such as a basement. For example, if there is not adequate heat getting to a room, the branch duct may be insulated for reasons of thermal comfort as long as the following items have been checked and/or implemented first:
        i. There are no branch duct obstructions to airflow.
        ii. The branch duct balancing damper is fully open.
        iii. The branch duct air leakage has been checked and sealed, if necessary.
3. Combustion vents should not be insulated.
4. For ductwork that is not within the thermal enclosure of the dwelling, install a minimum of R-6 on ducts and plenums.
    a. If ductwork is already insulated to a level of R-4 or greater, no additional insulation is required, however, make appropriate repairs to the existing insulation.
5. Insulation must have a flame spread rating no greater than 25.
6. It is best to use vinyl-backed, reinforced foil duct wrap, or two-part foam on ducts.
7. The duct insulation should be installed with the vapor barrier on the outside, which will serve to cover the insulation. Any ductwork used for space cooling should have the vapor barrier taped at joints.
8. Do not wrap duct insulation so tightly that it is excessively compressed. It should not be compressed more than 50 percent of normal thickness.
9. Maintain proper clearance between duct insulation and combustion appliance flues.
10. Install protective covering around the insulation where required by local regulations.
11. Ducts with existing asbestos insulation must not be disturbed.

11140 New Ductwork Installations

1. New ductwork should not be installed unless absolutely necessary.
2. Ducts, supply registers, and return grilles should be sized and selected according to the latest editions of *Residential Duct Systems*, *Manual D*, by ACCA; *Residential Comfort System Installation Standards Manua*l by the Sheet Metal and Air Conditioning Contractors' National Association (SMACNA); or a comparable industry-accepted method.
3. Attempt to install all new ductwork within the thermal enclosure.
4. Do not install ductwork within exterior walls.
5. Building frame cavities, closets, crawl spaces, and chases must not be used as ducts. However, ductwork may be housed by, or pass through these spaces.
6. Ductwork must be installed at least four inches from any bare earth.
7. Panned floor joists may not be used for air distribution.
8. A crawl space may not serve as a distribution plenum.
9. Do not use a dropped ceiling cavity as a plenum.
10. Flex duct can be used if more cost-effective to do so. Sections longer than 14 feet must be joined with a metal connection, mechanically fastened, and sealed at all joints. Flex duct must be supported according to manufacturers' specifications. Insulation mesh works very well for this purpose.

11200 Piped Distribution Requirements

Treatment of distribution pipes for hot water or steam heat, or for domestic hot water is dependent on a number of factors, including its location, accessibility, and its condition.

11210 Steam and Hot Water Heat Distribution Pipes

1. Make certain there are no leaks in hot water or steam distribution pipes.
2. Supply and return lines in spaces outside of the thermal enclosure must be insulated if they are accessible.
3. Pipes may be insulated within the habitable space if it is determined that the space does not require heating or is overheated.
4. Pipe insulation must be sized to the pipe being insulated.
5. Pipe insulation must be rated for 160^{o}F.
6. Secure the pipe insulation with mechanical fasteners or appropriate tape.
7. Pipe insulation must have mitered cuts at corner joints. Tape joints appropriately.

8. Pumps, valves, pressure relief devices, or vents should not be insulated. Do not insulate over heat tape.
9. Closed cell foam, high temperature rated insulation or elastomeric pipe insulation should be used that has a flame spread rating no greater than 25.
10. Maintain a proper clearance between pipe insulation and combustion appliance flues.

12000 Baseload Measures

The energy used by electric or gas appliances that is not related to space heating or cooling is called baseload energy. Usually the baseload use is consistent from month to month. Baseload energy includes lighting, refrigeration, water heating, cooking, washer and dryer, and electronics.

12100 Storage Water Heaters

Based on a run of sample NEAT audits, the following standards apply to installation of water heater tank insulation.

1. Never insulate the water heater if it will void the manufacturer's warranty.
2. If there are two inches or more of foam insulation or three inches or more of fiberglass insulation on the tank, no additional insulation is needed.
3. The water heater should be insulated if there is one inch or less of foam insulation or two inches or less of fiberglass insulation. While the SIR for water heaters in unconditioned areas is higher, the installation of water heater insulation is also justified in most conditioned areas.

12110 Water Heater Insulation Materials

1. Hot water tanks must be insulated to a minimum of R-5. Water heater tank wraps must be fiberglass insulation with a vinyl backing, installed with the protective backing to the outside.
2. A water heater blanket must be secured to the water heater with at least two (2) vinyl straps (zip strips), and the insulation seams must be stitch stapled. The installed straps must not excessively compress the water heater blanket. Taping is not allowed as a sole fastening system.

12120 Installation of Water Heater Insulation

1. The water heater tank must be inspected to determine the type of water heater (gas, electric, other), and whenever possible, the amount of existing insulation.
2. If there are signs that the water heater is leaking, this problem must be solved before insulation is added.
3. Do not insulate a water heater if added insulation will void the manufacturer's warranty.
4. A water heater blanket must not be installed when a temperature and pressure relief valve does not exist or does not operate properly. If the water heater will accommodate a temperature and pressure relief

valve and discharge line, install them and then insulate the water heater.

5. A electric water heater blanket must not cover the following:
   a. The pressure relief valve on an electric unit.
   b. The drain valve on an electric unit.
   c. Exception: The access panels to the controls can be covered but must be marked.
6. A gas water heater blanket must not cover the following:
   a. The top of the storage tank.
   b. The gas and temperature controls.
   c. Combustion air supply to the heater.
   d. Any opening between the tank and the floor.

12130 Domestic Hot Water Temperature

1. Whenever feasible, the domestic hot water temperature must be measured and reduced to 120^{o}F or less with the approval of the client/owner. If the client has a dishwasher without a water pre-heater, set the water temperature at 140^{o}F.
2. The client/owner must be informed that lowering the temperature of the water will result in less thermal energy stored in the hot water; therefore, they may run out of hot water sooner.
3. The original water temperature and the new settings must be documented on the HURMS page of the Work Plan.
4. Unless the water temperature is indicated on the thermostat or water heater control, the temperature coming out of the nearest faucet must be taken with a good quality digital thermometer to determine the water temperature.

12140 Domestic Hot Water Pipes

1. Make certain there are no leaks in domestic hot water pipes.
2. Insulate all exposed hot water pipes and the first three feet of cold water pipe with pipe insulation. In addition, insulate any exposed cold water pipe that is subject to freezing.
3. Closed cell foam, high temperature rated insulation or elastomeric pipe insulation should be used that has a flame spread rating no greater than 25.
4. Maintain a minimum of six inches between pipe insulation and all heat sources.
5. Pipe insulation must be sized to the pipe being insulated.

6. Secure the pipe insulation with mechanical fasteners or appropriate tape.
7. Pipe insulation must have mitered cuts at corner joints. Tape joints and seams appropriately.

12200 Water Heater Replacements

Water heaters can be replaced on a case-by-case basis under certain conditions. Replacement would rarely, if ever, be justified based on having a SIR greater than one; most replacements can be justified only because of health and safety concerns.

1. Replacement electric heaters must have an energy factor of at least 0.92. Replacement gas heaters must have an energy factor of at least 0.62.
2. Water heaters can be replaced based on the following conditions:
   a. The tank leaks and cannot be permanently repaired;
   b. The water heater does not work.
3. Replacements must be made according to manufacturers' specifications and applicable codes.

12300 Energy-Saving Showerheads

1. An energy-saving (low-flow) showerhead should be installed with client permission, if the existing showerhead flow is measured at greater than three gallons per minute (gpm) – or one gallon in 20 seconds – and the installation does not require the use of a plumber.
2. The energy-saving showerhead must have a flow rating of 2.5 gpm or less.
3. If an energy-saving showerhead is installed in conjunction with lowering the domestic hot water temperature, the chances are high that the client will not notice less hot water for showering, as they might if the temperature is reduced without installing the new energy-saving showerhead.

12400 Gas-Fired Cooking Ranges

Gas ranges shall be inspected, tested, and appropriate client education shall be delivered to an adult client in the household.

12410 Inspection, Testing and Adjustment of Gas-Fired Ranges

1. Check for CO in ambient air upon arrival. If greater than 9 ppm, determine the source and correct the problem before proceeding.

2. Inspect the gas range installation for code compliance. Refer to the latest edition of the National Fuel Gas Code (NFPA 54), section 6.15: Household Cooking Appliances.
3. Check for gas leaks. If leaks are found, repair and document them before proceeding.
4. Check the flexible range connector for the date ring. If the connector doesn't have a date ring and/or is brass, replace the connector. The connector must connect outside of the cabinet and must pass through the wall of the range cabinet.
5. For the range top burners:
   a. Turn on each burner and test for CO after four minutes of continuous operation. Measure the CO emissions approximately six inches above each operating burner.
   b. If the reading is above 25 ppm as-measured, then:
      i. Check to see that all burners light. If not, check pilot light, flash tube, and carryover ports for obstructions.
      ii. Remove and clean the burners if needed.
      iii. Check for obstructed secondary air and remove any obstruction and educate the client on how to keep from obstructing the burner.
      iv. Check primary air adjustment and adjust if necessary and clear away any restrictions.
      v. Check to see that all the burners are in alignment. This may require leveling the appliance.
      vi. Check the orifice size to ensure they are the right type and size in regard to LPG or natural gas. If the orifices need to be changed or adjusted, do so with the burner and the pilot orifices.
      vii. With a manometer (water column gauge), check that the gas pressure is correct. If the pressure regulator requires replacement, do so.
6. For the oven bake burner (do not test a separate broil burner):
   a. Remove cooking utensils from oven. Make sure foil or other materials are not obstructing the holes in the oven floor.
   b. Turn on burner to the maximum temperature, but not to "broil".
   c. Insert the probe into the oven vent far enough to get an undiluted exhaust gas sample.
   d. The CO emissions increase and then peak just after burner starts up; they then fall to a momentary plateau before the burner shuts down as part of the duty cycle. The reading CO ppm must be taken during this stable plateau. Record this "plateau" reading on the HURMS page of the Work Plan.
   e. If the reading is above 100 ppm as-measured or 400 ppm air-free, then:

i. Clean any rust and soot buildup on the spreader plate caused by flame impingement. It may be necessary to install spacers to raise the flame plate out of the flame. Educate the client on how to clean the flame plate.
ii. Clean the burner if needed.
iii. Check for obstructed secondary air. If it is obstructed, remove the obstruction and educate the client on how to keep from obstructing the burner.
iv. Check the primary air adjustment and adjust if necessary or clear away any restrictions.
v. Check to see that the burner is in alignment; it may require leveling the entire appliance.
vi. Check the orifice size to ensure they are the right type and size in regard to LPG or natural gas. If the orifices need to be changed or adjusted, do so with the burner and the pilot orifices.
vii. With a manometer (water column gauge), check that the gas pressure is correct. If the pressure regulator requires replacement, do so.

12500 Refrigerator Replacement and Metering

The refrigerator to be replaced must be the primary refrigerator used by the household. In cases where more than one refrigerator or freezer is being used, the agency should encourage the client to dispose of the secondary refrigerator or freezer by providing client education regarding the energy use of the unit(s). The disposal of a secondary refrigerator or freezer is an eligible activity.

12510 Refrigerator Replacement Policy

1. Refrigerator replacements must meet DOE requirements.
2. The replacement refrigerator must be cost-effective. If the savings-to-investment ratio is less than one, no replacement is allowed. If the savings-to-investment ratio is greater than one but less than two, the agency has the option to replace it or not. If the savings-to-investment ratio is greater than two, then the refrigerator must be replaced. The savings-to-investment ratio must be documented in the client file. Agencies may combine electrical usage for the purpose of calculating cost-effectiveness when more than one refrigerator or freezer is disposed as part of the refrigerator replacement.
3. American Electric Power (AEP) funds can be used for a refrigerator replacement, whether the home is electrically heated or not, if AEP or Allegheny Power is the electric vendor. The savings-to-investment ration must be 1.5 or greater to use AEP funds for the refrigerator replacement.
4. The client must give up possession of the old refrigerator.

5. The NEAT audit tool must be used to calculate savings-to-investment ratio (SIR) and to provide documentation that the replacement SIR is greater than one. NEAT can calculate the SIR of a refrigerator replacement in two ways:
   a. Built in Association of Home Appliance Manufacturers (AHAM) database of refrigerators.
   b. With the use of on-site metering data in units of kWh.
6. Age alone should not be the determining factor in replacing a refrigerator. Although older refrigerators were built to less efficient standards, other factors such as size and manual defrost impact energy use of existing refrigerators. However, any refrigerator older than 1993 may be a likely candidate for replacement. A refrigerator 10 years or older must be analyzed and considered for replacement, either by obtaining the information from the AHAM databases or by on-site metering.
7. The agency shall complete a Refrigerator Inspection and Replacement Form and make it part of the client file. The information entered on this form shall include, but not be limited to:
   a. Exact replaced refrigerator model number, not a shortened or abbreviated number.
   b. SIR value calculated with NEAT.
   c. If refrigerator is metered, the kWh – not watt hour – and meter run time.

12520 Refrigerator Metering

1. The Watts Up? PRO meter shall be connected to the refrigerator(s) for at least two hours. The longer the metering time, the more accurate the projected annual kWh/yr estimate will be. It is strongly recommended to conduct a 24 hour test whenever possible. A 24 hour test will be more accurate by including automatic defrost cycles and typical daily household use of the refrigerator.
2. Determine the average ambient temperature around the refrigerator during the metering and enter in the NEAT software.
3. Convert the “WATT HOUR” reading on the Watts Up? PRO to kilowatt hours (kWh) by dividing the WATT HOUR reading by 1000. Enter the resulting value in the appropriate place in the NEAT software. For example, if the WATT HOUR reading on the Watts Up? PRO is 525, the kWh value entered in the NEAT software is 525/1000, or 0.525.
4. Enter the time period of the metering in the NEAT software. Make sure the time is in units of minutes.

12530 Ordering Replacement Refrigerators

1. The replacement should be of a similar style and capacity as the removed refrigerator. A larger capacity model than the removed unit may be considered if multiple refrigerators/freezers are being replaced.
2. If the existing refrigerator has an ice maker, replacement can be ordered from the two available Whirlpool models with ice makers, if all criteria are met. An existing water connection must already be available for shipper to reconnect. If the replacement has a factory-installed ice maker, and client has no water connection, it shall be the client's responsibility to have connected. Neither WAP grant funds nor AEP nor Allegheny Power funds can be used to run water line for an ice maker.
3. The West Virginia Weatherization Assistance Program has made an agreement with Whirlpool, Inc. for the bulk purchase of refrigerators. Currently there are five models to consider as replacements. All replacement models are ENERGY STAR® rated models. The list of possible replacement models is on the Refrigerator Inspection and Replacement form.
4. Each agency is responsible for ordering refrigerators and for payment. Ordering shall be done using Whirlpool's on-line ordering system. Whirlpool will invoice each agency separately.

12540 Installation of New Replacement Refrigerator

1. The agency must ensure that the correct unit is being ordered. The replacement must fit into the existing refrigerator space and must have the hinges installed on the appropriate side. There will be a $20 fee charged to the agency if hinges need to be realigned at the client's home. The agency should also insure that a replacement is practical in that there is safe and adequate electrical supply, the floor is structurally adequate to properly support the new unit, and the doors and hallways of the home are sufficient to allow removal of the old refrigerator and installation of the new one.
2. The agency must stress that the client must be home at the time of the delivery. There will be a $70 fee charged if no one is home at the agreed delivery time. In this instance, the agency will have to invoice the client and remit the fee to Whirlpool.
3. Whirlpool's contractor, Quality Express, will deliver the replacement, install the unit, remove, and properly dispose of the old unit(s). They will also remove all packing from the client's premises.
4. Quality Express will arrange delivery date and time with the client. Quality Express can fax delivery dates and times to the agency, if

requested. Quality Express will be required to remove the old refrigerator and dispose of properly.

12600 Compact Fluorescent Bulbs

12610 Introduction

Many new compact fluorescent lamps (CFLs) meet the stringent criteria of ENERGY STAR® for long life, start time, energy savings, color, and brightness. These new CFLs provide high quality, warm light without the flickering or humming of older fluorescent bulbs.

Advanced technology enables CFLs to use up to 75 percent less energy than a standard incandescent bulb and last up to 10 times longer. This means that over the life of one CFL, a client can avoid replacing up to 13 incandescent bulbs.

12620 Replacement Procedure

1. All replacement CFLs must be ENERGY STAR® rated.
2. Discuss the lighting schedule with the client. Focus on incandescent lamps that are on for two or more hours each day.
   a. Educate the client about incandescent lamp use, including using these lamps as little as possible
   b. Ask the client, after your client education efforts, which incandescent lamps are likely to be on for two or more hours each day. Replace these incandescent lamps with compact fluorescent lamps (CFLs).
3. Any replacement CFLs should have a lumen rating (light output) very close to the replaced incandescent lamp. If the watt use of typical CFLs and incandescent lamps are matched according to Table 12-1, the lumens output will be approximately the same.

Table 12-1
CFL/Incandescent Lamp Equivalency Chart

CFL, Watts	Incandescent, Watts
9 - 13	40
13 - 15	60
18 - 25	75
23 - 30	100
30 - 52	150

13000 Agency Final Inspection Procedures

The Department of Energy and West Virginia GOEO require that final inspections be performed to assess adequacy and quality of work. The DOE regulation reads as follows:

"No dwelling unit may be reported to DOE (or West Virginia GOEO) as completed until all weatherization materials have been installed and the subgrantee (the CAA) or its authorized representative, has performed a final inspection(s) including any mechanical work performed and certified that the work has been completed in a workmanlike manner and in accordance with the priority determined by the audit procedures required by 440.21."[7]

Final inspections must be performed by certified post-work Inspectors who, except in rare cases, did not perform the actual work on the job. Inspectors who have not been certified cannot perform a final inspection without the accompaniment of a State monitor or certified inspector. Any exceptions to this policy must have approval from GOEO Weatherization Director.

13100 General Requirements

The following final inspection procedures shall be employed when and where applicable.

1. All weatherized units shall be reported to GOEO as completed only after the subgrantee has performed a final inspection. The purpose of the final inspection is to ensure that the work has been completed in a workmanlike manner and in accordance with the priority lists or the NEAT or MHEA energy audits and work order.
2. Subgrantees are required to inspect 100 percent of installed measures.
3. The certified inspector is responsible for ensuring all items specified in the Work Plan have been completed in a professional and workmanlike manner.
4. The certified inspector shall assess the job to ensure that the crew or contractor has not damaged any existing finishes and items in the home.
5. The certified inspector shall also ensure that the contractor or crew have left the dwelling in a clean and orderly manner, both inside and outside.
6. The Work Plan shall be followed at all times during the final inspection and any items that have not been completed to the

[7] *U.S. Department of Energy - Weatherization Assistance Program for Low-Income Persons - Title 10, Part 440, Final Rule* - Revised as of December 8, 2000, section 440.16.(5).(c).

satisfaction of the certified Post Work Inspector must be noted on an agency rework or a memo to the file.

7. The certified inspector is responsible for obtaining all the proper homeowner signatures on the final sign-off for the project.
8. The final inspection must verify that the materials were installed and confirm that they were installed in a professional manner in accordance with the West Virginia Weatherization Field Standards. The completed Work Plan must be signed and dated by the client, the on-site supervisor, and the certified post-work inspector.
9. Cited deficiencies noted in the State monitoring report that result in a call back or rework is considered as justification for requiring that the subgrantee re-inspect dwellings.
10. Client or scheduling obstructions to final inspection:
    a. GOEO recognizes that in some cases it may be impossible to complete a final inspection of the dwelling unit, even after repeated efforts to schedule the inspection. In these cases, the subgrantee must document that an inspector made a significant effort to inspect the dwelling after completion of the weatherization work. At a minimum, a visual inspection of any exterior weatherization measures must be completed.
    b. A memorandum must be put in the client file, signed by the inspector and the agency weatherization coordinator, indicating the dates when the subgrantee attempted to inspect the residence.
        i. The subgrantee will also be required to make every effort to obtain required signatures and to thoroughly document all work performed on all completions,
        ii. If the client does not respond within two weeks, the subgrantee may report the unit as a completion. In this situation, a second memorandum, signed by the inspector and weatherization coordinator and placed in the client file, should indicate that the agency was unable to conduct a final inspection.
11. The final inspection of a unit, at a minimum, shall include:
    a. Verification that all materials reported on the completed Work Plan is present or can be physically accounted for on the Daily In/Out Forms during the on-site inspection by the Post-Work inspector.
    b. Materials were installed in such a way as to be safe, effective, and neat in appearance.
    c. Confirmation that all materials used on the home meet required West Virginia Weatherization Field Standards.
    d. Verification that all combustion systems are in safe operating condition.

e. Documentation that any problems found during the inspection were resolved in an appropriate and timely manner.

13200 Inspection of Wall Insulation

1. Verify that the sidewall insulation has been installed in all required wall cavities.
2. All structural damage on the work order should have been repaired before the installation of wall insulation. This may include:
   a. Exterior moisture damaged areas, such as missing or rotted siding or trim boards.
   b. Deteriorated window or door components.
   c. Missing or damaged siding or trim boards.
3. Any replaced wood siding or trim must match the existing grade and be primed or sealed with an appropriate paint or stain.
4. Verify that blown insulation has not deformed or damaged the interior wall surfaces.
5. If the insulation was blown into the wall cavities from the inside, make sure that:
   a. The interior fill holes have been covered with a chair rail.
   b. Verify that no insulation or debris is left in the house.
   c. Verify that insulation has not escaped into wall heaters, vent fans, ducts, or other mechanical penetrations.
   d. Make sure that structural details such as interior soffits, pocket doors, and other bypasses have been properly addressed during the insulation installation.
6. Make sure the siding has been reinstalled properly and that the siding removal and replacement of siding has not unnecessarily damaged the siding or trim.
7. If the finished siding has been face-drilled and plugged, make sure that the reasons for doing so are included in the client file.
8. Verify that cellulose insulation has been installed at the proper density.
   a. Cellulose should be installed at a high density in walls whenever conditions permit. High density is at least 3.5 pounds per cubic foot.
   b. The density may be determined by:
      i. Core sampling after the insulation is installed.
      ii. Calculating density during installation by determining the cubic feet of wall to be insulated, taking note of the number of pounds of insulation installed in the calculated cubic feet of wall, and then figuring the pounds per cubic feet of installed cellulose.

13300 Inspection of Attic Insulation

1. Verify that damaged or rotted ceiling components have been repaired or replaced as needed. Verify that the ceiling can safely hold the weight of the insulation.
2. Verify that all voids and areas of incomplete coverage in the existing insulation have been repaired.
3. All appropriate attic bypass and safety items must have been completed properly, including:
   a. Chimney bypasses.
   b. Plumbing stack bypasses.
   c. Attic hatch or pull-down stair sealing and insulating.
   d. Recessed light damming.
   e. Junction boxes marking.
   f. Bathroom and kitchen exhaust fan venting.
   g. Knob-and-tube wiring.
4. Zone Pressure Diagnostics (ZPD) is a recommended tool for determining the pre- and post-tightness levels of attic pressure boundaries.
5. Verify that the proper type and amount of attic insulation has been installed. Uninsulated attics must be insulated to at least R-38.
   a. Cellulose insulation must be installed to allow for 10 percent settling. For example, if 12 inches of cellulose are called for on the work order, 14 inches must be installed so that the settled thickness is 12 inches.
   b. The thickness of blown insulation should be uniform throughout. The final top surface of the insulation must be reasonably level and uniform.
6. Verify that attic ventilation is added as specified in the Work Plan. Attic ventilation shall not be blocked with installed insulation.

13400 Inspection of Attic Access and Knee Wall Doors

1. Make sure the attic hatch is at least accessible and at least 20 inches in width or length, weatherstripped, latched, and insulated with at least four inches of extruded polystyrene (R-20) that is properly secured to the exterior surface of the attic hatch.
2. Verify that pull-down stairs are properly insulated and weatherstripped.
3. Make sure all knee wall areas have access doors and are properly insulated, weatherstripped, and latched.

13500 Inspection of Basement and Crawl Space Insulation

1. Verify that the treatment of a basement or crawl space corresponds with the appropriate definition of the thermal boundaries of the dwelling.
2. Make sure that all foundation air sealing has been completed.
3. Verify that allowable repairs have been made to correct any moisture or sewage problems.
4. Verify that all insulation installation required by the Work Plan has been properly installed.
5. Verify that an appropriate ground cover has been installed in crawl spaces, when possible.
6. Verify that water lines have been appropriately insulated, if necessary.
7. Verify that damaged or missing exterior doors have been repaired or replaced and that they are weatherstripped and insulated according to the Work Plan.

13600 Inspection of Dryer Vent

1. Verify that the dryer is properly vented to the outdoors and that the damper in the dryer vent is working properly.
2. Verify that dryer vents are extended to the outdoors without sags or in such a way as to allow the pooling of condensate.
3. Verify that the dryer vent is installed according to Section 4830 on page 52.

13700 Inspection of Kitchen and Bathroom Exhaust Fans

1. Verify that all exhaust fans are properly vented to a weather-protected termination fixture located on the outside of the dwelling, either through a sidewall or roof by means of rigid or flexible metal (no vinyl) duct.
2. Verify that all exhaust fans comply with Section 41000 on page 53.
3. Make sure the client knows how to properly use all newly installed exhaust fans.
4. Verify that the exhaust fans are working properly. Measure the actual exhaust fan CFM rate with the Exhaust Fan Flow Meter from The Energy Conservatory or with a similar device.

13800 Inspection of Baseload Measures

1. Verify that any work specified for the water heater has been completed according to the Work Plan and all work complies with the specifications of this Standard and applicable codes.
2. If a replacement refrigerator has been specified in the Work Plan, verify that the new refrigerator is in place and working properly. Verify that the replaced refrigerator(s) have been removed from the site.

3. If the work order specified replacement of incandescent bulbs with compact fluorescent lamps (CFLs), verify that the CFLs are in place and working properly.
4. Verify if low-flow showerheads were specified in the Work Plan and installed.

13900 Inspection of Heating and Cooling Systems

Verify that any work specified for central heating systems, space heaters, central cooling systems, window air conditioners, or heat pumps, has been completed according to the work order and all work complies with the specifications of this Standard and applicable codes.

131000 Documentation in Client File

1. Confirm that all required documentation is included in the client file, including:
   a. Client Application Form;
   b. Income Verification Form;
   c. Owner Agreement Form for rental unit (if applicable);
   d. Work Plan;
   e. Summary Sheet;
   f. Confirmation of Receipt of Lead Pamphlet (if applicable);
   g. Energy Saver's Partnership Plan and Energy Education Certification Form;
   h. Mold Procedure/Checklist Form;
   i. Hold Harmless Statement (if applicable); and
   j. Carbon Monoxide Warning Statement (if applicable).

Note: The paper application form and income verification form are not needed if the client is in the agency DBA FACS Pro system. All required information must still be complete.

14000 Field Monitoring Procedures

This section is designed to provide guidelines for GOEO Weatherization staff and subgrantee agencies regarding the monitoring and evaluation of local Weatherization Assistance Program subgrantees. Monitoring takes place while the program is in operation and provides oversight for the services being delivered at the local level. Monitoring activities ensure that accountability exists for program resources and provides information that can be used to improve the program's operation and services.

14100 Goals of Monitoring

The West Virginia Weatherization Assistance Program goals for monitoring activities include:

1. Analyzing whether best possible program services are being delivered to the low-income population.
2. Determining program compliance and accountability.
3. Analyzing program performance.
4. Analyzing quality and effectiveness of the work on completed dwellings.
5. Being an advocate for program improvement.
6. Identifying problems, deficiencies, and areas that need improvement.
7. Assisting agencies in their program operations and compliance with DOE and State regulations.
8. Advising agencies on how to correct any weaknesses and deficiencies.
9. Assessing the need for training and technical assistance to improve local agency service delivery, cost-effectiveness, and accountability.
10. Determining ways that monitoring activities can be improved.

14200 Guiding Principles of Monitoring Activities

1. Monitoring is intended to be a constructive process and will be conducted in a professional manner with consistency, fairness, respect, and timeliness.
2. The GOEO Weatherization staff is committed to fostering positive, open, and constructive working relationships. Monitoring serves as a two-way educational experience that promotes interaction, feedback, and improvements to both the State and local components of the West Virginia Weatherization network.
3. The GOEO Weatherization staff believes State and local weatherization staff share the same goals of optimizing program funds and resources to best serve the low-income population, striving for program improvement, and providing the most cost-effective and best quality program services possible.

4. The GOEO Weatherization staff will foster improvement when monitoring by providing technical assistance; reinforcing strengths; and sharing successes, innovations, good practices, and experiences encountered at other agencies.
5. Monitoring reports shall be consistent with, and based on, adopted program policies, procedures, and standards.

To achieve the defined goals based on the principles above, GOEO Weatherization staff will perform periodic monitoring reviews of the fiscal, programmatic, and field functions of local weatherization agencies.

14300 Desktop Reviews

1. The GOEO Fiscal Monitor will review and track annual subgrantee agency audits for timeliness, audit findings, and resolution of findings.
2. Weatherization staff will review agency Monthly Progress Reports and track agency production and expenditures on a monthly basis on the Statistical Production and Expenditures Tracking spreadsheet. In addition to being used and maintained by GOEO, this electronic file is required to be maintained monthly by each agency and used as a management tool to analyze production and expenditures. The file is used to track production and expenditures and helps determine the correct funding request amounts. The evaluation sections will analyze key program compliance criteria, including:
   a. Average costs per completion for each classification of completed dwelling unit,
   b. Percentage of production goals achieved,
   c. Percentage of grant and each line item expended, and
   d. Health and safety expenditures.
3. Weatherization staff will also review Job Summary Pages and the statewide database comprised of information from the Summary Pages. The summary sheets and database also serve as monitoring tools to detect trends in agency field work, such as field priorities, diagnostic tests, and measures installed. Some jobs may be tagged for field monitoring visits if there are unanswered questions resulting from reviewing the summary pages.

14400 Monitor Visits to Subgrantee Agencies

14410 Weatherization Fiscal Monitoring

Weatherization Fiscal Monitoring will typically occur during the GOEO / CSBG agency monitoring. The fiscal monitoring will be conducted by the GOEO Fiscal Monitor. During the visit, the fiscal monitor will review all of the fiscal operations

of all GOEO programs being administered by the local agencies. Activities of the fiscal monitoring at local agencies will include:

1. Review financial records.
2. Review purchasing and bidding practices.
3. Review payroll and documentation.
4. Review travel records.
5. Review vendor payments.
6. Review last fiscal audit (usually performed at GOEO, not during agency visit).

14420 Program Management Monitoring

Program Management Monitoring will typically occur once per year per local agency. Program Management Monitoring will be conducted by GOEO Weatherization Assistance Program Specialists and will be specific to the Weatherization Assistance Program. The Program Management Monitoring Form will be the basic guide used to perform this evaluation. Functions of the Program Management Monitoring will include:

1. Review client files.
2. Review production, expenditures, and related compliance issues.
3. Review material, tool, equipment, equipment maintenance records, and vehicle property records and inventory.
4. Review client flow charts and scheduling practices.
5. Review crew safety policies, meeting and personnel files, and practices.
6. Review insurance policies.
7. Inspect warehouse and vehicles.
8. Program Management Monitoring will also include some fiscal issues, including tracking of utility, ECIP, and other supplemental program funds, reporting, and other specific Weatherization issues.

14430 Field Monitoring

Field Monitoring will typically occur twice per year – more frequently, if needed – per local agency. Agencies demonstrating high quality field work may only be monitored once each year. Field monitoring will be conducted by GOEO Weatherization Program Specialists. Individual job inspections will be performed and documented on the Field Inspection Report. Jobs will be inspected for overall effectiveness, workmanship, appearance, and compliance with installation standards. An overall assessment of agency field practices will be performed using the Agency Field Assessment Overview. This tool will rank

agency field practices in eleven different field evaluation criteria, and identify major strengths, major field findings, and trends for concern.

1. Major strengths are areas where the agency field staff performs at a high level, including overall high effectiveness and workmanship, strengths in certain measures, crew organization and utilization, and teamwork.
2. Trends for concern are recurring issues that may be of secondary concern, such as repeated file omissions (for example, no date on form), procedural items that can be quickly or easily corrected, or a finding in work quality that is easily correctable and does not significantly impact on the overall results of work performed to achieve energy efficiency for the client (for example, failure to wrap the first three feet of water pipe from the water heater).
3. Major field findings are issues that are of significant concern and/or are contract violations, such as major health and safety problems, potential liability from poor workmanship, consistent omission of required measures, or consistently failing to follow program rules, standards, or specifications.

14500 Monitoring Procedures

1. Monitoring visits will be scheduled with the agency in advance of the visit. Fiscal Monitoring visits may be part of an overall GOEO and CSBG Team Monitoring and will be arranged by GOEO Management. Other fiscal monitoring visits may be targeted only for Weatherization and will be arranged and scheduled by the GOEO Fiscal Monitor and/or Weatherization staff. Typically, Program Management Monitoring and Field Monitoring will be scheduled by GOEO Weatherization staff. The Weatherization Director will send a memorandum to the agencies which includes the monitoring schedule. Subgrantee agency management will be given ample time to inform the Director if there are overriding conflicts with the scheduled dates for monitoring. If there are conflicts, new monitoring dates will be scheduled.
2. Upon arrival at the agency, the Monitor(s) will meet with appropriate agency personnel to explain the purpose of the visit, the records and information needed, and the planned timeframe of the visit. An exit conference will be tentatively scheduled with the Executive Director and Weatherization Coordinator. The Weatherization Coordinator must be available at all times during a monitoring visit.
3. At the conclusion of the monitoring visit, an exit conference will be conducted with the Executive Director and Weatherization Coordinator to review the monitoring results. The Monitor(s) will provide the agency with a draft outline of concerns and findings observed during the visit.

4. Every effort will be made to complete and mail a final monitoring report to the Executive Director and Weatherization Coordinator within fourteen days of the monitoring visit. The agency will be given thirty days to respond to the recommendations and/or findings noted in the report. The West Virginia GOEO will review the response and determine if the actions described are appropriate and sufficient. West Virginia GOEO may schedule a follow-up visit(s) to verify agency actions or to further analyze unresolved matters.

14600 Local Agency Monitoring Responsibilities

Local agencies are required to inspect 100 percent of all completed units to determine compliance with Weatherization Standards, to ensure proper documentation of client information, job measures and costs, and other appropriate information. Inspections must be performed by certified Post-Work Inspectors who, except in rare cases, did not perform the actual work on the job. The thoroughness and effectiveness of agency inspections will be assessed during the GOEO Field Monitoring visits.

14700 Agency Response to Monitoring Visits

1. The GOEO Weatherization Director will review the monitoring report and send to the agency Executive Director and the Weatherization Coordinator with a cover letter.
2. The cover letter will request that the local agency send a response to the monitoring findings outlined in the report within 30 days of receipt of the report, and any other specific instructions as noted in the cover letter.
3. The agency will respond to the findings of the report, including any areas of disagreement or uncertainty.
4. The response will provide specific steps taken or planned to correct the finding or to follow up on recommendations made by the GOEO WAP monitor(s).
5. The monitor who wrote the report will review the response to ensure all issues were properly addressed, and either accept the response or note issues that need further information or clarification.
6. The GOEO Weatherization Director will notify the appropriate agency personnel to assess them of the resolution of their monitoring response and any further issues that need attention.

14800 Job Rework Guidelines

Any jobs that were deemed as callbacks during a monitoring visit shall be corrected as per the instructions from the Field Inspection Reports. The agency must maintain documentation of the additional measures performed. Any additional costs will be reported on the subsequent Monthly Progress Report as an “Add-on” cost on page two of the report. A revised Summary Page for the job must also be submitted.

14900 Agency Discipline Policy

1. An agency can be placed on At-Risk status for serious management and/or repeated sub-standard field performance, including but not limited to:
   a. Program goals are not being met.
   b. Program resources cannot be accounted for.
   c. Serious evidence of the following:
      i. Misuse of funds.
      ii. Fraud.
      iii. Theft.
      iv. Noncompliance with program policies and procedures.
      v. Agency files and records incomplete or severely disorganized.
      vi. Repeated major field findings with no or minimal improvement from previous monitoring visit.
      vii. Significant number of “Unacceptable” rankings in Agency Field Assessment Overview.
      viii. The agency’s failure to respond to West Virginia GOEO requests and deadlines.
2. When placing an agency on At-Risk status, West Virginia GOEO will specify improvements that must be made by the agency. The agency will be instructed to submit a plan that identifies the steps and timelines to be taken to make the required improvements. When appropriate, related training and technical assistance will be provided. West Virginia GOEO will consider suspension or termination of the agency’s Weatherization contract unless the specified improvements are made and performance standards are met as outlined in the GOEO Weatherization contract, Finance and Administration Standards, and Field Standards. These corrections must be accomplished by the agency at risk in a specified period of time, as set by the GOEO Monitoring Assessment Team.

141000 Agency Appeals

After the agency response is reviewed and the GOEO Weatherization Director sends the monitoring resolution to the agency, the subgrantee agency may appeal the findings of the monitoring report to the Weatherization Program Director. This appeal should be sent in writing within 14 working days of receipt of the monitoring resolution.

15000 Diagnostic Testing Procedures

[Section reserved for later date]

16000 Glossary

- A -

Abatement – A measure or set of measures designed to permanently eliminate a hazard (e.g., lead-based paint). Abatement strategies include removal of the hazardous materials, replacement of building components containing the hazardous material, enclosure, or encapsulation. All of these strategies require proper preparation, cleanup, waste disposal, post-abatement clearance testing, and if applicable, record keeping and monitoring. Abatement activities are not allowable expenses to be funded by Department of Energy Weatherization Assistance Program dollars.

Absorption – Absorption is the process by which a substance can be readily taken into the body through the skin or membranes. The best defense is to have a protective barrier between the substance and the skin.

Air Changes per Hour at 50 Pascals (ACH_{50}) – The number of times that the complete air volume of a home is exchanged for outside air in one hour when a blower door depressurizes or pressurizes the home to 50 Pascals.

Air Changes per Hour Natural (ACH_{nat}) – The number of times the indoor air is exchanged with the outdoor air in one hour under natural driving forces. It can be estimated using a blower door.

Air Exchange – The process whereby indoor air is replaced with the outdoor air through air leakage and ventilation.

Air-Free Carbon Monoxide – A measurement of CO in an air sample or flue gas that takes into account the amount of excess air (oxygen, O_2) in the sample, incorporating an adjustment to the as-measured CO ppm value, thus simulating air-free (oxygen-free) conditions in the sample. Usually measured in units of parts per million (ppm). See “As-Measured Carbon Monoxide”.

Air Handler – A steel cabinet containing a blower with cooling and/or heating coils connected to ducts, which circulates indoor air across the exchangers and into the habitable space.

Air Infiltration Barrier – A spun polymer sheet (for example, house wrap) that stops almost all the air traveling through a building cavity, while allowing moisture to pass through it.

Altitude Adjustment – The input modification for a gas appliance installed at a high altitude. When a gas appliance is installed more than 2000 feet above sea

level, its input rating must be reduced by approximately 4 percent per 1000 feet above sea level.

Ambient Air – Air in the habitable space.

Ampere – A unit of measurement that tells how much electricity flows through a conductor. It is comparable to a cubic foot per second measurement of water flow. For example, a 1,200-watt, 120-volt hair dryer pulls 10 amperes of electric current (watts divided by volts).

ANSI – American National Standards Institute, Inc.

AFUE – Annual Fuel Utilization Efficiency – A laboratory-derived efficiency for heating appliances that accounts for chimney losses, jacket losses, and cycling losses, but not distribution losses or fan/pump energy use.

Aquastat – A heating control that switches the burner or the circulator pump in a hydronic heating system.

Asbestos – A fibrous mineral with fireproof and insulation characteristics which may be shaped into a variety of building materials. Small, sharp, asbestos fibers may cause damage to lungs if they are inhaled.

ASHRAE – American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc.

As-Measured Carbon Monoxide – A measurement of CO in a sample of air or flue gas that does not take account of the amount of excess air (oxygen, O_2) diluting the CO concentration. Usually measured in units of parts per million (ppm). See “Air-Free Carbon Monoxide”.

ASME – American Society of Mechanical Engineers.

ASTM – American Society for Testing and Materials.

Atmospheric Appliance – A combustion appliance that burns at normal atmospheric pressure. Most gas water heater burners and gas range top burners are atmospheric.

Atmospheric Pressure – The weight of air and its contained water vapor on the surface of the earth. At sea level this pressure is 14.7 pounds per square inch.

- B -

Backdrafting – Continuous spillage of combustion gases from a vented combustion appliance into the conditioned space.

Backdraft Damper – A damper, installed near a fan, that allows air to flow in only one direction and prevents reverse flow when the fan is off.

Backer Rod – Polyethylene foam rope used as backing for caulking.

Baffle – A plate or strip designed to retard or redirect the flow of flue gases.

Balance Point – The outdoor temperature at which no heating is needed to maintain inside temperatures.

Ballast – A coil of wire or electronic device that provides a high starting voltage for a lamp and limits the current flowing through it.

Balloon Framing – A method of construction in which the vertical framing members (studs) are continuous pieces, running the entire height of the wall.

Band Joist – See rim joist. Also know as “band board”.

Barometric Vent Damper – a device installed in the heating unit vent system to control draft. Usually used on oil-fueled units or gas units with power burners.

Batt – A blanket of preformed insulation, generally 14.5 inches or 22.5 inches wide, and varying in thickness from 3.5 inches to 9 inches.

Belly Return – A configuration found in some mobile homes that uses the belly cavity as the return side of the heating/cooling distribution system.

Bimetal Element – A metal spring, lever, or disc made of two dissimilar metals that expand and contract at different rates as the temperature around them changes. This movement operates a switch in the control circuit of a heating or cooling device.

Blocking – A construction element or material used to prevent the movement of air or insulation into or through building cavities.

Blow-Down – Removing water from a boiler to remove sediment and suspended particulates.

Blower – The “squirrel-cage” fan in a furnace or air handler.

Blower Door – A calibrated device to measure the air tightness of a building by pressurizing or depressurizing the building and measuring the flow through the fan.

Blown Insulation – A loose-fill insulation that is blown into attics and building cavities using an insulation blowing machine.

Boot – A duct section that connects between a duct and a register, floor, or wall cavity, or between round and square ducts.

Branch Circuit – An electrical circuit used to power outlets and lights within a home.

Brightness – The luminous intensity of any surface in a given direction per unit of projected area of the surface, as viewed in that direction.

British Thermal Unit (BTU) – The quantity of heat required at sea level to raise the temperature of one pound of water by one degree Fahrenheit.

BTUh – British Thermal Units per hour.

Building Cavities – The spaces inside walls, floors, and ceilings or between the interior and exterior sheeting.

Building Science – A complex perspective on buildings, using contemporary technology to analyze and solve problems of design, construction, maintenance, safety, and energy efficiency.

Building Tightness Limit (BTL) – Calculation procedure, expressed in units of CFM_{50}, based on the American Society of Heating, Refrigerating and Air-Conditioning Engineers Standard 62-2001, *Ventilation for Acceptable Indoor Air Quality*. This method was clearly explained in an article in *Home Energy* magazine, (Tsongas 1993). The method closely follows the parameters set in ASHRAE 62-2001: For acceptable indoor air quality, 15 CFM per person (set minimum of 5 people) or 0.35 air changes per hour (ACH), whichever is greater, must be supplied by natural air leakage and/or continuously operating ventilation.

Burner – A device that facilitates the burning of a fossil fuel like gas or oil.

Bypass – An air leakage site that allows air to leak out of a building passing around the air barrier and insulation.

- C -

Carbon Dioxide (CO_2) – A heavy, colorless, nonflammable gas formed by the oxidation of carbon, by combustion, and by the respiration of plants and animals.

Carbon Monoxide (CO) – An odorless, colorless, tasteless, and poisonous gas produced by incomplete combustion.

Caulking – A mastic compound for filling joints and cracks.

Category I Fan-Assisted Gas Appliance – An appliance that operates with negative static pressure in the vent, a temperature that is high enough to avoid condensation in vent, and an integral fan to draw a controlled amount of combustion supply air through the combustion chamber. *Comment: Airtight vent connector is not required; induced combustion fan installed by manufacturer.*

Category I Gas Appliance – An appliance that operates with negative static pressure in the vent and a temperature that is high enough to avoid condensation in vent. *Comment: May be atmospheric or fan-assisted combustion; airtight vent connector is not required.*

Category II Gas Appliance – An appliance that operates with negative static pressure in the vent and a temperature that is low enough to cause excessive condensation in the vent. *Comment: No or very little equipment in this category.*

Category III Gas Appliance – An appliance that operates with positive static pressure in the vent and a temperature that is high enough to avoid condensation in vent*. Comment: Airtight vent connector; vented through the wall; forced draft.*

Category IV Gas Appliance - An appliance that operates with positive static pressure in the vent and a temperature that is low enough to cause excessive condensation in the vent. *Comment: Airtight vent connector; vented through the wall; forced draft; often referred to as a "90-plus" unit.*

CAZ – See Combustion Appliance Zone.

Cellulose Insulation – Insulation, packaged in bags for blowing, made from newspaper or wood waste, and treated with a fire retardant.

Chimney – A building component designed for the sole purpose of assuring combustion by-products are exhausted to the exterior of the building.

Chimney Flue – A passageway in a chimney for conveying combustion gases to the outdoors.

Cleanout Opening – An opening in a chimney (usually at its base) to allow inspection and the removal of ash or debris.

Circuit Breaker – A device that automatically disconnects an electrical circuit from electricity under a specified or abnormal condition of current flow.

Coefficient of Performance (COP) – A heat pump or air conditioner's output in Watt-hours of heat removed, divided by Watt-hours of electrical input.

Coil – A snakelike piece of copper tubing surrounded by rows of aluminum fins that clamp tightly to the tubing to aid in heat transfer.

Cold Air Return (return side) – Ductwork through which house air is drawn for reheating during a furnace's cycle.

Color Rendering Index (CRI) – A measurement of a light source's ability to render colors the same as sunlight does. The CRI has a scale of 0 to 100.

Color Temperature – A measurement of the warmness or coolness of a light source in the Kelvin temperature scale.

Combustible – Susceptible to combustion; inflammable; any substance that will burn.

Combustible Gas Leak Detector – A device for determining the presence and general location of combustible gases in the air.

Combustion – The act or process of burning. Oxygen, fuel, and a spark must be present for combustion to occur.

Combustion Air – Air required to chemically combine with a fuel during combustion to produce heat and flue gases.

Combustion Analyzer – A device used to measure the Steady-State Efficiency (SSE) of combustion heating units.

Combustion Appliance – Any appliance in which combustion occurs.

Combustion Appliance Zone (CAZ) – The closed space or area that holds one or more combustion appliances.

Combustion Chamber – The area inside a heating unit where combustion takes place.

Common Vent – The portion of the vent or chimney through which passes products of combustion from more than one appliance.

Compact Fluorescent Lamp (CFL) – A small fluorescent light engineered to fit conventional incandescent fixtures.

Compressor – A motorized pump that compresses a gaseous refrigerant and sends it to a condenser where heat is released.

Concentrically Constructed Direct-Vent – A direct-vent appliance that has an exhaust-gas vent and a combustion-supply-air vent arranged in a concentric fashion, i.e., one vent is inside the other with a space between the walls of each. *Comment: Mobile home furnace vents are usually constructed this way; some Category I, direct-vent water heaters are constructed this way.*

Condense – To change from a gaseous or vaporous state to a liquid or solid state by cooling or compression.

Condenser – The coil in an air conditioning system where the refrigerant condenses and releases heat, which is then carried away by air moving across the coil.

Condensate – The liquid formed when a vapor is condensed.

Condensate Receiver – A tank for catching returning condensate water from a steam heating system.

Conductance – The quantity of heat, in BTUs, that will flow through one square foot of material in one hour, when there is a one degree Fahrenheit temperature difference between both surfaces. Conductance values are given for a specific thickness of material.

Conduction – The transfer of heat energy through a material (solid, liquid, or gas) by the motion of adjacent atoms and molecules without gross displacement of the particles.

Conductivity – The quantity of heat that will flow through one square foot of homogeneous material, one inch thick, in one hour, when there is a temperature difference of one degree Fahrenheit between its surfaces.

Confined Space – A space with a volume of less than 50 cubic feet per 1,000 BTU per hour of the total input rating of all combustion appliances installed in that space.

Control Circuit – A device that opens and closes a power circuit or opens and shuts a valve.

Convection – The transmission of heat by the actual movement of a fluid or gas because of differences in temperature, density, etc.

Conventionally Vented Combustion Appliance – Combustion appliances that are characterized by atmospheric burners or natural draft. Sealed or direct-vent appliances are not conventionally vented.

Cooling Load – The maximum rate of heat removal required of an air conditioner when the outdoor temperature and humidity are at the highest expected level.

Cost-Effective – Having an acceptable payback, return-on-investment, or savings-to-investment ratio.

Critical Framing Juncture – An intersection of framing members and envelope components that require special attention during prep and installation of insulation.

Cross Section – A view of a building component drawn or imagined by cutting through the component.

CFM – Cubic Feet per Minute – A measurement of air movement in cubic feet per minute past a certain point or through a certain structure.

CFM_{50} – The number of cubic feet per minute of air flowing through the fan housing of a blower door when the house pressure is 50 Pacals (0.2 inches of water column). This figure is the most common and accurate way of comparing the tightness of buildings that are tested using a blower door.

CFM_{nat} – The number of cubic feet of air flowing through a house from indoors to outdoors during typical, natural conditions. This figure can be roughly estimated using a blower door using the LBL (Lawrence Berkeley Labs) infiltration model.

- D -

Degree-days (DD) – A measure of outdoor temperature produced by summing the temperature differences between the inside (65°F) and the daily average outside temperature for a one-year period.

Demand – The peak need for electrical energy.

Density – The weight of a material divided by its volume, usually measured in pounds per cubic foot.

DOE – The United States Department of Energy.

Depressurize – To lower the pressure in an enclosed area with respect to a reference pressure.

Design Temperature - A high or low temperature used for designing heating and cooling systems when calculating the building load.

Dilution Air – Air that enters through an opening where the chimney joins to an atmospheric-draft combustion appliance.

Dilution Device – A draft diverter, draft hood, or barometric draft control on an atmospheric-draft combustion appliance.

Direct-Vent Appliance – A combustion appliance for which all combustion gases are vented to the outdoors through an exhaust vent pipe and all combustion supply air is vented to the combustion chamber from the outdoors through a separate, dedicated supply-air vent. *Comment: Most direct-vent gas appliances are Categories III and IV, but some are Category I; some direct-vent appliances utilize "Concentrically Constructed Direct-Vent".*

Distribution System – A system of pipes or ducts used to distribute energy.

DHW – Domestic Hot Water.

Dormer – A framed structure projecting above a sloping roof surface, and normally containing a vertical window.

Draft – A pressure difference that causes combustion gases or air to move through a vent connector, flue, chimney, or combustion chamber.

Draft Diverter – See "Draft Hood".

Draft Fan – A mechanical fan used in a venting system to augment the natural draft in gas- and oil-fired appliances. These electrically operated, paddle-fan devices are installed in vent connectors.

Draft Hood – A nonadjustable device built into an appliance or a part of the vent connector that is intended to 1) provide for escape of flue gases if blockage or backdraft occurs, 2) prevent a downdraft of outdoor air from entering the appliance, 3) neutralize the effect of stack action of the chimney, and 4) lower the dew point temperature of the flue gas by the infusion of ambient room air.

Draft Regulator – A self-regulating damper attached to a chimney or vent connector for the purpose of controlling draft. A draft regulator can reduce draft; it cannot increase draft.

Drywall – Gypsum interior wallboard used to produce a smooth and level interior wall surface and to resist fire. Also called gypsum wallboard and sheetrock.

Dry Bulb Temperature – Normal ambient air temperature measured by a thermometer.

Duct Blower – A blower door-like device used for testing duct leakiness and airflow.

Duct Zone – A building space or cavity that contains heating or cooling ducts.

- E -

Eave – The part of a roof that projects beyond its supporting walls. See also soffit.

Efficiency – The ratio of output divided by input.

Efficacy – The number of lumens produced by a watt used for lighting a lamp. Used to describe lighting efficiency.

Electric Service – The electric meter and main switch, usually located outside the building.

Emittance – The rate that a material emits radiant energy from its surface. Also called emissivity.

Encapsulation – Any covering or coating that acts as a barrier between the hazard (e.g., lead-based paint) and the environment, the durability of which relies on adhesion and the integrity of existing bonds between existing layers (e.g., paint) and the substrate.

Enclosure – The building shell. The exterior walls, floor, and roof assembly of a building. Also referred to as building envelope.

Energy – A quantity of heat or work.

Energy Audit – The process of identifying energy conservation opportunities in buildings.

Energy Consumption – The conversion or transformation of potential energy into kinetic energy for heat, light, electricity, etc.

Energy Efficiency – Term describing how efficiently a building component uses energy.

Energy Efficiency Ratio (EER) – A measurement of energy efficiency for room air conditioners. The EER is computed by dividing cooling capacity, measured in British Thermal Units per hour (BTUh), by the watts of power. (See also Seasonal Energy Efficiency Rating – SEER)

Envelope – The building shell. The exterior walls, floor, and roof assembly of a building. Also referred to as building enclosure.

Environmentally Sensitive – Highly susceptible to adverse effects of pollutants.

Evaporation – The process of being changed into a vapor or gas at a temperature usually below the boiling point. Evaporation is a cooling process.

Evaporative Cooler – A device for cooling homes in dry climates that cools the incoming air by the evaporation of water.

Evaporator – The heat transfer coil of an air conditioner or heat pump that cools the surrounding air as the refrigerant inside the coil evaporates and absorbs heat.

Exfiltration – Air flowing out of a building from its conditioned space through holes, leaks, or cracks in the shell.

- F -

Fahrenheit – A temperature scale for which water boils at 212° and freezes at 32°.

Fan-Assisted Combustion – A combustion appliance with an integral fan to draw combustion supply air through the combustion chamber. *Comment: Category I fan-assisted gas furnaces utilize this method of combustion control.*

Fan Control – A bimetal thermostat that turns the furnace blower on and off as it senses the presence of heat.

Fan-Off Temperature – In a furnace, the supply air temperature at which the fan control shuts down the distribution blower.

Fan-On Temperature – In a furnace, the supply air temperature at which the fan control activates the distribution blower.

Feeder Wires – The wires connecting the electric meter and main switch with the main panel box indoors.

Fenestration – Window and door openings in a building’s wall.

Fiberglass – A fibrous material made by spinning molten glass.

Fill Tube – A plastic or metal tube used for its stiffness to blow insulation inside a building cavity and allow the insulation to be delivered at the extreme ends of the cavity.

Fire Stop – Framing member, usually installed horizontally between studs, designed to stop the spread of fire within a wall cavity.

Forced Draft – A vent system for which a fan installed at the combustion appliance moves combustion gases to the outdoors with positive static pressure in the vent pipe. Because of this positive pressure, the vent connector must be air-tight. *Comment: Normally Category III or IV appliances; usually no draft diverter or barometric damper; fan for venting combustion gases at or near appliance; usually vented through the wall; may be condensing.*

Furring – Thin wood strips fastened to a wall or ceiling surface as a nailing base for finish materials.

Flame Safety Control – A device that prevents fuel delivery in the event the ignition does not work.

Flammable/Inflammable – Combustible; readily set on fire.

Flashing – Waterproof material used to prevent leakage at intersections between the roof surface at walls or penetrations.

Floor Joists – The horizontal framing members that support the floor.

Flue – A vent for combustion gases.

Foam Board – Plastic foam insulation manufactured most commonly in 4-inch x 8-inch sheets in thicknesses of ½ inches to 3 inches.

Foot-Candle – A measure of light striking a surface.

Footing – The part of a foundation system that transfers the weight of the building to the ground.

Friable – Easily broken into small fragments or reduced to powder, e.g., as with asbestos.

Frost Line – The maximum depth of the soil where water will freeze during the coldest weather.

- G -

Gable – The triangular section of an end wall formed by the pitch of the roof.

Gable Roof – A roof shape that has a ridge at the center and slopes in two directions.

GAMA – Gas Appliance Manufacturers' Association.

Gas Oven Bake Burner – Oven burner used for baking located just below the oven compartment floor.

Gas Oven Broiler Burner – Oven burner used for broiling located at the top of the oven compartment.

Gasket – Elastic strip that seals a joint between two materials.

Glazing – Glass installation. Pertaining to glass assemblies or windows.

Glazing Compound – A flexible, putty-like material used to seal glass in its sash or frame.

Ground Fault Circuit Interrupter (GFI or GFCI) – An electrical connection device that breaks a circuit if a short occurs. These are required for all exterior use of electrical equipment, or when an electrical outlet is located near a water source.

Gypsum Board – A common interior sheeting material for walls and ceilings, made of gypsum rock powder, packed between two sheets of heavy building paper. Also called sheetrock, gyprock, or gypboard.

- H -

Habitable Space – A building space intended for continual human occupancy. Examples include areas used for sleeping, dining, and cooking, but not bathrooms, toilets, hallways, storage areas, closets, or utility rooms. See occupiable space and conditioned space.

Hazardous Condition – A situation that is causing a danger to the client/crew/contractor that exists before, is created by, or is exacerbated by, weatherization. For example, a dwelling could have a moisture problem that is allowing biological hazards (molds, viruses, bacteria, etc.) to flourish. Another example would be fiberglass entering the conditioned space due to improperly fastened or sealed ductwork.

Hazardous Material – A particular substance that is considered a danger to the client or crew.

HHS – United States Department of Health and Human Services.

Heat Anticipator – A very small electric heater in a thermostat that causes the thermostat to turn off before room temperature reaches the thermostat setting, so that the house does not overheat from heat distributed after the burner shuts off.

Heat Capacity – The quantity of heat required to produce a degree of temperature change.

Heat Exchanger – The device in a heating unit that separates the combustion chamber from the distribution medium and transfers heat from the combustion process to the distribution medium.

Heat Loss – The amount of heat escaping through the building shell during a specified period.

Heat Pump – A type of heating/cooling unit, usually electric, that uses a refrigerant fluid to heat and cool a space.

Heat Rise – In a furnace, the number of degrees of temperature increase that air is heated as it is blown over the heat exchanger. Heat rise equals heated air temperature minus air return temperature.

Heating Degree Day (HDD) – Each degree that the average daily temperature is below the base temperature (usually 65°F) constitutes one heating degree day.

Heating Load – The maximum amount of heat needed by a building during the very coldest weather to maintain the desired inside temperature.

Heating Seasonal Performance Factor (HSPF) – Rating for heat pumps describing how many BTUs they transfer per kilowatt-hour of electricity consumed.

HVAC – Heating, Ventilating, Air-Conditioning.

High Limit – A bimetal thermostat that turns the heating element of a furnace off if it senses a dangerously high temperature.

Hip Roof – A roof with two or more contiguous slopes, joined along a sloping "hip."

Home Energy Index – The number of BTUs of energy used by a home, divided by its area of conditioned square feet and by the number of heating degree days during one year.

HVI – Home Ventilating Institute.

HWAP – Home Weatherization Assistance Program.

House Pressure – The difference in pressure between the inside and outside of the house.

HUD – United States Department of Housing and Urban Development.

Humidistat – An automatic control that switches a fan, humidifier, or dehumidifier on and off, based on the relative humidity at the control.

Humidity Ratio – The absolute amount of air's humidity measured in pounds of water vapor per pound of dry air.

Hydronic System – A heating system using hot water or steam as the heat transfer medium. Commonly called a hot-water heating system.

- I -

Illumination – The light level measured on a horizontal plane in foot-candles.

Inaccessible Cavity – An area that is too confined to enter and/or maneuver in by an average installer/technician.

Incandescent Light – The common light bulb found in residential lamps and light fixtures and known for its inefficiency.

Inches of Water Column (IWC) – A non-metric unit of pressure difference. One IWC is equal to about 0.004 Pascals.

Induced Combustion – See "Fan-Assisted Combustion".

Induced Draft – A vent system for which a fan – installed at or very near the termination point of the vent pipe – moves the combustion gases to the outdoors with negative static pressure in the vent pipe. *Comment: Normally Category I appliances; fan for venting combustion gases at point of exit to outdoors; vented through the wall.*

IAQ – Indoor Air Quality.

Infiltration – The uncontrolled movement of non-conditioned air into a conditioned air space.

Infrared – Pertaining to heat rays emitted by the sun or warm objects on earth.

Infrared Camera – A special camera that “sees” temperature differences on surfaces, allowing the user to determine if a building assembly is insulated properly. This instrument is also useful for detecting air leakage if used with a blower door.

Input Rating – The designed capacity of an appliance, usually specified in BTUs or units of energy.

Insulating Glass – Two or more glass panes spaced apart and sealed in a factory, and having a higher R-value than a single pane of glass.

Insulation – A material used to retard heat transfer.

Intermittent Ignition Device (IID) – A device that lights the pilot light on a gas appliance when the control system calls for heat, thus saving the energy wasted by a standing pilot.

Internal Gains – The heat generated by bathing, cooking, and operating appliances. At times, internal heat gains must be removed during the summer to promote comfort and they can reduce the heating demand in the winter.

Interstitial Space – Space between framing and other building components.

- J -

Joist – A horizontal wood framing member that supports a floor or ceiling.

Joule – A unit of energy. One thousand joules equals 1 BTU.

- K -

Kilowatt – One thousand watts. A unit of measurement of the amount of electricity needed to operate given equipment.

Kilowatt-Hour – The most commonly used unit for measuring the amount of electricity consumed over time; one kilowatt of electricity supplied for one hour.

Kinetic Energy – Consisting of, or depending on, motion; distinguished from potential energy.

- L -

Lamp – A light bulb.

Latent Heat – The amount of heat energy required to change the state of a substance from a solid to a liquid, or from a liquid to a gas, without changing the temperature of the substance.

Lath – A support for plaster, consisting of thin strips of wood, metal mesh, or gypsum board.

Lead-Safe Work Practices – Work practices required by DOE for pre-1978 homes when the weatherization work will disturb more than 2 square feet of painted surface in an interior room, 10 percent of a small component such as a baseboard or door casing, and/or when the work will disturb more than twenty square feet of painted exterior surface.

Light Quality – The relative presence or absence of glare and brightness contrast. Good light quality has no glare and low brightness contrast.

Living Space Return System – In a mobile home, a forced warm air circulation system where air returns to the air handler through the living space, rather than through ductwork or through the mobile home belly.

Low-Water Cutoff – A float-operated control for turning the burner off if a steam boiler is low on water.

Lumen – A unit of light output from a lamp.

Low-E – Short for "low emissivity", which refers to having a metallic glass coating to resist the flow of radiant heat.

- M -

Main Panel Box – The electric service box containing a main switch, and the fuses or circuit breakers located inside the home.

Make-Up Air – Air supplied to a space to replace exhausted air.

Manifold – A tube with one inlet and multiple outlets, or multiple inlets and one outlet.

Manometer – A differential gauge used for measuring pressure.

Manufactured Home – A mobile home or a "double-wide" structure.

Masonry – Stone, brick, or concrete block construction.

Mastic – A thick, creamy substance used to seal seams and cracks in building materials, and especially useful on ductwork.

Mechanical Draft – A combustion appliance with induced draft of forced draft.

MHEA – Manufactured Housing Energy Audit, developed by the Department of Energy for weatherization assistance programs. Used to audit mobile homes.

Mitigate – To make less severe.

Mortar – A mixture of sand, water, and cement used to bond bricks, stones, or blocks together.

MSDS – Materials Safety Data Sheet.

- N -

Natural Draft – A vent system that relies on natural draft (buoyant air) to move combustion gases to the outdoors. *Comment: Category I appliances; atmospheric, fan-assisted, or power burner type combustion; sometimes direct-vent; might be through-the-wall vented.* (Based on NFPA 54)

Natural Ventilation – Ventilation using only natural air movement, without fans or other mechanical devices.

NBS – The National Bureau of Standards, renamed by the Department of Commerce as the National Institute of Standards and Technology (NIST).

NEMA – National Electrical Manufacturers' Association.

NEAT – National Energy AudiT, developed by the Department of Energy for weatherization assistance programs. Used to audit single-family and low-rise multi-family buildings.

NFPA – National Fire Protection Association.

NWMA – National Woodwork Manufacturers Association.

Net Free Vent Area (NFVA) – The area of a vent, adjusted for the restrictions caused by insect screen, louvers, and weather coverings. The free area is always less than the actual area.

Nozzle – An orifice designed to change a liquid like oil into a mist to improve the combustion process.

- O -

O_2 – Oxygen.

Occupants – People of any age living in a dwelling. Animals are not defined as occupants.

Occupiable Space – An enclosed space inside the pressure boundary of a room or house, and intended for human activities including, but not limited to, all habitable spaces, bathrooms, toilet rooms, closets, halls, storage and utility areas, and laundry areas. See habitable space and conditioned space.

Ohm – A unit of measure of electrical resistance. One volt can produce a current of one ampere through a resistance of one ohm.

Orifice – A hole in a nozzle where gas exits to be mixed with air in a burner before combustion in a heating device. The size of the orifice will help determine the flow rate.

Output Capacity – The useful heat or work that a device produces after accounting for the energy wasted in the energy conversion process.

Oxygen Depletion Sensor (ODS) – A safety device for unvented (vent-free) combustion heaters that shuts off gas when oxygen is depleted.

- P -

Parts per Million (ppm) – The unit commonly used to represent the degree of pollutant concentration, where the concentrations are small.

Pascal (Pa) – A metric unit of measurement of air pressure. 2.5Pa = 0.01 inches of water column.

Payback Period – The number of years that an investment in energy conservation will take to repay its cost in energy savings.

Perimeter Pull – A technique used in attics previously insulated with batt insulation. The batts are cut back two feet from the eaves and the area is insulated with blown insulation to ensure coverage over the outer wall top plate, and to prevent wind washing of the insulation under the existing batts.

Perlite – A heat-expanded mineral used for insulation.

Perm – A measurement of how much water vapor a material will let pass through it, per unit of time, under a specified pressure difference.

Plaster – A mixture of sand, lime, and Portland cement spread over wood or metal lathe to form the interior surfaces of walls and ceilings.

Plate – A framing member installed horizontally to which the vertical studs in a wall frame are attached.

Plenum – The section of ductwork that connects the air handler to the main supply duct.

Plywood – Laminated wood sheeting with layers cross-grained to each other.

Polyethylene – A plastic made by the polymerization of ethylene, used in making translucent, lightweight, and tough plastics, films, insulations, vapor retarders, air barriers, etc.

Polyisocyanurate – Plastic foam insulation sold in sheets, similar in composition to polyurethane.

Polystyrene Insulation – Rigid plastic foam insulation, usually white, blue, pink, or green in color.

Polyurethane – Versatile plastic foam insulation, usually yellow in color.

Potential Energy – Energy in a stored or packaged form.

Power Burner- A burner for which air is supplied at a pressure greater than atmospheric pressure. Most oil-fired burners are power burners. Gas burners used to replace oil burners are usually power burners.

Power Draft – See “Mechanical Draft”.

Pressure – A force that encourages movement by virtue of a difference in some condition between two areas. High pressure moves to low pressure.

Pressure Diagnostics – The practice of measuring pressures and flows in buildings to control air leakage, and to ensure adequate heating, cooling, and ventilation.

Pressure Pan – A device used to block a duct register while measuring the pressure behind it.

Pressure Relief Valve – A safety component required on a boiler and water heater, designed to relieve excess pressure buildup in the tank.

Pressuretrol – A control that turns a steam boiler's burner on and off as steam pressure changes.

Primary Window – The main window installed on the outside wall. Not to be confused with a storm window.

- R -

R-value – A measurement of thermal resistance.

Radiant Barrier – A foil sheet or coating designed to reflect radiant heat flow. Radiant barriers are not mass insulating materials.

Radiant Temperature – The average temperature of objects in a home, including walls, ceiling, floor, furniture, and other objects.

Radiation – Heat energy that is transferred by electromagnetic energy or infrared light, from one object to another. Radiant heat can travel through a vacuum and other transparent materials.

Radon – A radioactive gas that decomposes into radioactive particles.

Rafter – A beam that gives form and support to a roof.

Rated Ventilation – A ventilation system that has been designed and installed under the guidelines established by the American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) Standard for Acceptable Indoor Air Quality (Standard 62).

Reflectance – The ratio of lamination or radiant heat reflected from a given surface to the total light falling on it. Also called reflectivity.

Refrigerant – Any of various liquids that vaporize at a low temperature, used in mechanical refrigeration.

Register – A grille covering a duct supply outlet used to diffuse the airflow and sometimes control the flow.

Relative Humidity – The percent of moisture present in the air compared to the maximum amount possible at that given temperature. Air that is saturated has 100 percent relative humidity.

Relay – An automatic, electrically operated switch.

Reset Controller – A device that adjusts fluid temperature or pressure in a central heating system according to outdoor air temperature.

Resistance – The property of a material resisting the flow of electrical energy or heat energy.

Retrofit – An energy conservation measure that is applied to an existing building. Also, the action of improving the thermal performance or structural condition of a building.

Return Air – Air circulating back to the furnace or central air conditioning unit from the house, to be heated or cooled and supplied back to the living area.

Rim Joist – The outermost joist around the perimeter of the floor framing. Also know as “band joist” or “band board”.

Rocking on the High Limit – Refers to the gas burner being shut down by the high limit switch on a furnace, instead of being properly activated by the fan-on/fan-off control.

Room Air Conditioner – An air conditioning unit installed through a wall or window, which cools the room by removing heat and releasing it outdoors.

- S -

Sash – A movable or stationary part of a window that frames a piece of glass.

Savings-to-Investment Ratio (SIR) – For an energy saving measure, the ratio of the savings divided by the investment (cost), including the discounted investment value and escalation of fuel costs. See SIR below.

SIR – Savings-to-Investment Ratio. The SIR value of an energy-saving measure should be at least one for it to be installed. The equation used for SIR is below. The life of a measure is discounted with factors published by the Department of Energy every April.

$$SIR = \frac{\text{Annual Savings from Measure}}{\text{Cost of Measure}} x \text{ Discounted Life of Measure}$$

Sealed-Combustion Appliance – An appliance that draws combustion air from outdoors and has a sealed exhaust system. Also called a direct-vent appliance.

Seasonal Energy Efficiency Ratio (SEER) – A measurement of energy efficiency for central air conditioners. The SEER is computed by dividing cooling capacity, measured in BTUh, by the Watts (see also Energy Efficiency Rating).

Sensible Heat – The heat required to change the temperature of a material without changing its form.

Sequencer – A bimetal switch that turns on the elements of an electric furnace in sequence.

Service Wires – The wires coming from the utility transformer to the service equipment of the building.

Shall – For the purposes of this Standard, the word "shall" means the action is required. If, for any reason, a required act or task cannot be done, the reasons must be documented in the client file.

Sheathing – Structural sheeting, attached on top of the framing, underneath the siding and roofing of a building. Any building material used for covering a building surface.

SMACNA – Sheet Metal and Air Conditioning Contractors' National Association.

Sheetrock – See drywall.

Shell – The building’s exterior envelope – the walls, floor, and roof of a building.

Shingle – A roofing component installed in overlapping rows.

Should – For the purposes of this Standard, the word "should" means the action is strongly recommended, but not required.

Short Circuit – A dangerous malfunction in an electrical circuit, where electricity is flowing through conductors and into the ground without going through an electric load, such as a light or motor.

Sill – The bottom of a window or doorframe.

Sill Box – The area bounded by the rim joist, floor joists, sill plate, and floor.

Site-Built Home – Includes a house built on the site from building supplies, or manufactured homes assembled on the site from pieces shipped to the site on flatbed trucks. Does not include mobile homes and double-wides.

Slope – The roof section of an attic with the roof and ceiling surfaces attached to the rafters.

Soffit – The underside of a roof overhang or a small lowered ceiling, as above cabinets or a bathtub.

Solar Gain – Heat from the sun that is absorbed by a building.

Solenoid – A magnetic device that moves a switch or valve stem.

Sone Level – An international unit used to measure sound levels. One Sone is equivalent to the sound of a quiet refrigerator in a quiet kitchen.

Space Heating – Heating the habitable spaces of the home with a room heater or central heating system.

Spillage – The temporary flow of combustion gases from a dilution device.

Stack Effect – The tendency for warm buoyant air to rise and leak out of the top of the house and be replaced by colder outside air entering from the bottom of the house.

Steady-State Efficiency (SSE) – The efficiency of a heating appliance, after an initial start-up period and while the burner is operating, that states how much heat crosses the heat exchanger. The steady-state efficiency is measured by a combustion analyzer.

Steam Trap – An automatic valve that closes to trap steam in a radiator until it condenses.

Steam Vent – A bimetal-operated vent that allows air to leave steam pipes and radiators, but closes when exposed to steam.

Stud – A vertical framing member used to build a wall.

Subfloor – The sheathing over the floor joists and under the flooring.

Supply Air – Air that has been heated or cooled and is then moved through the ducts and out the supply registers of a home.

Suspended Ceiling – Modular ceiling panels supported by a hanging frame.

- T -

Therm – A unit of energy equivalent to 100,000 BTUs or 29.3 kilowatt-hours.

Thermal Break – A piece of relatively low-conducting material between two high conducting materials, installed to reduce heat flow through the assembly.

Thermal Bridging – Rapid heat conduction resulting from direct contact between thermally conductive materials like metal and glass.

Thermal Boundary – A ceiling/roof, wall, floor, window, or door that separates the habitable, occupiable, and conditioned spaces from the outdoor weather. The thermal boundary should be air sealed and/or insulated if it is cost-effective to do so. Exterior doors are always examples of thermal boundaries. An attic floor is most often an example of a thermal boundary.

Thermal Bypass – An indirect penetration that tends to reduce the effectiveness of insulation by allowing conditioned air to move out of a structure, or allowing unconditioned air to move in.

Thermal Conductance – A material's ability to transmit heat; the inverse of the R-value (see U-factor).

Thermal Enclosure – The boundaries of a dwelling that serve to envelop the space to be kept warm during cold weather and cool during warm weather. The surfaces of the thermal enclosure usually serve as a thermal and pressure barrier.

Thermal Resistance – R-value; a measurement expressing the ability to retard heat flow.

Thermocouple – A bimetal-junction electric generator used to control the safety valve of an automatic gas valve.

Thermostat – A device used to control a heating or cooling system to maintain a set temperature.

Through-the-Wall Vented – Combustion appliances that are vented through a wall rather than into a vertical-rise chimney or vent. Such appliances are usually Category III or IV, but might also be Category I (e.g., direct-vent Category I water heater).

Transformer – A double coil of wire that reduces or increases voltage from a primary circuit to a secondary circuit.

Truss – A braced framework usually in the shape of a triangle to form and support a roof.

Type IC Recessed Electrical Fixture – An electrical fixture that is rated to be in direct contact with thermal insulation.

- U -

U-factor – The total heat transmission in BTUs per square feet per hour with a 1°F temperature difference between the inside and the outside; the thermal conductance of a material.

Ultraviolet Radiation – Light radiation having wavelengths beyond the violet end of the visible spectrum; high frequency light waves.

Unconditioned Space – An area within the building envelope that is not heated or cooled, but tends to be the same temperature as outside.

Underlayment – Sheeting installed to provide a smooth, sound base for a finish material.

UL – Underwriter's Laboratory.

- V -

Vapor Barrier – A material that retards the passage of water vapor.

Vapor Diffusion – The flow of water vapor through a solid material.

Vapor Retarder – A vapor barrier.

Vaporize – To change from a liquid to a gas.

Vent Connector – The pipe that connects the combustion appliance to a vent or chimney.

Vent Damper – An automatic damper powered by heat or electricity that closes the chimney while a heating device is off.

Ventilation – The movement of air through an area to remove moisture, air pollution, or unwanted heat.

Venting – The removal of combustion gases by a chimney.

Venting System – A continuous passageway from a combustion appliance to the outdoors through which combustion gases can safety pass.

Vermiculite – A heat-expanded mineral used for insulation.

Volt – A unit of electromotive force. It is the amount of force required to drive a steady current of one ampere through a resistance of one ohm. Electrical systems of most homes in the United States have 120-volt systems.

- W -

Watt (W) – A unit of measure of electric power at a point in time, as capacity or demand. One Watt of power maintained over time is equal to one joule per second.

Watt-hour – One Watt of power extended for one hour. One thousandth of a kilowatt-hour.

Weatherization – The process of reducing energy consumption and increasing comfort in buildings by improving the energy efficiency of the building and maintaining health and safety.

Weatherstripping – Flexible gaskets, often mounted in rigid metal strips, for limiting air leakage.

WAP – Weatherization Assistance Program.

Weep Holes – Drilled holes that allow water to drain out of an area of a building component where it may accumulate.

Wet Bulb Temperature – The temperature of a dampened thermometer of a sling psychrometer used to determine relative humidity.

Window Films – Plastic films, coated with a metalized reflective surface that are adhered to window glass to reflect infrared rays from the sun.

Window Frame – The sides, top, and sill of the window, which form a box around window sashes and other components.

Worst-Case Depressurization – A condition created when 1) all exhaust appliances (bathroom exhaust, kitchen exhaust, vented dryers, etc.) are operating, 2) the interior doors of a house are in a position that causes the greatest negative pressure in the Combustion Appliance Zone, and 3) the furnace air handler is operating (if such operation causes increased negative pressure in the Combustion Appliance Zone).

17000 Index

A