

Weatherization Work Standards

Iowa Weatherization Program

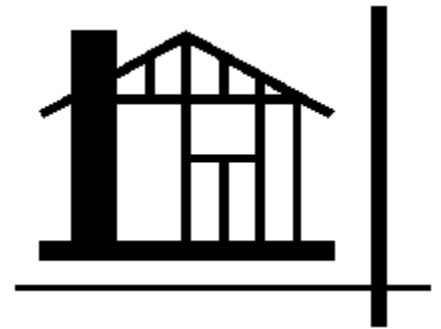


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SECTION 1000 GENERAL INFORMATION

1010 Policies

STANDARD

To provide Iowa Weatherization Program clients with the most cost effective, long-lasting energy efficient measures in order to decrease energy consumption and increase general health and well-being of the client. This will be accomplished by providing high quality materials and workmanship using trained, competent staff and/or contractors.

Energy Auditor/Inspector

Refer to *Iowa Weatherization Policies and Procedures Manual* for details on program policies, including Occupational Safety and Health Administration (OSHA), crew safety, and State Historic Preservation Office (SHPO) requirements.

1011 Cost Limits

- The Iowa Weatherization Program has a limit on the total amount of program funds spent on a home as well as limits on how much can be spent on various measures.
- These limits are listed in the *Iowa Weatherization General Appendix*. Agencies must obtain prior approval from DCAA to exceed established expenditure limits.

1012 Fuel Switching

- Situations may arise when an agency should consider changing fuels for the heating system or water heater that uses a different fuel source.
- Due to the complaints the agency and program may receive from a fuel vendor who has lost business due to fuel switching, a lot of consideration must be given to this decision.
- The reasons for considering fuel switching are:
 - When it is more cost effective to replace the existing appliance with one that uses a different fuel.
 - When it is necessary for health and safety reasons; usually when a gas water heater is back-drafting or has spillage and the only solution is to install an electric water heater. This may only be done if all other options, such as moving the existing water heater or installing a power-vented water heater, have been considered and will not work. These situations must be reviewed and approved by DCAA.
- Client requests for fuel switching will only be allowed if cost effective.

Client Approval

- The agency must obtain client written approval before installing an appliance that uses a different fuel. This prevents the fuel vendor, who had supplied the fuel that is being replaced, from complaining the program is “taking his/her business away.” If a vendor complains, the client request is documented.
- If a client requests the replacement appliance using a different fuel, the fuel switch may only be done if it is cost-effective as demonstrated by either the NEAT or MHEA Audit or the Fuel Switching Calculation form.

Fuel Switching

- When determining whether it is cost-effective to switch fuels, all costs associated with the installation of a new system using a different type of fuel must be considered. For example:
 - If ductwork would have to be added for a new furnace, the cost of adding the ductwork needs to be included in the cost-effectiveness determination. Also,
 - If applicable, the cost of hooking up the house to a natural gas pipeline needs to be considered.
 - Program funds cannot be used to pay the cost of LP tanks or running gas lines to the house.
 - These costs must be covered by the client or another source of funds.
- The cost analysis must include estimates of both installation and operation costs.
- Cost-effectiveness of fuel switching must be shown by one of the following methods.
- Heating Systems:
 - The NEAT audit will calculate savings for switching fossil fuel to fossil fuel. Therefore, any switching from oil to gas or LP to natural gas, etc., now requires a copy of the NEAT audit heating system

input and all recommended measures be submitted with the Fuel Switching Request Form. The Fuel Switching Calculation Form is not required in these cases.

- The NEAT audit will NOT calculate savings for switching fossil fuel to electric or vice versa. Therefore, the Fuel Switching Calculation Form must be submitted with the Fuel Switching Request Form. Agencies must use the current fuel costs from the NEAT audit in the calculation to determine cost effectiveness. If a utility company offers a special rate for using their fuel (lower electric rate for all electric houses), the agency may use the lower rate only if it is documented by the utility and submitted with the request for approval. A copy of the clients' fuel usage documentation must also accompany the request to demonstrate that accurate BTU calculations were made.
- The MHEA audit will calculate switching all fuel types. Therefore, agencies must submit a copy of the MHEA audit heating system input and all recommended measures with the Fuel Switching Request Form. The Fuel Switching Calculation Form is not required in these cases.
- Water Heaters:
 - Both the NEAT and MHEA audits will calculate fuel switching savings for water heaters. Therefore, agencies must submit a copy of the NEAT/MHEA audit input and all recommended measures with the Fuel Switching Request Form. The Fuel Switching Calculation Form is not required in these cases.

State Approval

- The agency must receive approval from DCAA before making any fuel switch in regard to heating systems and water heaters.
- This is done through the use of:
 - The Fuel Switching Request Form,
 - Fuel Switching Request Calculations Worksheet, or
 - The NEAT/MHEA Audit (whichever is applicable),
 - AND the client fuel usage documentation, as appropriate.
- Forms are available on the State of Iowa Weatherization website <https://humanrights.iowa.gov> in the Members Only section as well as in the *Iowa Weatherization General Appendix*.
- Once the fuel switch is approved by DCAA, copies of the forms are to be maintained in the client house file.

1013 Sub-grantee and Contractor Staff Expectations

- Sub-grantee and contractor staff must behave in a professional manner at all times, as they function as weatherization representatives.
- Sub-grantee and contractor staff must use all required Protective Personal Equipment (PPE) and comply with Federal, State or Agency Having Jurisdiction (AHJ) Codes or Program Policies; including, but not limited to OSHA and Lead Safe Weatherization.
- **Prohibited Activities**
 - Drinking, illegal drugs, or the inappropriate use of prescription drugs while on the job or in interactions with the client;
 - Harassment, including but not limited to, sexual harassment;
 - Engaging in any discussion of work, or the performance of work, with the client either at no-cost or at-cost of the client outside of the scope of weatherization work with the client;
 - Violence against self, other staff, or the client;
 - Presence of weapon or firearms at the job site (weapon/firearm may be locked in vehicle); and
 - All other illegal activities not specified above."

1014 Quality of Work

- The quality of all materials and work performed for weatherization must be guaranteed to be free from defects in workmanship for a period of one year after the date of completion.
- All work must be neat in appearance.
- An agency's continued inability and/or refusal to comply with these Standards are grounds for DCAA to suspend, terminate, or otherwise apply special conditions to the agency's contract to provide weatherization services.

1015 Work Order

- Agency auditors are to create their work order from the NEAT/MHEA Audit Recommended Measures material list. The work order is to include all insulation R-values, U-values, efficiencies of mechanical equipment, infiltration and duct sealing targets. The work order must also include all energy conservation measures, repairs, health and safety and general heat waste measures (faucet aerators, pipe wrap, etc.) that are going to be installed on the dwelling. The work order must clearly explain where measures are to be installed.

1016 Material

- Materials used for energy efficiency measures must meet or exceed the specifications described in 10 CFR 440, Appendix A, "Standards for Weatherization Materials".
- Materials used for health and safety purposes and repairs are not required to meet or exceed the specifications described in 10 CFR, 440, Appendix A.
- The complete 10 CFR, 440, Appendix A is available in the *Iowa Weatherization General Appendix*.
- All materials shall be installed according to the International Residential Code, local building codes, manufacturer specifications and/or these standards. If local codes or ordinances are more stringent than the Standards, the local codes or ordinances shall apply. If the Standards are more stringent than local codes or ordinances, the Standards shall apply.
- Select insulation materials that have a flame spread and smoke development index of 25/450 or less when tested in accordance with [ASTM E84](#) or [UL 723](#)
- Materials selected for work on manufactured homes will comply with manufactured housing rules and HUD regulations.
- SDS sheets (electronic or hard copy) will be provided onsite and available during all work.
- If cellulose insulation is installed, it must be manufactured with boric acid. Cellulose insulation containing ammonia sulfate is not allowed.
- When replacing materials/equipment, the old items must be removed from the premises.

1017 Required Tests and Documentation

- The Iowa Weatherization Program requires agencies to conduct certain diagnostic tests and document results in the client (house) file.
- Some of this information must also be recorded on the Client Home Energy Audit Form and reported in WAMS. Agencies are allowed to utilize their own documentation format as long as all required information is included on the Client Energy Audit.
- Following is a list of the required tests and documentation.
 - Spillage results (for both pre- and post-weatherization) for the heating system and water heater under the worst-case scenario. (See [Section 2041](#))
 - Record baseline pressure readings of the combustion appliance zone (CAZ) with reference to (WRT) outside. Then set the house up in worst case – reference BPI standards.
 - Record CAZ volume.
 - Carbon monoxide (CO) readings (for both pre- and post-weatherization) for each gas appliance, except gas stove burners and clothes dryers. (See [Section 2043](#))
 - Temperatures on the supply and return plenums to obtain the temperature rise results. Record results for both pre- and post-weatherization. (See [Section 2044](#))
 - Pre- and post-weatherization pressure pan test reading. (See [Section 2046](#))
 - Pre- and post-weatherization garage leakage test readings for homes with attached or tuck-under garages. (See [Section 2052.02](#))
 - Pre- and post-weatherization blower door readings. (See [Section 2051](#))
 - Room-to-room pressures. (See [Section 2048.01](#))
 - Appliance (refrigerator/freezer) meter readings.
 - Static pressure testing on all furnaces.
 - If pre- and post-weatherization attic by-pass leakage is tested, it needs to be reported in WAMS. (See [Section 2052](#))
 - Target and post REDCalc calculation results.
 - Heat Loss Calculation Worksheet and full Manual J calculation. Worksheet not needed if agency does Manual J calculations.
 - Other recommended tests include:

- Draft pressure results (for both pre-) for both the heating system and water heater under the worst-case scenario. (See [Section 2042](#))
- DTL results.

1018 Completed Home

Site Built Home

The following measures and tests must be done in order for a standard dwelling to be considered a completion:

- If NEAT Audit Cumulative SIR => 1.0 Blower Door Test
 - Infiltration Reduction
 - Attic By-pass Sealing (if needed) within health and safety guidelines
- Health & Safety procedures and diagnostic testing
- Other allowable health and safety measures (if needed)
 - Ground vapor barrier (if accessible)
- All Energy Conservation Measures (not including infiltration) with an individual SIR => 1.0 called for by the NEAT Audit, in sequence and within structural and health and safety guidelines.
- Other Measures (if appropriate and client consents). These measures must be included in the NEAT Audit to determine cost effectiveness.
 - Water Pipe Insulation
 - Low-flow showerheads if feasible (with client permission)
 - Energy efficient light bulbs
- Refrigerator/freezer metering and replacement, if appropriate
- Faucet aerators (with client permission)
- A final inspection of the dwelling performed by the local agency certified QCI

Manufactured Homes

For a manufactured home to be reported to the state as complete the following requirements must be met:

- If MHEA Audit Cumulative SIR => 1.0
 - Blower Door Test
 - Infiltration reduction (if needed)
 - By-pass sealing (if needed)
 - Health and safety procedures and diagnostic testing
 - Other allowable health and safety measures (if needed)
 - Crawl space vapor barrier (if accessible)
 - All Energy Conservation Measures (not including infiltration) with an individual SIR => 1.0 called for by the MHEA Audit, in sequence and within structural and health and safety guidelines.
 - Other Measures (if appropriate and client consents). These measures must be included in the MHEA Audit to determine cost effectiveness.
 - Water pipe insulation
 - Low-flow showerheads and faucet aerators if feasible (with client permission)
 - Energy efficient light bulbs
 - Refrigerator/freezer metering and replacement, if appropriate
 - Faucet aerators (with client permission)
 - A final inspection of the dwelling performed by the local agency certified QCI

Multi-Unit Dwelling

- Refer to the *Iowa Weatherization Policies and Procedures Manual* Section 5.61 for the definition of a completion for multi-unit dwellings.
- Multi-unit dwellings containing 5 or more units require DCAA and DOE prior approval before the dwelling can be weatherized.

1019 Incomplete Home

- An incomplete home is one the local agency has physically traveled to in order to begin the weatherization process, but could not begin work due to one or more factors. See [Section 1020](#) Work

Deferral for more information.

- An incomplete home is also one in which work has started but cannot be completed due to one or more factors. See [Section 1020](#) Work Deferral for more information.
- Deferral notification, with client and energy auditor signature, must be completed and a copy provided to the client.
- Refer to Section 5.62 of the *Iowa Weatherization Policies and Procedures Manual* for more information.

1020 Work Deferral

- There are situations or conditions where weatherization services should be deferred (i.e., delayed or postponed) for eligible clients.
- The decision to defer weatherization should be made before work, or any significant work, begins on a dwelling.
- There are times when work will have begun on a dwelling before one of the situations or conditions is identified. In those cases, the local agency should defer doing any additional work.
- Deferring work on a dwelling does not mean the dwelling will never be weatherized. If the situation or condition causing the deferral changes, it may be possible to begin or complete the work. For example,
 - A dwelling shouldn't be weatherized if it has a bad roof. However, the dwelling can be weatherized later if the roof is replaced or repaired. Another example is
 - A dwelling undergoing remodeling. The dwelling should not be weatherized while it is being remodeled. However, after the remodeling is completed, the dwelling may be weatherized.
- If a reason for deferral is identified at the time of audit, carbon monoxide and smoke alarms may be installed as described in [Section 2060](#) if needed. No other measures may be installed.

1020.01 Deferral Notification

- When an agency defers work on a dwelling, it must notify the client, and the landlord when appropriate, in writing of the reason using the Deferral Documentation Form.
- A copy of the notification, with documentation justifying the decision to defer services, must be kept in the house file.
- Agencies should attempt to identify all reasons why work is being deferred on a home and notify the client and/or landlord of all the reasons and what must be done in order for weatherization work to begin.
- In cases of deferral, the client is to be referred to other sources of funding to help alleviate the issues causing the deferral. Referrals are not limited to, but may include USDA 501 loans and grants, HUD, utility companies and local public health agencies.
- Following are reasons weatherization services should be deferred. This list is not intended to be all inclusive:
 - When a client:
 - Refuses to sign the "Release of Liability Form" (See [Section 2010](#))
 - Is uncooperative including, but not limited to:
 - ✓ Refusing to allow the installation of top energy efficiency measures or important health and safety measures.
 - ✓ Refusing access to parts of the house that prevent the evaluation of the house from being performed or prevents required measures from being installed.
 - ✓ Refusing to change behavior that can cause health and safety problems (e.g., refusal to discontinue using excessive number of humidifiers).
 - Moves or dies while weatherization services are being provided. (Weatherization services may be completed if the majority of work is done prior to the client moving/dying.)
 - When a client, or other occupant in a dwelling:
 - Is threatening or physically or verbally abusive.
 - Has known health conditions which prohibit the installation of insulation or other materials.
 - Is involved in illegal activities.
 - When a dwelling:
 - Has a SIR of < 1.0– smoke and CO alarms may be installed in this case
 - Is posted as being "For Sale" or is known to be for sale (except homes currently in a housing rehabilitation program).

- Is scheduled for demolition.
- Poses a health or safety hazard to crew workers or contractors, for example, rats, bats, roaches, reptiles, insects, animals, or other vermin inappropriately or not properly contained on the premises.
- One or more health and safety hazards exist that must be corrected by the client (or landlord) before weatherization services may begin. Examples include, but are not limited to:
 - ✓ Severe mold or moisture problems (such as pooling in the crawlspace or standing water in the basement) so severe they cannot be resolved within program limits when included in the cost of an ECM.
 - ✓ The presence of animal feces or raw sewage that prevents weatherization measures from being installed.
 - ✓ The presence of a primary heat source unvented space heater unless the unvented space heater is removed from the dwelling. If the unvented space heater is a secondary heat source it may be left in place if it meets ANSI Z21.11.2 requirements and passes required testing procedures.
 - ✓ The presence of disconnected water waste pipes or hazardous electrical wiring.
 - ✓ The presence of asbestos, including vermiculite that contains asbestos, that prevents weatherization measures from being installed.
 - ✓ When health and safety hazards, including unsafe combustion appliances, could pose a health or safety threat to clients but the weatherization program cannot mitigate the hazards due to expenditure limits or program rule/policy limits.
- Is undergoing remodeling or has unfinished areas, which directly affect the weatherization process. Weatherization work may be done when the remodeling is completed.
- Is so full of clutter a weatherization evaluation or weatherization services cannot be done.
- Is beyond the scope of the program due to major structural deficiencies or is in such a state of disrepair that failure is imminent and the conditions cannot be resolved in a cost-effective manner. Examples would be dwellings requiring a new roof or foundation repair or where lead exposure cannot be mitigated with safe work practices.
- When a manufactured home:
 - Includes a heating system other than a heating system designed for manufactured homes. A sealed combustion high efficiency furnace with modifications per manufacturer's instructions and installed properly to include outside air for combustion is allowable.
 - Has a solid-fuel burning appliance drawing combustion air from inside.
 - Has an installation deficiency that may affect worker safety.

1021 Worker Safety

- All agencies are required to have an agency-wide Health and Safety Plan as outlined by OSHA which must incorporate these guidelines.
- All on-site weatherization workers, including Energy Auditors, crews, contractors, and Inspectors are expected to follow OSHA safe work practices, confined spaces, as well as any practices spelled out in these standards.
- All materials will be handled in accordance with manufacturer specification or Safety Data Sheets (SDS) standards to eliminate hazards associated with volatile organic compounds (VOCs), sealants, insulation, contaminated drywall, dust, foams, asbestos, lead, mercury, and fibers.
- Appropriate personal protective equipment (PPE) will be provided to agency staff.
- Workers will be trained on how to use PPE. Workers will be expected to always use appropriate PPE during work.

1022 Emergency Health Preparedness Policy

The Emergency Health Preparedness Policy is only in force when DCAA sends out a program notice to implement the policy. The policy will then remain in effect until further notice from DCAA.

SECTION 2000 HEALTH AND SAFETY

2010 Health and Safety Assessment

STANDARD

Before beginning work on the dwelling, the agency must ensure client health and safety. Eligible dwellings will be inspected for potential problems, including areas where the weatherization process could exacerbate issues. When possible, program funds will be utilized to alleviate those issues.

FIELD GUIDE

Energy Auditor/Inspector

The health and safety assessment includes, but is not limited to, the following:

1. Client informed consent process
2. Visual assessment of:
 - Electrical wiring, looking for bare wires and knob and tube wiring.
 - Mold/mildew and possible moisture problem areas.
 - Unsanitary conditions which preclude weatherization work.
 - Friable asbestos which preclude weatherization work.
 - Potential fire hazards.
 - Dryer ducts held together by screws.
 - Building structure to ensure a safe working area.
 - Observed hazards not affecting weatherization.
 - Lead-based paint which requires lead safe work practices.
3. Pre- and Post-Weatherization Testing:
 - Carbon monoxide levels for all combustion appliances in the home except dryers.
 - Spillage for all combustion appliances under the worst-case scenario. Conducting this test is optional for induced-draft units. Documentation regarding why the test was not run must be included in the file.
 - Temperature rise for the heating system.
 - Static pressure testing on all furnaces.
 - Baseline pressures of the combustion appliance zone (CAZ) with reference to (WRT) the outside.
 - Air leakage using the blower door.
 - Room-to-room pressure test.
 - Duct leakage to the outside using pressure pan test.
 - Garage leakage using zone pressure test in homes with an attached or tuck-under garage.
 - Fuel line leaks.
 - Zonal testing for missed opportunities.
 - ASHRAE 62.2 2016 testing for indoor air quality

Agencies must use the Release of Liability Form – Release of Liability and Waiver of Claims, the Health and Safety Assessment Findings Forms, Part 1 & 2, Health and Safety Notification Form and Client Home Energy Audit Forms as part of the health and safety assessment.

Health and safety problems found during the health and safety assessment will result in the agency taking one of three actions

1. If the problem will not prevent the dwelling from being weatherized and installing weatherization measures won't exacerbate the problem, the agency can proceed with weatherizing the dwelling but will notify the client of the problem.
2. If the problem must be remedied before weatherization measures can be installed, the agency must determine if the program can remedy the problem or if the client or landlord will have to correct the

problem. If the program can remedy the problem, weatherization can proceed once the agency has corrected the problem.

3. In those cases where the client or landlord is responsible for correcting the problem, the agency must ensure the client understands either he/she or the landlord is responsible for correcting the problem before weatherization can begin. The agency must notify the client of the problem regardless of who is responsible for correcting it.

Health and safety testing must also be repeated after weatherization to ensure the activities did not create a health and safety problem in the home. Program funds may be used to conduct the assessment and testing, and to abate certain health and safety problems.

It is very important the agency document any health and safety problems and any problems or conditions which could result in health and safety problems. Documentation must include photos. Good documentation can protect the agency from claims made by clients that the work done by or on behalf of the agency caused a health and safety problem.

Client Informed Consent and Release of Liability Form

Because it is possible weatherization activities could have an adverse effect on an occupant's health, it is important clients provide an "informed consent," consenting to the weatherization activities before they are started. The Release of Liability form is reviewed with the client at the time of initial home assessment. Agencies must inform all clients weatherization activities can release dust and dust-like particles in the air. Occupants with certain health conditions could have those conditions aggravated by the dust and dust-like particles and should be out of the house when insulation is being blown. Health conditions aggravated by dust include:

- Asthma
- Emphysema
- Allergies
- Respiratory problems
- Pregnancy
- Decreased immune function
- Other serious health conditions

It is also recommended infants less than 12 months old should be out of the house when blown insulation or two-part foam is being installed. Persons who leave the dwelling during the insulation process should remain outside the house for the amount of time specified in the manufacturer's instructions.

Clients are required to sign and date a Release of Liability and Waiver of Claims (Release of Liability) Form informing them of this. The consent form should be signed before the dwelling is evaluated. If the client refuses to sign the form, no work will be completed on the home and it will be closed incomplete. The original of the signed Release of Liability Form must be in the client file, and the copy will be left with the client.

The Release of Liability and Waiver of Claims is a 2-part NCR form that is provided by the Weatherization Program. A sample can be found in the Forms section of the *Iowa Weatherization General Appendix* as well as on the Weatherization Program Members Only section of <https://humanrights.iowa.gov/>.

The Release of Liability Form is important because it documents the client has been informed weatherization activities could result in airborne particles being released in the home which could aggravate a health condition of one or more of the occupants in the home. It documents the client authorizes the agency to weatherize the home.

If a client is not available to sign the Release of Liability Form when the Energy Auditor arrives to conduct the energy audit of the home, the Energy Auditor may proceed with the energy audit. However, the Energy Auditor must leave a copy of the Release of Liability Form, a return envelope, and

instructions to the client that no work will be done on the home until the client signs the form and returns it to the agency.

Health and Safety Visual Assessment

A visual assessment of the dwelling must be performed in order to identify any existing health or safety problems or conditions, such as leaky water pipes, could result in health and safety problems. Information about what should be checked is summarized in these standards.

Health and Safety Assessment Forms

The Health and Safety Assessment Findings Forms, Part 1 & 2, Health & Safety Notification and the Client Home Energy Audit Form must be used by agencies to document certain health and safety problems identified in the dwelling and to document the results of certain safety tests. If the health and safety problem has to be remedied before weatherization measures can be installed, and the program does not allow for the remediation by the agency, the client or landlord is responsible for remediation of the problem. The client or landlord must remediate the problem before weatherization activities can begin.

The Health and Safety Assessment Findings Part 1 & 2 and the Health and Safety Notification forms are to always be signed and dated by the client. A copy of the form must be given to the client and/or landlord and the original signed form must be filed in the client file.

If the health and safety problem needs to be remedied before weatherization measures can be installed, and the program allows for the remediation by the agency, the health and safety problems must still be documented on the Health and Safety Assessment Form.

If a health and safety problem is identified by the agency but the problem will not prevent the dwelling from being weatherized and installing weatherization measures won't exacerbate the problem, the agency can proceed with weatherizing the dwelling but should notify the client of the problem. Agencies must document these problems on the Health and Safety Assessment Form.

A copy of the Health and Safety Assessment Findings Forms, Part 1 and 2, Health and Safety Notification form and the Client Home Energy Audit are in the *Iowa Weatherization General Appendix* and are available on the weatherization website <https://humanrights.iowa.gov/> in the Weatherization Program Members Only Section.

2020 Combustion Appliance Testing and Repair/Replacement

STANDARD

To provide a safe, reliable, and efficient heat and hot water source that meets occupant needs at lowest possible cost of ownership and operation. To meet this goal, accurate information about appliance operation is gathered. The program's health and safety inspection protocol require all combustion appliances be tested and ensure system components function and operate in the correct sequence. Tests are preformed prior to the start of any weatherization work. Tests are repeated after work is completed. Carbon monoxide problems must be corrected before any air-sealing work is started on dwellings. The required work will be completed in accordance with the most recent IRC adopted by authority having jurisdiction or adopted by the State of Iowa (whichever is stricter).

2021 Fuel Lines

SWS 5.0504.1a Though.1i 5.0504.2a-f

Auditors and QCI must have a combustion gas analyzer variable tick rate or changing tone based on gas concentration levels. Note: The tick rate provides the indication of concentration but only accounts for relative concentration changes, not necessarily identifying hazardous concentration thresholds.

Be capable of providing a digital display of percentage of Lower Explosive Limit (LEL) and/or provide an alarm when detecting combustible gas concentrations exceeding 10% Lower Explosive Limit (LEL).

FIELD GUIDE

Energy Auditor/Inspector

- Check all gas piping on all combustion appliances, including gas cooking stoves and dryers, for leaks.
- Check all exposed exterior gas lines for leaks.
- If a natural gas leak is found before the meter, notify the utility. Defer work until the leak is repaired.
- If a natural gas leak is found after the meter, program funds may be used to repair the leak.
- If a propane leak is found outside the house, it is the responsibility of the client/landlord or the propane company to repair the leak. The client must be notified of the leak. Defer work until the leak is repaired.
- Use a combustible gas leak detector to check all gas lines, including flexible brass and flexible copper, for leaks.
- Gas line connections must be tested by moving the probe around the connections at a rate of 1" per second.
- Gas leaks must be verified by soapy or bubbling solution to eliminate false positives.
- No weatherization can be done until leaks detected by any means are repaired by the program.
- Copper pipe supplying natural gas to an appliance is not to be replaced unless leaking or required by local code or the appliance is being replaced with weatherization funds (furnace or water heater).
- Copper or flex lines passing through floors to appliances may be replaced at the agency discretion unless the appliance is being serviced. In that case the line must be replaced.
- All gas piping must be installed according to the NFPA54/ANSI/AGA Z223.1.
- Flexible brass fuel lines must be replaced on all appliances.
- Flexible connectors manufactured before 1973 must be replaced. These can be identified by the manufacturer's tag on the connector.
- Older style shut off valves (shown below) must be replaced when replacing appliances.



- All unused gas lines must be capped or plugged.
- Inspect for fuel leakage in kerosene and fuel oil heating units. Inspect fuel oil tank for leaks. No weatherization work may be done until oil or kerosene leaks are corrected.

WX Worker

- All gas piping must be installed according to the NFPA54/ANSI/AGA Z223.1.
- When installing a new appliance (furnace or water heater) fuel lines coming down from the ceiling to the appliance gas valve must be hard pipe.
- Corrugated stainless steel tubing (CSST) will not be used to drop to the appliance. When used for other purposes, must be installed in accordance with manufacturer guidelines and the National Electrical Code.
- If required, fuel leaks will be repaired and inspected in accordance with the most current IRC adopted by authority having jurisdiction or adopted by the State of Iowa (whichever is stricter).

- Locate/route gas piping/train so as to not create a trip hazard, not be damaged by water, and to create the least pressure drop possible
- Seal all gas piping in accordance with manufacturer specifications
- All piping installations must contain at a minimum a manual gas shut off valve, union joint, and a sediment trap at each appliance. Fuel oil lines must be installed in accordance with applicable code NFPA 31 or IMC.

2022 Combustion Air Requirements

5.0502.1a,b

FIELD GUIDE

Energy Auditor/Inspector

- The required volume of combustion air (BTU / 20) will be determined in accordance with the combustion air section of the most current I *NFPA 54*, *IFGC*, or *NFPA 31*, adopted by authority having jurisdiction or adopted by the State of Iowa (whichever is stricter).
- Many building codes and code officials no longer allow openings between the CAZ and the interior of the house. If this is the case, extra combustion air must be obtained from outside.

WX Worker

- If supplemental combustion air is required, installation must be made in compliance with most current IRC adopted by authority having jurisdiction or adopted by the State of Iowa (whichever is stricter).

Supplemental Combustion Air from Outside Dwelling

Energy Auditor/Inspector

- Use the following procedures for adding a measured amount of supply air to the CAZ from outside to provide adequate combustion air if required by the authority having jurisdiction.
- Measure the static pressure at the mid-point of a main return duct or trunk where an additional combustion air supply branch and register can be installed.
- This combustion air supply branch must be at least 6' from the heat exchanger.
- If this method is used, be sure there is a supply register installed in the combustion zone that has adequate airflow to meet the combustion air requirements.

Using Table 1 below, find the appropriate minimum diameter duct for the Btu/hr. requiring make-up air (vertical axis) and the static pressure measured across the duct (horizontal axis).

TABLE 1

Assuring Adequate Combustion Air for Btu/Hr. Input over the Volume of CAZ By static pressure and duct diameter						
BTU/HR	5 PA	10 PA	15 PA	20 PA	25 PA	50 PA
10,000	4"	3"	3"	3"	3"	3"
20,000	5"	4"	4"	3"	3"	3"
30,000	5"	5"	4"	4"	4"	3"
40,000	6"	5"	5"	4"	4"	4"
50,000	6"	5"	5"	5"	4"	4"
60,000	6"	6"	5"	5"	5"	4"

Use the calculation and table below to determine the diameter of duct necessary to meet the additional combustion air requirement for a CAZ.

1. 50 cubic feet of air volume is required for each 1000 Btu/hr. of combustion (1/20th rule).
2. 50 cubic feet per hour / 60 minutes = .83 CFM of air per 1000 Btu/hr. of combustion.
3. 1000 Btu/hr. x .83 CFM = Total CFM additional air necessary for combustion.

Using Table 2 below, find the duct diameter that will deliver the minimum supply flow, given the static pressure across the duct where it will be installed.

TABLE 2

CFM of Flow By duct diameter and static pressure						
	5 PA	10 PA	15 PA	20 PA	25 PA	50 PA
3"	<10	10	14	18	20	28
4"	10	22	28	36	40	60
5"	30	44	56	64	74	100
6"	50	70	90	108	120	170
8"	110	150	200	240	270	360
10"	200	280	360	420	460	660

WX Worker

- Supplemental combustion air from outside may be brought in through a permanent duct, located a minimum of 6' from the heat exchanger and sized with a free opening of 1 square inch per 5000 Btu/hour.
- If central air conditioning exists, an inline damper shall be installed into the duct that can be closed during the summer. The damper handle should be clearly labeled "Summer Closed" and "Winter Open" and operation explained to the client.

2023 Furnaces

SWS 5.01 5.02 5.03

FIELD GUIDE

Energy Auditor/Inspector

2023.01 Heating Unit Efficiency Testing

Furnaces may be replaced for efficiency reasons if, after running the steady state efficiency test, the NEAT Audit lists the measure with an individual SIR of 1.0 or greater.

Combustion Analysis

Steady state efficiency testing is required for all furnaces.

- With the heating unit operating in winter operating condition, for induced draft furnaces, insert the sampling probe of a combustion analyzer in the flue one to two feet (1'-2') before (if possible) or after the first elbow. For atmospheric burning furnaces, insert the probe into the heat exchanger before the draft diverter. Each chamber must be tested separately.
- When checking a high efficiency furnace with (one-pipe system):
 - The flue pipe must be drilled with a unibit so the particles don't fall into the furnace blower unit, if local codes allow.
 - Insert combustion probe into the exhaust pipe. Seal with metallic tape that encompasses the complete pipe or with a plastic plug.
- When checking a high efficiency furnace with **two-pipe system** (power vent or sealed combustion):
 - Each pipe must be drilled (if local codes allow) with a unibit so the particles don't fall into the furnace blower unit.
 - PVC should be drilled two feet from the inducer motor blower.
 - Insert temperature probe of combustion analyzer into intake pipe to measure ambient combustion air.
 - Insert combustion probe into the exhaust pipe.
 - The combustion analyzer will then determine a more accurate efficiency test of the furnace by using ambient combustion air rather than ambient basement temperature.
 - Seal both pipes with metallic tape that encompasses the complete pipe or with plastic plugs.

THIS IS NOT A BPI STANDARD. BPI DOES NOT ALLOW PVC PIPE TO BE DRILLED – READINGS MUST BE TAKEN AT TERMINATION.

- After the unit has reached steady state or has been operating at least five minutes, measure and record the steady state efficiency. However, if the analyzer can only register O₂ (oxygen) and net stack temperature reading; determine whether the readings are within the acceptable limits listed in Table 3.

Oxygen Change (Optional)

Note: During the combustion efficiency test on forced air systems, measure and record any change in the oxygen level when the furnace blower motor comes on. If there is a change in the reading, re-check the heat exchanger for cracks.

TABLE 3

Heating Unit Type	(O ₂) Oxygen	Net Stack Temp
Atmospheric gas (Natural gas, propane)	4 – 9%	300°-600° F
Fan Assisted	4 – 9%	300°-480° F
Space Heater	5 – 15%	300°-650° F
Standard Power Burner	4 – 9%	275°-550° F

2023.02 Heating Unit Safety

SWS 2.0103; 2.0201; 5.3003

Energy Auditor/Inspector

- During the heating season, no weatherization work may be done until a non-operational or hazardous primary heating unit is repaired or replaced.
- All primary heat source unvented fuel-fired heating units which cannot be vented must be removed or replaced with properly vented units. No weatherization work can be completed until the problem is corrected.
- If a furnace is located in a garage, an enclosure should be built around the furnace to separate it from the garage. If the furnace is not a sealed unit, combustion air will need to be addressed.
- The sequence of operation will be verified in accordance with the manufacturer installation, operation, and maintenance manual.
- Use a combustible gas leak detector to check all gas lines, including flexible brass and flexible copper, for leaks (Refer to [Section 2021](#)). All Auditors and QCI must have a combustion gas leak detector that has a variable tick rate or changing tone based on gas concentration levels. Note: The tick rate provides the indication of concentration but only accounts for relative concentration changes, not necessarily identifying hazardous concentration thresholds. Be capable of providing a digital display of percentage of Lower Explosive Limit (LEL) and/or provide an alarm when detecting combustible gas concentrations exceeding 10% lower Explosive Limit (LEL).
- Inspect for fuel leakage in kerosene and fuel oil heating units. Inspect fuel oil tank for leaks. No weatherization work may be done until all fuel leaks detected by any manner are repaired.
- Test the pilot safety switch. If the pilot safety switch is non-functioning or non-existent, one must be installed if possible or the furnace must be replaced.
- Any existing humidifier should be removed with client permission.
- Inspect the wiring to the heating unit. Note whether the electric line to the heating unit is a dedicated circuit and is properly grounded, sized and fused according to electrical codes. Existing wiring can be used if properly sized and grounded, unless local jurisdiction is stricter.
- Inspect all wiring at or in the heating unit for charred, frayed, or missing insulation on the wire and improper or loose connections. If the wiring is hazardous it must be corrected before beginning other weatherization work. Program funds may be used to correct the problem within allowable expenditure

limits. If the problem cannot be corrected within the expenditure limit, inform the client all work will be deferred until the problem is corrected by the client.

- Check that the blower compartment safety switch is operating properly. Repair if needed.
- Inspect the heat exchanger for evidence of deterioration and cracks or holes. If a crack in the heat exchanger is verified (i.e., visually, tracer gas or smoke bomb), then the heat exchanger or the heating unit must be replaced. Inspect for water leakage in boilers.
- With the heating unit operating, use a personnel CO monitor to test for carbon monoxide in the ambient air possibly caused by a crack in the heat exchanger. If the source of the CO is not the heating unit, then look for other possible sources of CO. (See [Section 2043](#))
- During the combustion efficiency test on forced air systems, measure and record any change in the oxygen level when the furnace blower motor comes on. If there is a change in the reading, re-inspect the heat exchanger.
- Inspect the unit to determine whether combustibles or flammable items are around the furnace. If items are within three feet (3'), they need to be removed and the client needs to be notified of this safety problem.
- Record the make and model of the furnace, and input rating for future use in NEAT.
- As houses become tighter, there is a concern about sufficient combustion air. One simple check is to observe the flame. There are several symptoms of insufficient air. They are:
 - Light blue flames with yellow tips
 - Lazy flame with poorly defined edges that appear to be “reaching-out” for air
 - Long flames that roll around, sometimes completely off the burner ports
 - Flames that roll out the front of the cabinet
 - Carbon monoxide production
- If the flame shows any of these symptoms, open an outside door or window in the CAZ. If this improves the flame, extra air is definitely needed. See [Section 2022](#) for combustion air requirements.
- If one does not exist, a filter rack cover must be installed.

- **SECONDARY HEATING SYSTEM**
 - Secondary heating system (may be permanent or portable) is defined as a heat source which is only used occasionally to provide supplemental heat during extreme temperatures. It does not refer to heating sources which provide all the heat to specific areas in the house.
 - Replacement of a secondary heating system is not allowed.
 - If the unvented space heater is a secondary heat source it should be removed with client approval. Dispose of any equipment removed from service.
 - If the client does not approve, it may be left in place if it meets ANSI Z21.11.2 requirements. If ANSI 121.11.1 requirements are met, the following testing must be completed.
 - ✓ Ambient CO testing must be completed in the CAZ of unvented space heaters.
 - ✓ If ambient CO testing exceeds 9 PPM the unit must be removed or all work will be deferred.
 - ✓ If the Undiluted gas of the main burn exceeds 200 PPM free air, the unit must be removed or all work will be deferred.
 - ✓ All CO readings must be documented.
 - If ANSI Z21.11.2 requirements are not met, and the client does not approve removal, all work must be deferred.
 - Solid Fueled space heaters – secondary heating
 - Inspect solid fuel space heaters for proper venting and clearance.
 - If unsafe, the unit must be removed or work must be deferred.

Manufactured Homes

- All units shall be sealed combustion. If the combustion air is being drawn from the inside, repair or replace the heating system before beginning weatherization activities.
- The sequence of operation will be verified in accordance with the manufacturer installation, operation, and maintenance manual.

2023.03 Heating Unit Clean & Tune

SWS 5.3003; 5.3104

WX Worker

- Based on heating unit conditions, the Energy Auditor may determine a clean & tune is necessary.
- The heating system will be inspected to determine whether the A-coil requires cleaning.
- If the heating system is a two-pipe high efficiency system and is over two years old, the blower must be removed to clean the secondary heat exchanger.
- When required, the clean and tune must be performed as described below.
- See [Section 2044](#) for Temperature Rise and Static Pressure Testing requirements.
- Post on equipment, or in a conspicuous location, a list of all systems and components inspected, results, and services performed that includes legible service personnel name, contact information, and date of service

Gas Forced Air

- Ensure the thermostat is level and dirt free. Relocate if necessary.
- Verify proper function and safety of the blower motor, bearings, safety devices, electrical disconnect, electrical wiring, contactors, capacitors
- Clean the furnace cabinet interior, blower fan and motor (cleaning may entail removal of the blower motor, vacuuming, wiping parts with solvent, etc.).
- Change and/or clean existing filters. If no filter rack exists, install one outside the furnace cabinet.
- If one does not exist, a filter rack cover must be installed.
- Check that the amperage of the blower and compressor do not exceed manufacturer full load amperage.
- Verify the blower speed is set in accordance with manufacturer specifications. Adjust if needed.
- Inspect the heat exchanger for evidence of deterioration and cracks or holes. If a crack in the heat exchanger is verified (i.e., visually, tracer gas or smoke bomb), then the heat exchanger or the heating unit must be replaced.
- Inspect pulleys and drive assembly for alignment, wear, and tension and correct as necessary. Inspect belt for wear and replace as necessary.
- Inspect motor bracket for tightness and correct as necessary.
- Lubricate all moving parts according to manufacturer specifications.
- Clean burner of lint, rust, scales, etc.
- If necessary adjust primary and secondary air PMI or per NFPA – 54-80,8.2.
- Adjust pilot flame so the flame envelops the hot tip of the thermocouple.
- Test pilot safety switch (thermocouple) for both the furnace and the gas water heater. Maximum drop out time is 2.5 minutes. If there is not an existing pilot safety switch, one must be installed if possible or the furnace must be replaced.
- Check manifold gas pressure and adjust if necessary (11" WC for LP and 3.5" WC for natural gas).
- Set heat anticipator to the proper amp setting by matching amp draw of the gas valve.
- Check limit control (fan on/fan off control, if applicable) to determine if it is operating properly and repair, if necessary.
- Check static pressure. (See [Section 2044](#))
- Check temperature rise. (See [Section 2044](#))
- Operate unit with blower disconnected to check high limit control and repair as necessary.
- Where two or more appliances are connected to a single vent or chimney, verify the connections meet NFPA 54-80,7.9.4 codes. (See [Section 2031](#))
- Ensure that vented heating units have adequate draft and no spillage. (See [Section 2042](#))
- Inspect and clean, if necessary, chimney, vents, and vent connectors to ensure adequate draft, clearance, soundness, and freedom from combustible deposits.
- If an air conditioning A-coil exists, follow procedures described in [Section 6020](#).
- Manufactured Homes
- ELECTRICAL SAFETY
 - Visually inspect all wiring at or in the heating unit for charred, frayed, or missing insulation on the wire and improper or loose connections.
 - If the wiring is hazardous, program funds may be used to correct the problem within the furnace repair/replacement expenditure limit. If the problem cannot be corrected within the expenditure limit,

inform the client that the manufactured home cannot be weatherized until the problem is corrected by the client.

- Polarity of equipment will be verified by a qualified technician if wiring is to be modified or repaired.
- Voltage will be in accordance with manufacturer specifications.
- Voltage drop will be within acceptable range in accordance with manufacturer specifications.
- Grounding will be connected in compliance with local code requirements, ANSI/NEMA GR 1-2007, and NFPA 70 National Electric Code.
- Amperage will not exceed manufacturer full load amperage.
- Blower compartment safety switch operation will be verified, if present.

Gas Boiler

- Verify proper function and safety of the following system elements: thermostat, ignition system, gas valves, venting system, safety devices, electrical wiring, gas piping, burners, low water cutoff, blow-down systems, fuel delivery, distribution system, insulation, gauge glass, temperature and pressure measurement devices, expansion tanks, automatic fill valves, circulator pumps, zone valves, condensate drainage, air vents, combustion air. Repair or replace elements as needed.
- Refer to [Section 2040](#) for Combustion Diagnostics
- Remove combustible/flammable materials from area
- Purge, verify system pressure, and flush or skim steam boiler
- Clean heat exchanger and burners.
- Inspect for water, steam, or fuel leaks.
- Inspect pipe insulation.
- If asbestos is suspected, do not disturb.
- Pipes through unconditioned areas must be insulated if possible.
- If necessary adjust primary and secondary air PMI or per NFPA 54-80, 8.2.
- Adjust pilot flame so the flame envelops the hot tip of the thermocouple.
- Test pilot safety switch (thermocouple) for both the furnace and gas water heater. Maximum drop out time is 2.5 minutes. If there is not an existing pilot safety switch, one must be installed if possible or the system must be replaced.
- Check that the amperage of the pump does not exceed manufacturer full load amperage.
- Inspect expansion tank. Replace if necessary.
- Check manifold gas pressure and adjust if necessary (11" WC for LP and 3.5" WC for natural gas).
- Inspect automatic fill valve to ensure it maintains system pressure. Correct if needed.
- If necessary, adjust the aquastat high limit and pump control in accordance with the manufacturer's suggested set point.
- Lubricate circulator pump motor if necessary.
- Check for the existence of a pressure valve and verify that it is functional. If not, repair, replace, or add as necessary.
- Check system pressure will be 1 pound per square inch gauge (psig) per 28" of system height.
- Bleed air out of distribution system if necessary.
- Vacuum and clean fins if possible.
- Where two or more appliances are connected to a single vent or chimney, verify the connections meet NFPA 54-80, 7.9.4 codes. (See [Section 2031](#))
- Ensure that vented heating units have adequate draft and no spillage. (See [Section 2042](#))
- Inspect and clean, if necessary, chimney, vents, and vent connectors to ensure adequate draft, clearance, soundness, and freedom from combustible deposits.
- Ensure gauge glass is in good condition. Clean or replace if necessary.
- Make sure zone valves work, if present.

Oil Forced Air

Energy Auditor/Inspector

- Oil systems must have a smoke test before completing any combustion tests.
- Smoke test reading will be in accordance with burner manufacturer specifications.
- If it is more than actionable levels, a tune and clean is required.
- Steady state efficiency, net stack temperature, excess air, and CO and oxygen must be verified and in accordance with manufacturer specification.

- Undiluted flue gases will be checked with a calibrated combustion analyzer. CO levels over 100 PPM as measured require corrective actions.

WX Worker

- Change oil filter and check storage system for water (drain if necessary).
- Clean out the blower wheel and blower compartment (cleaning may entail removal of the blower motor, vacuuming, wiping parts with solvent, etc.).
- Change and/or clean filter or add if needed.
- If one does not exist, a filter rack cover must be installed.
- Inspect the blower assembly's electrical wiring system for bad insulation and loose connections and repair as necessary.
- Verify the blower speed is set in accordance with manufacturer specifications. Adjust if needed.
- Inspect blower and squirrel cage for excessive free play and correct as necessary.
- Inspect the heat exchanger for evidence of deterioration and cracks or holes. If a crack in the heat exchanger is verified (i.e., visually, tracer gas or smoke bomb), then the heat exchanger or the heating unit must be replaced.
- Check that the amperage of the blower and compressor do not exceed manufacturer full load amperage.
- Inspect pulleys and drive assembly for alignment, wear, and tension and correct as necessary. Inspect belt for wear and replace as necessary.
- Inspect motor bracket for tightness and correct as necessary.
- Lubricate motor and motor bearing cups if necessary.
- Safety check primary controls (cad cell), to make sure it is functional and repair or replace as necessary.
- Inspect nozzle size for correct design input and within equipment firing rate. Replace the nozzle, if needed, according to manufacturer's specification and adjust and/or replace electrodes PMI.
- Check fuel pressure. Measurement must be in accordance with manufacturer specifications.
- Clean combustion chamber.
- If necessary adjust primary and secondary air PMI or per NFPA – 54-80,8.2.
- Set the heat anticipator to the proper amp setting by matching the amp draw of the gas valve.
- Check limit control (fan on/off control, if applicable) to determine if it is operating properly and repair if necessary.
- Check static pressure. (See [Section 2044](#))
- Check temperature rise. (See [Section 2044](#))
- Operate the unit with the blower disconnected to check high limit control and repair as necessary.
- Where two or more appliances are connected to a single vent or chimney, verify the connections meet NFPA 54-80,7.9.4 codes. (See [Section 2031](#))
- Ensure that vented heating units have adequate draft and no spillage. (See [Section 2042](#))
- Inspect and clean, if necessary, chimney, vents, and vent connectors to ensure adequate draft, clearance, soundness and freedom from combustible deposits.
- If an air conditioning A-coil exists, follow procedures described in [Section 6020](#).

Electric Warm Air Unit

- Inspect blower assembly's electrical wiring system for bad insulation and loose connections and repair as necessary.
- Verify the blower speed is set in accordance with manufacturer specifications. Adjust if needed.
- If one does not exist, a filter rack cover must be installed.
- Check that the amperage of the blower and compressor do not exceed manufacturer full load amperage.
- Inspect belt for wear and replace if necessary.
- Inspect blower for excessive free play and correct as necessary.
- Inspect pulleys and drive assembly for alignment, wear, and tension and correct as necessary.
- Inspect motor brackets for tightness and alignment and correct as necessary.
- Lubricate motor and motor bearing cups if necessary.
- Ensure the thermostat is level and dirt free. Relocate if necessary.
- Check safety limits (if present) and correct as necessary.
- Check for proper sequencing and element operation.

- Check static pressure. (See [Section 2044](#))
- Check temperature rise. (See [Section 2044](#))
- Clean blower element vestibule and clean or replace filter.
- Check for adequate line voltage and correct as necessary.
- If an air conditioning A-coil exists, follow procedures described in [Section 6020](#).

Electric Baseboard

- Note and record the location of electric baseboard heaters.
- Inspect the heat transfer fins, noting their condition and the presence of dirt, bends, or kinks.
- Discuss with the client the importance of keeping the fins clean and furniture or other objects away from the heaters.

Heat Pump

- Do not test heat pumps when the exterior air temperature is above 70° or below 30°.
- Outside Unit
 - Verify proper function and safety of the following system elements:
 - Fan motor, compressor, outdoor temperature sensors, bearings, safety devices, electrical disconnect, electrical wiring, contactors, capacitors, fan blades, refrigerant access ports
 - Clean outdoor condenser coil and straighten bent fins
 - Level outdoor unit
 - Remove debris from inside unit (e.g., leaves, twigs, insects, spiderwebs)
 - Clear debris, foliage, grass, etc. from within 3' of the unit
 - Verify refrigerant charge is correct per manufacturer specifications
 - Replace damaged refrigerant line insulation
 - Repair or replace additional elements as needed
 - Inside Unit
 - Visually inspect the outside unit to determine that clearances meet manufacturer's instructions (PMI). Make sure the cooling fins are not obstructed or dirty. Determine whether access to the unit is blocked. Explain to the client why this is important.
- Inside Unit
 - Visually inspect the inside unit to determine if there is proper condensate drainage. Make sure there are no puddles or residue present.
 - Visually inspect the A-coil for dirty or obstructed fins and for the existence of cracks or holes. The A-coil may be repaired using program funds if it can be done within heating system repair expenditure limits. If refrigerant is needed, an EPA certified contractor must complete this work.
 - Inspect the wiring to the heat pump unit. Determine whether the unit has a dedicated circuit that is properly sized and fused. Do not fix unless the unit is being replaced.
 - With the unit operating, measure the temperature at the supply and return ducts. Subtract the measured temperatures to determine temperature rise/drop. Determine if the temperature is within the manufacturer's instructions.
 - Check that the amperage of the blower and compressor do not exceed manufacturer full load amperage.
 - Determine whether the thermostat is operating correctly. Adjust the temperature to determine whether the thermostat properly activates the heating and cooling unit.
 - Determine that the emergency heat circuit is functioning properly.
 - Any refrigerant that must be evacuated must be captured rather than illegally releasing it to the atmosphere. For systems with fixed metering devices (capillary tube or fixed orifice), the evaporator superheat method should be used along with the manufacturer's recommendations. For systems with thermostatic expansion valves (TXV), the sub-cooling method should be used along with the manufacturer's recommendations.
 - Test for refrigerant leaks.
 - Check for and seal duct leakage in central systems. Duct sealing and insulation is especially important for ductwork running through unconditioned spaces.
 - Inspect electric terminals, clean and tighten connections, and apply a nonconductive coating if necessary.
 - Oil motors and inspect belts for tightness and wear.

- Check the accuracy of the thermostat.
- Test for proper operation of the heat pump defrost control. This control for the outdoor coil must be adjusted to optimize heating efficiency.
- Check static pressures. (See [Section 2044](#))

2023.04 Heating Unit Installation

SWS 5.0108.4a-p 3.0101.1c

Energy Auditor/Inspector

- All furnace work shall be performed by a qualified, furnace technician, or trained agency personnel.
- Load calculation will be performed in accordance with ANSI/ACCA 2 Manual J/ Manual S and manufacturer specification based on post-retrofit dwelling characteristics.
- Room by room load calculations will be performed when installing a new duct system or in retro-commissioning projects
- Energy Auditor must perform either an estimated Manual J calculation (Residential Heat Loss Calculation form) or full Manual J calculations to be included with the invitation to bid. All calculations (Residential Heat Loss Calculation and full Manual J calculations) must be included in the client house file.
- When a new heating system is required, a new thermostat must be installed if mercury style thermostat exists.
- Furnace repair shall be performed in conformance with **ANSI Z223.1-1999 (same as NFPA 54-2009) including Appendix H** and shall be done in accordance with program spending limits. All furnace work must be in compliance with:
 - International Residential Code (IRC)
 - The Uniform Mechanical Code
 - National Fire Prevention Association (NFPA)
 - Local Codes adopted by the authority having jurisdiction (where they exist)
 - The Furnace Manufacturer's Specifications (must be left in the home)
- Electrical service must be inspected to determine if it will handle the unit to be installed.
- If a new space heater is installed it must be vented and the agency must ensure there is an operable smoke and CO alarm in that room. (See [Section 2060](#))
- Perform a temperature rise and static pressure test to ensure they are within the manufacturer's guidelines.
 - Perform CO testing to ensure it does not exceed 100 PPM, without any alterations to the furnace, lowering gas pressure below manufacturer recommendations, or changing orifice size. This is different than BPI requirements. **BPI requires PPM air free testing procedures.**
- Basic operation of the new equipment will be explained to the occupant including:
 - Efficiency measures
 - Proper operation of controls
 - Electrical and fuel disconnects or shut offs
 - Location of combustion air intake including importance of not blocking the intake
 - Importance of cleaning dust and debris from return grilles
 - Importance of not blocking return or supply registers
 - Importance of proper filter selection and how to change the filter
 - Importance of routine maintenance

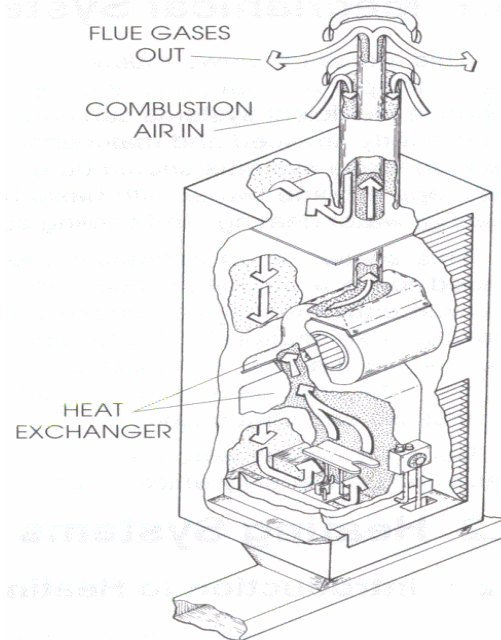
Manufactured Homes

- All units shall be sealed combustion. If the combustion air is being drawn from the inside, repair or replace the heating system before beginning weatherization activities.

Furnace Types

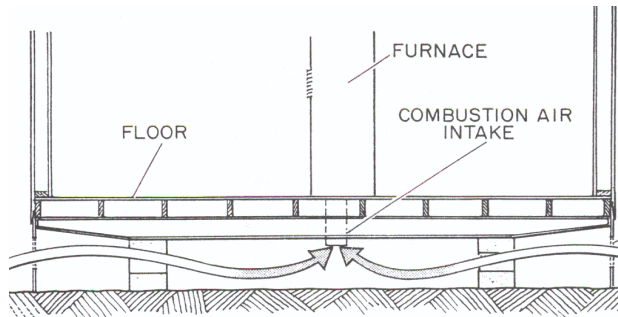
- Concentric Pipe Combustion Air
Combustion air from the roof comes down the outside of the flue pipe, around the furnace cabinet, and into the heat exchanger where it mixes with gas during combustion. (See Figure 1)

FIGURE 1



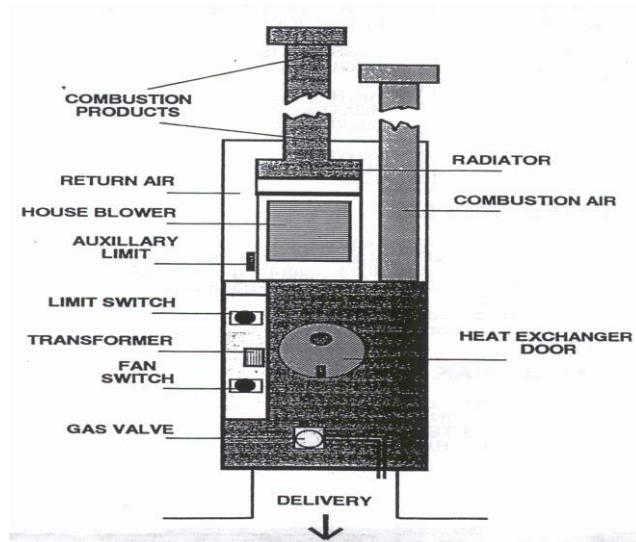
- Floor Supply Combustion Air
A floor supply, sealed combustion air system supplies combustion air directly to the heat exchanger through a duct from under the manufactured home. (See Figure 2)

FIGURE 2



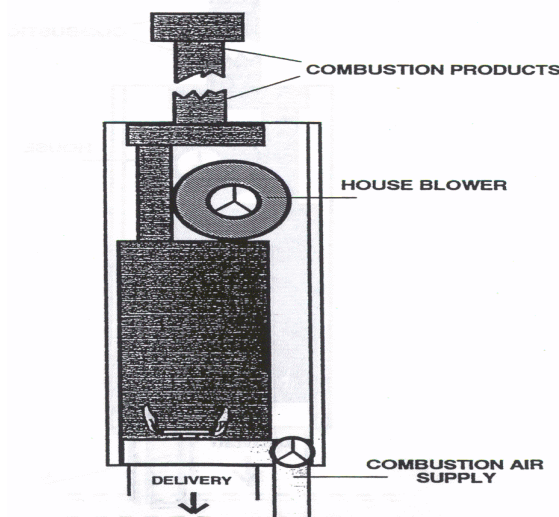
- Dual Pipe Combustion Air
A dual pipe, sealed combustion air system supplies combustion air to the heat exchanger from above the manufactured home through a separate pipe. (See Figure 3)

FIGURE 3



- Induced Combustion Air
An induced combustion air, sealed combustion air system supplies combustion air to the heat exchanger using a small blower. An induced system may bring the air in from above or below the manufactured home. (See Figure 4)

FIGURE 4



WX Worker

- No used furnaces may be installed.
- Select system that is Energy Star certified or equivalent up to 95%
- Locate unit in a dry location and within conditioned space (when feasible) that provides adequate service access according to manufacturer specifications and applicable code
- Install indoor unit according to manufacturer specifications and applicable building code (e.g., [IRC](#), [IMC](#), [IBC](#)) and [ANSI/ACCA](#) Standard 5 ([HVAC](#) Quality Installation Standard)

- All new units shall carry a minimum one-year (1) warranty on workmanship. Each customer shall receive the manufacturer's product warranty information, clear maintenance instructions, and a phone number of who to contact for warranty problems. Furnace specifications must also be left with the client.
- The output rating of all replacement heating units shall be properly sized as in accordance with Manual J.
- A mercury thermostat must be replaced when installing a new furnace.
- When installing a new furnace, it must be installed at least ¾" but not more than 8" off the floor on blocks or a plastic pad.
- The new furnace may not be raised using concrete pads or any type of wood structure.
- Concrete blocks may be used but air must be able to circulate between the bottom of the furnace and the concrete.
- The return air drop also needs to be raised to the level of the furnace.
- Cardboard panning is not allowed during new installation or to repair existing ductwork. Sheet metal must be used for panning and to repair ductwork.
- All deteriorated cardboard panning must be replaced with sheet metal.
- All furnaces must have a filter rack outside the cabinet with a cover and shall prevent return air leakage. Avoid filters with high static pressure drop unless system is designed for them.
- Furnaces installed in manufactured homes must be for that purpose or a sealed combustion high efficiency furnace may be installed with proper modifications per manufacturer's instructions.
- New forced air furnaces must be a minimum of 95% or higher AFUE except in cases of attic or garage installation. A minimum of 80% is required in those cases.
- A two-pipe system is required.
- If the furnace panel of a high efficiency furnace is being used as a combustion air chamber, there must be a rubber gasket around the panel to seal the combustion chamber.
- Grommets and/or rubber gaskets must be installed to seal openings in the furnace cabinet.
- Ensure thermostats are working properly, replace if defective. Thermostats installed with new furnaces must be wired for fan-only function.
- For new furnace installation, wiring from ceiling down to appliance must be secured at the top and bottom and in rigid or flexible metal conduit or non-metallic (gray) electrical PVC.
- Repair or replace any unsafe power supply and install a properly sized and fused switch on the appliance or within 24".
- By code, all new furnaces must be on a dedicated electrical circuit. This will not be enforced in cases where this causes excessive work (inaccessible panel, finished ceiling in furnace area, breaker/fuse box can't handle another circuit, etc.) unless required by local jurisdiction.
- Boilers
 - Boilers installed must be a minimum of 84% AFUE.
 - Hot water boilers must be induced draft or high efficiency condensing.
 - Install boiler according to manufacturer specifications and applicable building code (e.g., IRC, IMC, IBC)
 - Install fuel delivery to the unit according to [Section 2021](#) Fuel Lines
 - Situate equipment on a stable, non-wicking, and fireproof material
 - Ensure unit is level, stable and supported independently of the distribution system

Gas Lines

- For gas line specifications, refer to [Section 2021](#) or the NFPA 54-2009.
- Drip legs (sediment traps) need to be installed to code.
- When installing a new appliance (furnace or water heater) fuel lines coming down from the ceiling to the appliance gas valve must be hard pipe.
- Corrugated stainless steel tubing (CSST) will not be used to drop to the appliance.
- When used for other purposes, it must be installed in accordance with manufacturer guidelines and the National Electrical Code.

Venting

- All venting shall be completed according to the manufacturer's specifications.
- Combustion and exhaust air must terminate outside (not under decks, in crawlspaces, or attics)
- They must both draw air from the same location. This applies to both new and existing terminations

- Support for the PVC piping need to be installed per the manufacturers' specifications or a maximum of four feet apart.
- See [Section 2110](#) for procedures if venting through possible asbestos material.
- If an atmospheric appliance (water heater) shares a chimney with a draft-induced appliance, the draft of the atmospheric appliance must be checked to ensure no drafting problems. (See [Section 2031](#) & [Section 2043](#))

Testing

- Perform a temperature rise and total external static pressure test to ensure they are within the manufacturer's guidelines.
- Perform CO testing to ensure it does not exceed 100 PPM, without any alterations to the furnace, lowering gas pressure below manufacturer recommendations, or changing orifice size.

Condensate Lines 5.0108.4I; 5.0102.1

- All condensate lines must be 3/4" line (unless using a condensate pump) and slope downward to terminate to a drain line or according to local code. They cannot terminate outside the envelope of the house or to a sump pump unless required by local code.
- If required by manufacturers' installation instructions, condensate from condensing furnaces must first pass through a neutralizer if using waste lines for disposal.
- Seal all piping that conveys condensate
- Install vents and traps on condensate drain lines in accordance with manufacturer specifications and applicable building code and in a manner that allows for cleaning of condensate lines without cutting the existing pipe
- Install a secondary drain pan under all condensing appliances installed in or above conditioned space and where water damage may occur to the structure.
- Install an independent condensate drain for the secondary drain pan that drains to a visible termination location. Slope drain pan towards the condensate drain. If termination of condensate drain is to the outdoors, direct it downwards with an elbow fitting at the end of the exterior termination
- Ensure the condensate line does not present a trip hazard for the client.
- No copper piping may be used as a condensate line.
- Install condensate drain pumps when condensate cannot be drained by gravity
- Condensate pumps must be installed at the same level as the furnace (if the furnace is raised because of flooding issues, the pump must be raised also).
- Drain lines from a condensate pump must be 3/8" line.
- Condensate pump cord must have original plug, it cannot be cut and hard wired into the unit.
- There must be a single outlet receptacle for the pump.
- Ensure the condensate line does not present a trip hazard for the client.
- No copper piping may be used as a condensate line.
- High efficiency boiler condensate discharge will be an acceptable pH level in accordance with local code.

Other

- Contractor must record information from the equipment data plate for future service work.
- Contractors must remove and dispose of equipment being replaced. In cases of existing hazardous materials such as asbestos, the agency may direct the contractor to disable and leave in place the existing.

Manufactured Homes

- All furnace installed in manufactured homes must be two pipe, high efficiency units.
- Furnaces installed in manufactured homes must be for that purpose or a sealed combustion high efficiency furnace may be installed with proper modifications per manufacturer's instructions.
- Condensate lines installed with high efficiency furnaces must go to a drain line and not through the bottom of the home because it could freeze.
- Space heaters will not be installed.
- Adjust the heating anticipator in the thermostat to match the amp draw of the system control.
- Repair or replace any unsafe power supply.

- All gas piping must be installed according to the American Gas Association (AGA) specification and any other appropriate codes
- Hard pipe must be used to go into the furnace closet. Flexible gas line connector or hard gas pipe may be used to go through the wall of the furnace cabinet.
- All venting shall be completed according to the manufacturer's specifications. A collar should be installed at the ceiling around the flue pipe. Where the venting exits through the ceiling, it must be air sealed.

Attic Furnace

- Attic furnaces are to be installed only if all other possible installation locations have been exhausted.
- If not present, a code compliant walkway and fireproof service platform will be installed in attics. Walkway and platform will be above the level of insulation.
- Install vibration pads/isolators according to manufacturer specifications.
- A secondary drain pan must be installed under the system if it includes air conditioning. It must drain to a sewer line or outside.
- Install a float switch in the primary and secondary drain pan that is interlocked with the system power circuit and will break the circuit when drainage fails to remove condensate
- When there is potential for condensation or freezing of the drain line, insulate condensate drain lines to a minimum of R-4 with insulation that contains a Class II or greater vapor retarder
- All loose fill insulation must have a 12" clearance around the back, sides, top, and plenum and a 24" clearance in the front.
- Un-faced fiberglass may also be used as a damming material, but it must equal the height of the loose fill insulation and extend 24" away from the furnace in all directions.
- If the combustion air is taken from the bottom 6" clearance must be provided below the unit.
- Seal all seams and joints with mastic on ducts and plenum when located in the attic
- Whenever possible the return drop must allow for the filter to be changed by the client from the living side of the ceiling in a safe and easy manner. The client must sign-off if the filter cannot be changed from the living area.
- All furnaces installed in the attic areas must be installed according to local codes and manufacturer's instructions.

Horizontal Furnace

- Support equipment on a non-wicking, fireproof material or suspend with threaded rod in accordance with local codes and manufacturer specifications
- Install vibration pads/isolators according to manufacturer specifications
- Support equipment on a durable, fireproof platform capable of supporting the weight of the equipment
- Support equipment on ductwork capable of supporting the weight of the equipment
- Install equipment connections (e.g., electrical service, condensate drains, ductwork, fuel, venting, refrigerant lines) to allow for necessary service and repair access to all portions of the equipment
- Install a secondary drain pan with a float switch interlocked to the system power under all condensing units that exist in or above conditioned space
- Pipe condensate to a properly sized drain and provide with traps as specified by the manufacturer and applicable building code
- When there is potential for condensation or freezing of the drain line, insulate condensate drain lines to a minimum of R-4 with insulation that contains a Class II or greater vapor retarder
- Install electrical wiring according to NFPA 70, and
- Install all high voltage wiring inside of protective conduit and approved junction boxes, no wiring connections will occur outside of appropriate junction box

Heat Pumps and Air Conditioners

Electric service must be adequate to handle the needs of the unit.

- Replacement heat pumps and air conditioners should be sized properly.
- All air-source heat pumps with electric auxiliary must be served by a control system – thermostat(s) – to minimize the operation of the electric heaters.
- The heat pump must also include a properly functioning outdoor lockout thermostat.

- The outdoor lockout thermostat must lock out the auxiliary heat (usually electric resistance) when the outdoor temperature is greater than the heat pump balance point (usually 25°F to 40°F, depending on the climate).
- This also serves to lock out the heat pump at the lower temperatures.
- Heat pumps must be a minimum 15 SEER and 8.0 HSPF.
- All new units shall carry a minimum one-year (1) warranty on workmanship.
- Each customer shall receive the manufacturer's product warranty information, clear maintenance instructions, and a phone number of who to contact for warranty problems.
- All furnaces must have a filter rack outside the cabinet with a cover and shall have no open returns in the combustion area.
- Contractors must remove and dispose of equipment being replaced.
- Measure air flow across the indoor coil. Airflow across this coil should be 400 CFM per ton for a wet coil (condensation on coil) and 425 CFM per ton for a dry coil (no condensation on coil), plus or minus 50 CFM.
- Check for correct amount of refrigerant. Follow the manufacturer's specification for refrigerant charge. The airflow across the indoor coil should be adjusted and verified before the refrigerant charge is checked.
- The efficiency for new heat pumps is designated as Seasonal Energy Efficiency Rating (SEER) for cooling performance and Heating System Performance Factor (HSPF) for heating performance. New heat pumps have SEERs ranging from 15.0 to over 18.0 and HSPFs from 8.0 to over 10.0.
- For split heat pump systems with an indoor and outdoor coil, the system efficiency varies with the match of these coils. The manufacturer should be consulted to determine the combined efficiencies.
- Clients will be provided maintenance and upkeep instructions for new heat pump.

Electric Baseboard

- Baseboard heaters must be hard wired on dedicated circuits with individual thermostatic wall control in each room.
- Electric service must be adequate to handle the needs of the units.

Wall Furnaces SWS 5.0301.3

- Perform residential load calculation in accordance with the current version of ANSI/ACCA Manual J (Residential Load Calculation) or equivalent using interior design temperatures of 70 degrees for heating
- Calculated loads based on post-retrofit dwelling characteristics
- Select new unit that is ENERGY STAR® qualified or equivalent
- Install unit per manufacturer specifications and in accord with applicable building code
- Supply air temperature and gas pressure will be within the manufacturer specifications
- Install a wall mounted thermostat that is not directly affected by supply air flow
- Pipe condensate away from the building or to a sanitary drain
- Before installing unit, seal adjacent framing or cavity if recessed into wall
- After installation, seal the perimeter with suitable materials
- Seal all penetrations through the thermal boundary
- Permanently remove equipment from job site and recycle or dispose of removed equipment and refrigerant in accordance with local and federal law (e.g., EPA Section 608 of Clean Air Act of 1990)
- Permanently decommission old equipment
- Provide occupants/owners with user's manual, warranty information, installation instructions and installer contact information

2023.05 Thermostats

SWS: 5.0201.1

FIELD GUIDE

Energy Auditor/Inspector

- Document the location of the thermostat. Ensure it is not on an outside wall or near an outside door or over a heat supply/return duct.
- Thermostats should not be installed on a marriage wall of the manufactured home.

- If a thermostat is located in these areas, the thermostat may be moved using program funds and within program expenditure limits.
- All existing mercury thermostats must be replaced.
- Compatibility will be verified (e.g., voltage, wiring condition, location) and documented. Location of existing thermostat will be assessed for appropriateness (e.g., central to the house, out of direct sunlight, away from supply air, protected from abnormal radiant surface temperatures).
- Thermostats installed with new furnaces must be wired for fan-only function.
- Verify that sufficient number of thermostat wires is available to meet the needs of the replacement unit and the existing system
- Ensure the thermostat is level and dirt free. Relocate if necessary. Ensure thermostats are working properly, replace if defective. When possible, the thermostat must be wired for “fan only” function.
- At Energy Auditor’s discretion, a set-back thermostat may be installed if the NEAT/MHEA Audit calls for it. The energy auditor must activate the measure in the NEAT/MHEA Audit set up to determine cost effectiveness. The Energy Auditor must first determine if the client is capable of re-setting the thermostat.

WX Worker

- All thermostats must be installed according to the manufacturer’s instructions. When possible, the thermostat must be wired for “fan only” function.
- Install a thermostat that allows for full functionality of the installed system
- If being replaced, mercury containing thermostats will be disposed of properly.
- Heat pump thermostats
 - Connect supplementary heat to second-stage heating terminal in accordance with manufacturer specifications
 - Install and connect outdoor temperature sensor that is compatible with the thermostat in accordance with manufacturer specifications
 - Calculate and select an optimum thermal balance point for supplementary heat operation in accordance with ANSI/ACCA Manual S and manufacturer specifications
- Program setup
 - Program the thermostat to match the equipment and control board settings per manufacturer specifications
- Program the thermostat setbacks to a schedule that accommodates the occupant and reduces overall run time.
- Seal penetrations for control wiring with a durable sealant (e.g., caulk, silicone) that complies with applicable fire safety code
- The client will be taught how to use the thermostat and written manufacturer’s instructions are to be left with the client.

2023.06 Heating System Distribution

SWS 3.1601; 5.3104; 6.6188

Energy Auditor/Inspector

- Forced Air
 - Note the location of the registers in each room.
 - Note any blocked or covered registers, and unblock them.
 - Explain to the client why this is important.
 - Note the location of any registers outside the heated area or in other inappropriate locations. Consult with the client about appropriate corrective measures.
 - Note any supply/return registers in the garage. These must be removed and sealed.
 - Note the presence and condition of any suspected asbestos on the ductwork. Follow safe work practices when in the presence of asbestos and distribute the Asbestos in Homes handout to the client and/or owner. The handout can be found on the Weatherization Program Members Only page of <https://humanrights.iowa.gov/>. Do not disturb friable asbestos. Program funds can be used for minor asbestos removal within General Health & Safety expenditure limits. Refer to [Section 2150](#) for more information.

- Ductwork inspection:
 - Inspect for supply and return duct leakage location. (See [Section 2046](#) & [Section 2047](#))
 - Return air cannot come from unconditioned and unintentionally conditioned basement and crawl spaces.
 - Seal return air in plenum.
 - Inspect ductwork support system. Note any areas needing additional support.
 - Inspect for adequate supply and return ductwork.
 - Note sections of the ductwork that are missing or disconnected, severely corroded, rusted through or punctured or other problems in the panned floor joist returns.
 - Note any damage to the supply or return duct restricting airflow and repair as needed.
 - Note the presence of ducts passing through unconditioned spaces. (See Table 4)
 - Note the existence of any duct insulation. Determine if any insulation is needed and record measurements and the amount needed.
 - Note the size of the furnace filter and whether it is dirty. Show the client how to change the filter and educate the client on the importance of changing filter monthly.
 - Note closeable rooms containing supply registers and no return.
 - Note whether the central return is located in a room with a closeable door.
 - Note the client's door closing habits.
 - Discuss with the client the importance of having an uninterrupted airflow from the supply register to the return register. (See [Section 2048](#))
 - New ductwork will be designed in accordance with ANSI/ACCA Manual D and manufacturer specifications. Termination design will be performed in accordance with ANSI/ACCA Manual T and manufacturer specifications.

TABLE 4

CLASSIFICATION & RETROFIT OF ZONES			
Zone	Conditioned	Unintentionally Conditioned	Unconditioned
	If the air temperature is near that of the living area	If the air temperature is between the inside and outside temperature	If the air temperature is near the outside temperature
How the area is used:	Living Area	Workshop or laundry	Cellar or storage
Area has:	Supply register, radiator or heating source	Distribution system, furnace/boiler cabinet loss	No heat
Intended communication with house	Door from zone to house open	Door from zone to house open	Door or outside access always closed
Retrofit			
Insulation:			
Perimeter?	Based on NEAT	Based on NEAT	Based on NEAT
Floor?	No	No	Yes
Duct/boiler pipes?	No	No	Yes
Water pipes?	No	No	Yes
Air Leakage:			
Seal envelope leaks	To outside	To outside	To both in and outside
Seal duct leaks			
Return?	Yes	Yes	Yes
Supply?	Based on tests	Based on tests	Yes
Ventilation?	No	No	No

WX Worker

- Supply or return runs into the garage will be truncated as near to the supply/return plenum as possible.
 - All holes in sheet metal ducts will be patched with sheet metal and secured with sufficient screws to hold the patch flat without gaps.
 - All patches will be sealed with mastic meeting UL 181.
 - Holes created by removing the register and boot will be patched and taped using material meeting local codes.
- Replace ductwork as required by work order.
 - Cardboard panning is not allowed during new installation or to repair existing ductwork.
 - Sheet metal must be used for panning and to repair ductwork.
 - All deteriorated cardboard panning must be replaced with sheet metal.
 - Existing duct board and flexible ducts must be supported every 4'. Use 1 ½" (minimum) wide materials for support to reduce sagging.
 - If installing flex duct, it must be rated to R-8.
 - Metal ducts will be supported at least every 10' using 18-gauge metal straps or 12-gauge galvanized wire.
- New Duct Installation SWS 5.0104.1
 - Select duct materials with a flame spread of no more than 25 when tested in accordance with ASTM E84 or UL 723 and that are UL 181, SMACNA, NAIMA approved or conform to ASTM A653
 - Design residential duct systems using friction charts and ANSI/ACCA Manual D (Residential Duct Systems) or equivalents
 - Do not use building cavities as ductwork under any situation
 - Route ducts so that standard service and repair to the building and its systems does not damage the ducts
 - Design supply terminations to be capable of delivering air with the proper speed and throw to cover the entire space they serve and that do not produce noticeable flow noise when system is operating at full speed
 - Design return grille gross area to be equal to or larger than return box
 - Design all plenums, reducers, supply branches, take-offs, flexible ducts and boots to minimize static pressure and maximize air flow
 - Install accessible filter grills that have no air bypass around the filters
 - Install filter slot covers to prevent return air leakage
 - Avoid filters with high static pressure drop unless system is designed for them
- Duct repair and sealing see [Section 2047](#).
- Duct Support SWS 5.0105.2
 - Support flexible and duct board ducts and plenums with 1-1/2" wide or greater material, installed every 4' or less, without crimping or pinching the ductwork or reducing the interior dimensions
 - Ducts must never contact the ground
 - Support metal ducts with 1/2" wide or greater eighteen-gauge metal straps, 12-gauge galvanized wire, or metal rods every 10' or less
 - Support upflow supply plenums or downflow return plenums independently from the air handler attachment

Boiler SWS 5.0203.1b

- Locate all water lines.
- Inspect for leakage.
- Repair leaks within allowable expenditure limits.
- Check for the presence of insulation on the heated distribution pipes.
- Consult with the client about the usage patterns of the area to determine if the water lines should be insulated.
- All distribution pipes in unconditioned areas are to be insulated to R-5 or greater.
- Inspect heat transfer fins and radiator, noting their condition and the presence of leaks and/or dirt.
- Inspect all bleeder valves for signs of leakage.
- Check for presence of zone valves. Inspect all zone valves for leaks and corrosion. If it is heating season, test the zone valves to see if they work.

- Note the presence and condition of any suspected asbestos on the pipes.
- Follow safe work practices when in the presence of asbestos and distribute the Asbestos in Homes handout to the client and/or owner. The handout can be found on the Weatherization Program Members Only page of <https://humanrights.iowa.gov/>.
- Do not disturb friable asbestos.
- Program funds can be used for minor asbestos removal within General Health & Safety expenditure limits. Refer to [Section 2151](#) for more information.

Manufactured Homes

Energy Auditor/Inspector

- Pre- and post-weatherization pressure pan testing and operating pressures must be completed in all manufactured homes to determine duct leakage to the outside.
- Operating pressures are measured by
 - Turn on air handler
 - At each register, insert pressure probe into center of duct.
 - Record each reading
 - Add all readings together and divide by the number of registers
 - Record as before duct sealing duct operating pressure in MHEA
 - The after-duct sealing duct operating pressure will be recorded as 5 Pascal more than the pre-weatherization number.
- The pressure pan readings must be documented in the file and the Client Home Energy Audit Form.
- Inspect duct system to determine location of ducts and registers.
- Visually check all boots and repair and seal with mastic, if necessary.
- Visually check any crossover ducts and repair and seal with mastic, if necessary.
- Make sure these ducts are supported properly.
- Visually check furnace-plenum joint and repair and seal with mastic, if necessary.
- All ducts should be sealed immediately after the final registers.
- Supply Plenum (furnace to trunk duct connection)
 - Plenum will be rebuilt or repaired using compatible materials and will be:
 - Mechanically fastened
 - Sealed
 - Durable
 - Structurally sound
 - Insulated
 - Equipped with a vapor retarder where climate appropriate
 - If possible, flow diverter or turning vanes will be installed for air flow and/or balancing (e.g., bullhead T's, offset air handler)
- Repair work access
 - Point of access options include:
 - Option 1: Through the trunk duct
 - ✓ Repair and seal access hole in the trunk duct
 - ✓ Install insulation
 - ✓ Repair belly/bottom liner
 - Option 2: Remove crossover duct
 - ✓ Reattach crossover duct
 - ✓ Seal and insulate crossover duct
 - ✓ Repair belly/bottom liner
 - Option 3: Remove air handler
 - ✓ Install new gasket, if necessary
 - ✓ Mechanically attach furnace to the structure
 - ✓ Reconnect utilities
 - ✓ Replace and seal panels
 - Option 4: Through the furnace panel
 - ✓ Replace and seal panels
- Pre- and Post-weatherization duct leakage will be performance tested using a duct blaster or pressure pan and results will be documented on the Client Home Energy Audit form.

Crossover Duct Repair and Treatment SWS 5.0105.3

- Crossover ducts shall be installed in a manner that prevents compressions or sharp bends, minimizes stress at connections, avoids standing water, and avoids excessive length. When skirting is not present, the crossover duct shall be protected against rodents, pets, etc.
- When replacing crossover ducts, remove existing duct materials from installation area that are damaged or wet and prepare trunk surface to accept new installation and sealants
- When replacing damaged crossover ducts, 26-gauge rigid ducts must be installed. The rigid ducts must be insulated to R-8 or greater.
- Flexible crossover ducts shall have a minimum R-8 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 aluminum foil backed butyl.
- Install a rigid metal transition (e.g., rigid elbow) for all changes in airflow direction that is the same size as the crossover duct and is positioned towards the direction of flow
- Fasten duct connections in accordance with [Section 2047](#)
- Install insulation to a minimum of R-8 that includes a vapor retarder layer
- Seal all crossover ducts in accordance [Section 2047](#).
- End cap must be sealed.
- The crossover 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.
- Crossover ductwork must be appropriately secured above the ground. It may be supported by strapping or blocking.
- Flexible duct shall not be allowed to sag more than 12 inches for a span of eight feet.
- Fiberglass (with the exception of duct board) shall not be left exposed in ductwork.

Mobile Home Duct Boots SWS 5.0105.5

- Use a minimum of 28 gauge galvanized or aluminum sheet metal to build new boots
- Build boot 1/8" smaller in width than the opening in the main duct trunk and a minimum of 2" longer than the distance between the top of the duct trunk and the top of the subfloor
- Bend a 1/2" wide outward facing lip on all sides of the top facing end of the boot
- Cut 1" wide tabs in the bottom 1-1/2" of the sheet metal boot that will fold under into the duct trunk
- Install boot into subfloor register hole aligning sheetmetal tabs with the interior of the duct trunk register hole until the outward facing lip on the top of the boot is firmly in contact with the subfloor surface
- Fold all tabs up into the duct trunk so that the boot is firmly in contact on both the top of the subfloor and the inside top of the duct trunk line
- Attach all four sides of the boot to the subfloor using galvanized or stainless steel fasteners
- Seal the boot to the interior of the trunk line using UL 181 approved mesh tape and mastic
- Seal the seam, joints, and any gaps in the boot using UL 181 approved mesh tape and mastic
- Sealant will not be visible beyond edges of the register cover
- Allow sealing materials to dry before replacing register cover
- Register must be easily removable by the occupant

Forced Air Units - Manufactured home Belly-Return Conversion

- Belly-return systems in manufactured homes are notoriously leaky. These leaky return systems can significantly increase the space heating costs and lead to thermal discomfort and indoor air quality problems.
- All belly-return systems shall be converted to a living space return system. Follow the procedures described below.
- Manufactured home belly return air systems must be permanently sealed from the living space.
- A living space return air system must be created by
 - 1) Either removing the furnace closet door or installing an adequately sized return air grille(s) in the furnace closet door;
 - 2) Allowing for return airflow under closed bedroom and bathroom doors; and
 - 3) Sealing the return air grille in the furnace closet.

WX Worker

Belly-Return Conversion Process

- When converting a belly-return system in a manufactured home to a living space return, follow these procedures.
 - Add a grille with at least 200 in² of net free area to the furnace closet door.
 - Block all floor return registers with a durable and tight air barrier being careful to find hidden registers under built-ins, behind furniture, and in kitchen kick spaces.
 - Completely block all floor openings in the furnace closet using a fire-retardant air barrier, being careful to not seal the combustion air inlet.

2024 Water Heaters

2024.01 Water Heater Safety

SWS 2.0103.1abc

Energy Auditor/Inspector

- All combustion water heaters must be properly vented before proceeding with any weatherization work.
- Any water heater which cannot be properly vented must be replaced.
- See [Section 2022](#) to determine if there is adequate combustion air for the appliance.
- Determine if the gas valve is working properly. If not, replace the valve or the water heater, whichever is most cost effective.
- Examine the temperature setting on the gas valve or thermostat. Consult with client to determine if the temperature can be lowered to 120°F without affecting the client's life style.
- Inspect the unit to determine whether combustibles or flammable items are around the water heater. If items are within 3', they need to be removed and the client needs to be notified of this safety problem.
- Record the appliance make, model, and input ratings for additional testing if needed.
- As houses become tighter, there is a concern about sufficient combustion air. One simple check is to observe the flame. There are several symptoms of insufficient air. They are:
 - Light blue flames with yellow tips
 - Lazy flame with poorly defined edges that appear to be "reaching-out" for air
 - Long flames that roll around, sometimes completely off the burner ports
 - Flames that roll out the front of the cabinet
 - Carbon monoxide production
- If the flame shows any of these symptoms, open an outside door or window in the CAZ. If this improves the flame, extra air is definitely needed.
- Venting systems need to be inspected. Refer to [Section 2030](#) for correct procedures.
- Combustion appliances must be tested for spillage.
 - All spillage testing must be taken under "Worst-Case Scenario". (See [Section 2041](#))
 - The purpose of spillage testing is to ensure the proper venting of all combustion devices in the home.
 - Testing should greatly reduce the incidence of spillage.
- Determine if the tank is leaking. If it is leaking, it should be determined if it is a health and safety concern and should be replaced.
- Determine whether a temperature pressure relief valve and a discharge pipe are present. If the relief valve and/or the discharge pipe are not present and there is an existing location for them, determine whether it could be a safety concern and install if needed.
- Examine the plumbing to determine if there are leaks. If leaks exist, they may be repaired within program limits for General Health & Safety repairs.
- A water heater should not be replaced solely on the basis of its age. The age of a water heater does not provide an accurate indication of whether it should be replaced.
- When a water heater is replaced, document the reason for the replacement in the file.

Table 5 should be used in determining when a water heater should be replaced or repaired.

TABLE 5

WATER HEATERS - REPLACE or REPAIR	
Requires water heater replacement	Does not require water heater replacement
<ul style="list-style-type: none"> ● Excessive tank corrosion has caused irreparable water leaks ● Missing parts are no longer available - <i>for example, an original equipment replacement cannot be located for a draft hood and the CO cannot be adjusted to acceptable levels with a generic draft hood.</i> <ul style="list-style-type: none"> ● Water heater is full of corrosion and sediment - <i>as a result, the water heater cannot provide an adequate amount of hot water for the household.</i> ● Exceeds cost limit for repair 	<ul style="list-style-type: none"> ● CO readings exceed the threshold because: <u>Combustion byproducts are not venting properly.</u> <i>Blocked chimneys, vents terminating inside the living space and back drafting can be identified and remedied without having to replace the water heater. The flame is being impinged. The baffle or other parts may need adjusted so the flame burns properly.</i> <u>The water heater has the wrong burner nozzle for the fuel type.</u> <i>The nozzle can be replaced with one appropriate for the fuel type. <u>Combustion air and gas pressure settings are out of adjustments.</u> Air and pressure can be adjusted to reduce CO to acceptable levels.</i> ● If the water heater location prohibits weatherizing the dwelling - <i>the crew or contractor could move the existing water heater.</i>

Manufactured Homes

- Venting systems need to be inspected.
- If the water heater can be accessed from inside the home and has a draft diverter, it must be replaced with a direct vent unit that pulls combustion air from underneath the manufactured home (see Figure 6).
- If the water heater only has outside access, a unit with a draft diverter is acceptable if it is drafting properly.
- Manufactured homes have a much smaller volume than most residential homes. For this reason, care must be taken to avoid back drafting of vented combustion appliances such as the water heater.

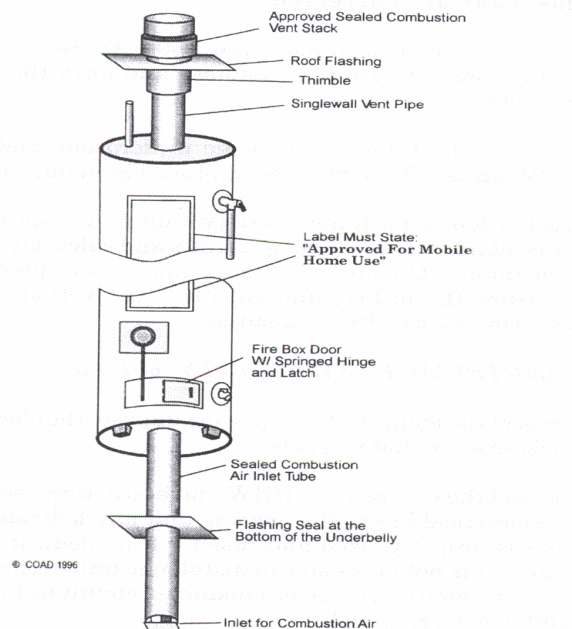
FIGURE 6



- At a minimum, water heater closets with an exterior wall must be treated as follows:
 - The exterior access door and adjacent exterior walls of closets containing electric or gas water heaters shall be insulated, if possible.
 - If the door and adjacent wall can be insulated, the water heater shall not be wrapped with insulation.
 - Cover any air vents in the door or adjacent exterior wall.
 - Bring combustion air from underneath the belly or through the skirting by installing an appropriately sized metal chute with a rodent barrier.
 - Holes in the closet walls that allow air leakage into the interior must be sealed.
 - All plumbing within the closet that is susceptible to freezing must be insulated.
 - An adequate amount of combustion air must be provided to gas water heaters.
 - The floor of the water heater closet must be able to support the water heater in a secure, level position. If needed, the floor of the water heater closet may be repaired using program funds.

Figure 7 is an example of a sealed combustion domestic hot water tank.

FIGURE 7



2024.02 Water Heater Installation

SWS 2.0103.1abc 7.0302.1 7.0302.1 7.0302.2 7.0302.3 7.0303.5

WX Worker

- All water heater work must be in compliance with the:
 - Uniform Mechanical Code
 - International Residential Code (IRC)
 - National Fire Prevention Association (NFPA)
 - Local codes adopted by authority having jurisdiction (where they exist)
 Water heater manufacturer's specification must be left in the home
- No used water heaters may be installed.
- For all new water heater installation, wiring from ceiling down to appliance outlet must be secured at the top and bottom and in rigid or flexible metal conduit or non-metallic (gray) electrical PVC.
- Select piping materials according to the applicable code requirements (i.e., IRC, IBC)
- For new installation or in case of a leaking pipe, dielectric unions will be installed in accordance with the most current IRC adopted by authority having jurisdiction or adopted by the State of Iowa (whichever is stricter).and according to manufacturer specifications.
- The water heater temperature should be set at 120°.

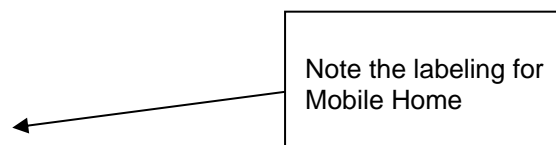
- Provide a level working space not less than 30" in length and 30" in width in front of the control side of the appliance.
- When installing a new water heater, it must be installed at least ¾" off the floor on blocks or a plastic pad.
- Concrete pads and wood blocks are not acceptable.
- Concrete blocks may be used but air must be able to circulate between the bottom of the water heater and the concrete.
- Water heaters installed in a living area in an emergency drain pan are exempt from this rule.
 - If the water heater is installed in a living area or in an area that could be damaged by leaks, an emergency drain pan will be installed with sides that extend a minimum of 2½" above floor in accordance with P2801.5 of the most current IRC adopted by authority having jurisdiction or adopted by the State of Iowa (whichever is stricter).
 - These water heaters do not need to be on ¾" blocks. A ¾" or larger drain line will be connected to tapping on pan and terminated in accordance with P2801.5.2 of the most current IRC adopted by authority having jurisdiction or adopted by the State of Iowa (whichever is stricter).
- There must be a grounded outlet close enough to the water heater so it may be plugged in directly without the use of an extension cord.
- Show the client how to operate the water heater including the temperature controls and maintenance.
- Occupants will be educated on the safe and efficient operation and maintenance of the system, including:
 - Adjustment of water temperature and target temperature in accordance with local code
 - Periodic drain and flush
 - Expansion tank and backflow preventer (no occupant maintenance required)
 - Periodic inspection, maintenance
- A potable water expansion tank will be installed on the cold-water side of new water heaters when required by authority having jurisdiction or if the water supply is or will be a closed system.
 - Water expansion tanks will be installed according to manufacturer specifications.
 - Install or support expansion tank so that it does not move or sag using rigid support material that is able to support twice the weight of the tank filled with water
 - Provide occupants/owners with user's manual, warranty information, installation instructions, and installer contact information
- Backflow prevention will be installed if required the authority having jurisdiction or if potable water expansion tank will be installed.
- For gas line specifications, refer to [Section 2021](#) or the NFPA 54-2009. Drip legs (sediment traps) need to be installed to code.
- Gas Water Heaters:
 - All new gas water heaters installed by the program must meet ENERGY STAR® guidelines.
 - Manufactured homes are exempt from this requirement since water heaters labeled for use in manufactured homes do not meet ENERGY STAR® requirements.
 - Combustion water heaters must be power vented (direct vent for manufactured homes) and have a low nitrogen oxide burner.
 - When installing a new appliance (furnace or water heater) fuel lines coming down from the ceiling to the appliance gas valve must be hard pipe.
 - All venting shall be completed according to the manufacturer's specifications.
 - If venting through possible asbestos materials, refer to [Section 2110](#) for procedures.
 - Combustion and exhaust must terminate outside (not under decks, in crawlspaces, or attics). This applies to both new and existing terminations.
 - Support for the PVC piping need to be installed per the manufacturers' specifications or a maximum of four feet apart.
- Electric Water Heaters:
 - All new electric water heater must have an Energy Factor (EF) of 0.93 or better.
 - Manufactured homes are exempt from this requirement since water heaters labeled for use in manufactured homes do not meet ENERGY STAR® requirements.
- Heat Pump Water Heaters:
 - Manufactured homes are exempt from this requirement since water heaters labeled for use in manufactured homes do not meet ENERGY STAR® requirements.

- Select a water heater that is ENERGY STAR® certified, equivalent, or better fits in the installation space with required clearances and provides sufficient hot water for the home and occupants
- Install appliance where it is in conditioned space is accessible for service has sufficient volume of air per manufacturer specifications will not affect indoor thermostat readings or blow directly on occupants
- Install water heater in compliance with applicable code (e.g., NFPA 70, IRC, IBC, IMC) and manufacturer specifications
- Install appliance and plumbing to allow for inspection, maintenance, and replacement of the appliance and its components, without disturbing other installed equipment, controls, piping, and components, other than what requires repair/replacement
- Ensure that anode rod is accessible for replacement
- On Demand Water Heaters:
 - On-demand water heaters will only be installed with DCAA prior approval.
 - Verify current plumbing infrastructure is sufficient to support the installation(s) and is leak-free
 - Install fuel supply components per NFPA 31 (for oil) and NFPA 54 (for gas) and manufacturer specifications
 - If conflict exists between code and manufacturer specifications, apply the more restrictive requirement
 - Install an emergency fuel cut-off switch within reach of the water heater
- Pressure Relief Valves
 - All water heaters installed must have a temperature pressure relief valve with extension to within 6" of the floor.
 - Select temperature and pressure relief valve in accordance with IRC and according to manufacturer specifications that comply with ANSI Z21.22
 - Select temperature and pressure relief valve in accordance with IRC and according to manufacturer specifications that comply with ANSI Z21.22
 - Flows by gravity and without any trap
 - Is not directly connected to the dwelling drainage system
 - Does not contain any valves or tees, nor end with a threaded connection

Manufactured Homes

- When a new water heater is installed it must be labeled as a manufactured home water heater. (See Figure 8) New units must be direct vent or electric. Replacement electric water heaters must be manufactured for manufactured homes. Existing electric water heaters, unless unsafe, should not be replaced.
- All water heater work must be in compliance with the:
 - Uniform Mechanical Code
 - International Residential Code (IRC)
 - National Fire Prevention Association (NFPA)
 - Local codes adopted by authority having jurisdiction (where they exist)
- All water heaters installed must have a temperature pressure relief valve with extension to within 6" of the floor.
- Water heaters being replaced are to be replaced with the existing size, not to exceed 40 gallons.
- The water heater temperature should be set at 120°
- Show the client how to operate the water heater including temperature controls.
- Water heater manufacturer's specification (must be left in the home).
- If the water heater is installed in a living area or in an area that could be damaged by leaks, an emergency drain pan will be installed where possible. The pan sides must extend a minimum of 2½" above floor in accordance with P2801.5 of the most current IRC adopted by authority having jurisdiction or adopted by the State of Iowa (whichever is stricter).

FIGURE 8





2030 Combustion Appliance and Dryer Venting

STANDARD

Combustion appliance and dryer venting systems will be inspected for damage, leaks, disconnections, inadequate slope, and other safety hazards. Any hazards identified will be corrected within program limits.

2031 Furnace and Water Heating Venting FIELD GUIDE

Energy Auditor/Inspector

- **Solid-fuel burning system cannot share the same flue with a gas-fired appliance. The venting system must be separated.**
- If the venting system cannot be reconfigured, the house will not be weatherized.
- Inspect all vent systems (including solid-fuel) to ensure they extend from the heating unit to the outside of the dwelling.
- Look for excessive corrosion or rust, cracks, holes and unsealed or disconnected sections.
- Inspect the vent/chimney connections to determine whether they are securely fastened.
- Existing problems must be corrected.

- All new heating systems and/or water heaters must be vented in accordance with the manufacturers' specifications, the IRC, or NFPA 31, 54, 58 and 211 whichever is stricter.
- Exception: No venting is allowed to terminate under decks.
- Any horizontal run in the vent connector must have a rise of at least $\frac{1}{4}$ " per foot. If the existing connector does not, it should be repaired if possible. (See Figure 9)
- Exception: If the appliance drafts properly under worst-case setup, this requirement is waived.
- When a common flue is used for more than one appliance, a 'Y' connector is the preferred connection. Be sure that vent connections are not directly across from each other, when an induced appliance is used. (See Figure 10)

FIGURE 9

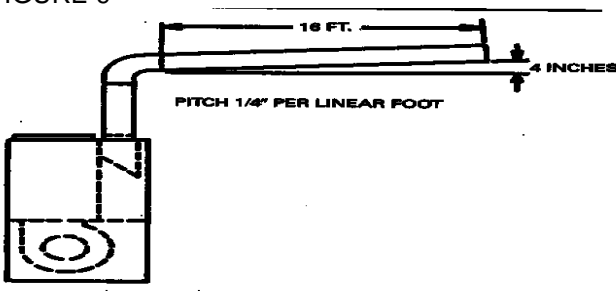
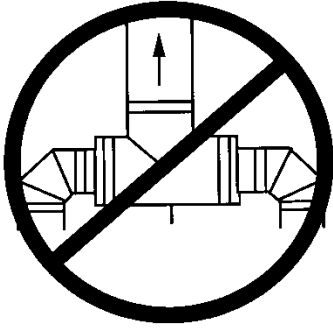


FIGURE 10



- When checking vent sizing for proper venting, refer to local codes or the most recent IRC adopted by governing jurisdiction, NFPA codes, or the State of Iowa, whichever is stricter.
- If a sealed combustion, two pipe furnace exists or is being installed, test the atmospheric draft water heater draft under worst-case conditions.
- Line the chimney according to code, if proper draft is not achieved.
 - If water heater does not have spillage, the chimney does not need to be lined.
 - If, at the time of inspection, the water heater spills, consider lining chimney before replacing water heater by using DTL, CAZ pressure and target blower door.
- Chimney vents will have an airspace clearance to combustibles in accordance with most current IRC adopted by governing jurisdiction or the State of Iowa, whichever is stricter.
- If present, thermal flue dampers must be removed.
- Determine whether all chimneys, including brick, blocks and mortar are in good condition and unobstructed.
- Necessary minor chimney repair must be made for air sealing, for example, seal between brick and metal liner in the attic.
- If a space heater is vented using a masonry chimney, it must be lined.
- All disconnected non-functioning chimneys in the attic must be sealed.
- Determine whether chimney liners are in good condition and unobstructed.
- Necessary repairs or replacement of liners must be completed.
- Inspect the exterior of chimneys for proper termination height according to most current NFPA 54 Chapter 12 adopted by authority having jurisdiction or adopted by the State of Iowa (whichever is stricter) or according to manufacturer's specifications.
- Install new chimney caps on all chimneys, if one does not exist.

WX Worker

- If present, thermal flue dampers must be removed.
- Any horizontal run in the vent connector must have a rise of at least ¼" per foot.
- Install new chimney caps on all chimneys, if one does not exist.

2032 Dryer Venting

SWS 6.0202.1

FIELD GUIDE

Energy Auditor/Inspector

- All dryers must be vented completely outside prior to beginning weatherization work.
- Dryer vents must not terminate in a crawlspace, garage, or attic.
- Determine whether the dryer is vented with rigid duct, metal flex, or flexible duct that is approved for use with the applicable energy source. It must be installed in a manner that minimizes overall length, and provides sufficient support to eliminate sagging.
- All replacement dryer duct must be rigid 28-gauge metal duct with a smooth interior.
- Existing vinyl or foil duct on gas dryers must be replaced with 28-gauge metal duct.
- Existing vinyl or foil which is in good shape on an electric dryer may be left.
- Any venting problems should be remedied as a health and safety expense.

- Any inline diverter that is inside the envelope of the home must be removed.
- Screws are not to be used to install any dryer exhaust because of a build-up of lint inside the vent. Metallic tape meeting UL 181 requirements should be used to connect the duct joints. Screws in existing dryer ducts must be removed and the joints sealed with metallic tape.
- The use of a clamp to secure the vent pipe to the dryer outlet is required.
- As short a run as practical of rigid 28-gauge metal with a smooth interior venting material will be used in accordance with manufacturer specifications. Determine whether the diameter of the dryer vent is at least the diameter of the appliance outlet. Determine the length of a 4-inch diameter dryer vent duct. The maximum length should not exceed 25 feet from the clothes dryer outlet to the termination point. If the length exceeds 25 feet, increase the duct diameter to 5". (A reduction in maximum length of 2.5 feet for every 45-degree bend and 5 feet for every 90-degree bend shall apply.)
- Dryer duct that passes through unheated areas must be insulated with a minimum of R-8 insulation (this includes dryer duct on manufactured homes that passes under the underbelly to the skirting).
- Termination fitting manufactured for use with dryers will be installed. Dryer termination should match the color of the siding as close as possible or be white. A backdraft damper will be included, as described in termination fitting detail.

Manufactured Homes

- All dryers must be vented completely outside the attic or beyond the skirting. Dryer duct that passes through unheated areas must be insulated with a minimum of R-8 insulation (this includes dryer duct on manufactured homes that passes under the underbelly to the skirting, which must be insulated to a minimum of R-12).

WX Worker

- Dryer duct that passes through unheated areas must be insulated with a minimum of R-8 insulation (this includes dryer duct on manufactured homes that passes under the underbelly to the skirting).
- Termination fitting manufactured for use with dryers will be installed. A backdraft damper will be included, as described in termination fitting detail.
- The use of a clamp to secure the vent pipe to the dryer outlet is required.
- Occupant will be instructed to keep lint filter and termination fitting clean.
- Occupant will be instructed to keep dryer booster fan clean, if present.

Manufactured Homes

- All dryers must be vented completely outside the attic or beyond the skirting. Dryer duct that passes through unheated areas must be insulated with a minimum of R-8 insulation (this includes dryer duct on manufactured homes that passes under the underbelly to the skirting).

2040 Combustion Appliance Diagnostics

STANDARD

Analysis on critical components and operations completed in accordance with industry and manufacturer specifications. This analysis includes: testing appliances with the house in worst case setup; testing for proper combustion and dilution air; testing the temperature rise and total external static pressure to identify potential problems with the furnace; pressure pan testing; testing for duct leakage; and pressure differential testing.

2041 Worst Case Setup

SWS 5.0501.1

FIELD GUIDE

Energy Auditor/Inspector

Documentation

- The test results must be documented on the Client Home Energy Audit.

When Required

- Houses must be configured in the worst-case setup when conducting spillage tests and carbon monoxide tests.

Procedures

- The configuration of the house must be determined on a house to house basis.
- This configuration will include interior doors open or closed and the exhaust devices to be activated.
- In every case, the combustion test should be done with the house in its worst-case situation.
- Consideration must be given to the following:
 - The type and location of the heating system.
 - The location and strength of all the exhausting equipment (bath fans, dryer, kitchen exhaust devices, etc.).
 - The location of wood stoves, fireplaces and water heater.
 - The location of the forced air system returns, or supply leaks to the outside
- Place the home in winter mode with all the windows and doors closed. If the blower door is set up, make sure the cover is on the fan.
- Fireplace or wood stove dampers must be closed when testing primary heating system.
- Deactivate all combustion appliances and exhaust fans.
- Check furnace filter, clean or remove.
- All supply or hot air ducts that are in the same zone or room as the furnace are to be closed. If the basement or CAZ has a return register that will not be sealed in a heated basement like a living area, this return register needs to be left open.
- If it is to be sealed permanently, close off temporarily with duct tape.
 1. Close any existing door to the combustion appliance zone (CAZ). While standing in the combustion appliance zone using a digital pressure gauge run a hose to the exterior (outside) of the house to the "B" side reference tap on the digital gauge. This measures the CAZ with reference to (WRT) the outside. This is called the baseline measurement. Record this reading for future reference. Baseline is the natural pressure difference for the interior and exterior of the home caused by natural elements such as temperature, wind and stack affect. Leave the pressure gauge and hose in this set-up for more testing.
 2. With all interior doors open, activate all exhausting equipment in the house except a whole house fan and furnace air handler. Record the pressure reading of the CAZ with reference to (WRT) the outside.
 3. With the house still set up as in #2, activate the furnace air handler if present. Caution: If the only way to activate the air handler is to fire the furnace, extreme caution must be used due to the potential of combustion back drafting or flame rollout. It may be prudent to test for ambient CO levels in the combustion appliance zone during the test. If the ambient CO exceeds 35 PPM, abort the test and follow procedures in [Section 2043](#).
 - a. Leave air handler on.
 - b. Using another DG 700, place a hose on the input tab, channel A.
 - c. Starting at the room furthest from CAZ throw a hose in the room and close the door, if the room pressure is positive, leave door closed.
 - d. If room pressure is negative, open the door.
 - e. Complete these steps for all rooms with doors, moving back to the CAZ area.
 - f. Once the door positions have been determined, take another CAZ reading WRT outside.
 - g. If CAZ pressure is more negative than reading in #2 leave air handler on.
 - h. If CAZ pressure is more positive than reading in #2 turn air handler off.
 - i. You are now set up in worst case.
 4. If CAZ pressure in step 3 is equal to or greater than step 2 reading, subtract baseline reading from step 3 reading. If CAZ reading in step 2 is greater than step 3 reading, subtract baseline reading from step 2 reading. Review the results of the testing and determine the configuration of the building that results in the greatest negative pressure being developed in the combustion appliance zone (CAZ) after subtracting the baseline reading. This pressure reading must be recorded in the file.
- Recreate the configuration that results in the greatest negative pressure in the CAZ (Step 2 or Step 3). Be sure to monitor ambient CO levels while performing tests. Pre- and post- CAZ pressures must be

recorded. Keep in mind that CAZ WRT outside greater than -5 might result in spillage issues. If ambient CO levels exceed 35 PPM, abort test and refer [Section 2022](#).

- If the CAZ pressure is high causing spillage, agency should try to relieve the pressure (see [Section 2042](#) for possible solutions).
- Turn off all exhaust fans and return combustion appliances to normal settings.

Secondary CAZ Areas

- If the house has a secondary combustion heating source, a separate CAZ test is required unless combustion air is drawn from outside. Follow steps 1 – 4 above for this test.
- When testing secondary CAZ with fireplace or wood stove, the dampers must be open during test.
- The concern about fireplaces is, after a fireplace has died down, other equipment in the house may cause it to spill. In the case of the fireplace, only pressure readings can be used to determine if the depressurization potential can cause problems.
- Caution: If depressurization in the fireplace zone with reference to the outside exceeds –5 Pa, there could be a potential for spillage.
- Turn off all exhaust fans and return combustion appliances to normal settings.

2042 Spillage Testing

FIELD GUIDE

Energy Auditor/Inspector

- The purpose of the spillage test is to ensure the proper venting of all combustion devices in the home to reduce the chances of the appliances spilling combustion gases into the home.
- Spillage tests must be done at the time of the energy audit and during the final inspection on all natural and induced draft heating systems and water heaters.
- All spillage tests must be taken under “Worst-Case Scenario” and under natural conditions if spillage tests fail under worst case scenario.

Documentation

- The test results must be documented on the Client Home Energy Audit and must also be recorded in WAMS.

When Required

- Pre- and post-weatherization spillage must be done on all dwellings except:
 - Houses and apartments, which are total electric with no combustion appliances, wood stoves, or fireplaces.
 - Houses with double-wall vent pipe (such as manufactured home furnaces).
- Gas dryers are excluded from these tests.

Test Procedures

- Put house in worst case setup.
- Spillage Assessment & CO Measurements in [Cold Vent](#) (except water heaters which is always measured in the Warm Vent).
 - Spillage shall be assessed at 5 minutes of main burner operation (see Table 6 for action levels in case of spillage).
 - CO measurements of undiluted flue gas shall be taken at 5 minutes of main burner operation (See Table 8 for CO action levels).
- Spillage Assessment and CO Measurements in [Water Heater and/or Warm Vent](#).
 - Spillage will be assessed at 2 minutes of main burner operation (See Table 6 for action levels in case of spillage).
 - CO measurements of undiluted flue gas shall be taken at 5 minutes of main burner operation (See Table 8 for CO action levels).
- [Multiple Combustion Appliances Sharing Chimney \(Warm Vent\)](#)
 - When a chimney and/or venting system is shared by multiple combustion appliances, the following procedures to test for spillage and CO levels must be used.

- Combustion appliances shall be tested in order from lowest BTU/hour input rating to highest BTU/hour input rating.
- The appliance with the lowest BTU/hour input rating shall be assessed for spillage and CO measurement in undiluted flue as described above in Cold or Warm Vent.
- Upon completion of spillage testing and CO measurement of the first appliance, place the next largest BTU/hour combustion appliance in operation with the first appliance still firing. Do not wait for the chimney to cool.
- Retest the first appliance for spillage when the second appliance has reached 2 minutes of main burner operation. Test the second appliance for spillage immediately thereafter.
- Measure CO level in the undiluted flue gas of the second appliance at 5 minutes of main burner operation. Continue this process for each additional commonly-venting combustion appliance in order of BTU/hour input rating until all are running simultaneously.
- See Table 6 for action levels in case of spillage. See Table 8 for CO action levels.
- If spillage during under worst case, turn off appliance, let vent cool and retest under natural condition. If spillage fails under natural condition, the appliance(s) must be repaired or replaced.
- Document pre- and post-weatherization spillage testing.
- As a guideline to help determine possible spillage after weatherization a draft test is recommended. Low draft numbers would indicate possible spillage post weatherization.
- Pre-weatherization, if the water heater has spillage the energy auditor must install CO alarms. If after weatherization is completed, the water heater is spilling, the water heater must be repaired or replaced.

TABLE 6

Action Levels for Spillage in Combustion Appliances	
TEST RESULTS	ACTION REQUIRED
Greatest CAZ depressurization occurs with air handler on*	Conduct further analysis of the distribution system to determine if leaky ducts or other HVAC-induced imbalances are the cause of the spillage. If so, recommend distribution system repairs that will reduce or eliminate the CAZ depressurization
Greatest CAZ depressurization occurs with door to CAZ closed, but is alleviated when door to CAZ is open*	Recommend measures to improve air transfer between the CAZ and the core of the house
The cause of spillage has been traced to excessive exhaust** independent of CAZ door position, air handler or a problem with the flue***	Verify that sufficient combustion air is available per ANSI Z223.1/NFPA54 for gas-fired appliances and NFPA 31 for oil-fired appliances or recommend verification by a qualified professional and/or Recommend further evaluation/service by a qualified professional to address the venting/combustion air issues
<p>* In the case where both spillage and excessive CO are present, in addition to the specific recommendations above, recommend that the appliance be shut down until it can be serviced by a qualified professional</p> <p>** Refers to exhaust caused by mechanical ventilation and/or other means of exfiltration</p> <p>*** When a recommendation to replace atmospherically-vented combustion equipment inside the pressure boundary is made, and when cost-effective, recommend replacement with direct-vented or power-vented equipment (or non-combustion equipment) which is ENERGY STAR® labeled.</p>	

Table 7 indicates which types of combustion appliances must be tested for spillage, draft, and CO.

TABLE 7

Testing for Various Vented Combustion Appliances under Worst Case Conditions		
<i>Combustion Appliance Type</i>	Tests Under Worst Case Conditions	
	<i>Spillage Test (at 2 minute)</i>	<i>CO Emissions Test As-measured CO <100 PPM (at 5 minutes)</i>
Gas-fired, natural draft and fan assisted	yes	yes
Oil-fired w/typical power burner	yes	yes
Gas-fired, side wall vented, but not direct vent/sealed combustion	no	yes
Manufactured home furnaces	no	yes

Solutions to Spillage under Worst Case Conditions

If spillage is a problem correct the problem by one of the following methods:

- Check for blockage in the vent system and, if found, correct the problem.
- Check vent system for leaks, including missing or loose cleanout doors or open or cracked mortar joints. Seal vent system as appropriate. Lining a chimney may solve this problem.
- Properly seal return duct leakage in the CAZ.
- Increase the CAZ air volume by connecting the CAZ to other areas within the conditioned volume of the dwelling (see NFPA 54, NFPA 31).
- Increase the CAZ air volume by connecting the CAZ to the outdoors (see NFPA 54, NFPA 31, or NFPA 211).
- Install fan to supply air to pressurize the CAZ. It is best to link the controls of such a make-up air fan to the operation of the combustion appliance(s) in the CAZ.

WX Worker

- At the end of each day:
 - Turn on any exhausting appliances (i.e. exhaust fans, dryer, furnace fan).
 - Test naturally drafting appliances for spillage with mirror/smoke.

2043 Carbon Monoxide Testing

FIELD GUIDE

Energy Auditor/Inspector

- The purpose of carbon monoxide testing is to ensure unsafe levels of carbon monoxide gas are not being emitted from the combustion appliances in the dwelling. Carbon monoxide testing must be done at the time of the energy audit and also during the final inspection.

Documentation

- The pre- and post-weatherization test results must be documented on the Client Home Energy Audit and must also be recorded in WAMS.

When Required

- Pre- and post-weatherization carbon monoxide testing must be done on all combustion appliances in all dwellings except for dryers.

Test Procedure

- Pre- and post-weatherization carbon monoxide testing should begin when entering the house.

Ambient Air in Dwelling

- Before entering the house, zero the combustion analyzer or carbon monoxide detector in the outside ambient air.
- Ambient CO will be monitored at the time of energy audit. Action levels are listed below:
 - Zero to eight (8) PPM the audit/inspection may proceed.
 - Nine (9) to 35 PPM auditor/inspector must advise client of CO levels and check all possible sources. Open all windows and doors.
 - 36 to 69 PPM auditor/inspector must advise client of CO level and turn off all possible sources of CO. Open all windows and doors. After CO returns to acceptable levels, locate the source of the CO and contact appropriate personnel to have repairs completed before proceeding with audit/inspection.
 - 70 PPM or greater, auditor/inspector will terminate work immediately and notify client to evacuate the building. Contact local appropriate personnel to remedy situation.

Ambient Air in CAZ

- If at any time ambient air in CAZ exceeds 35 PPM during combustion testing, abort test and exhaust the CAZ.
- After readings drop to below 9 PPM, retest under natural draft conditions.
- If ambient air remains below 9 PPM under natural conditions, weatherization work may proceed, but the issue must be addressed.
- If the CAZ ambient air exceeds 9 PPM under natural conditions, the problem must be corrected before any other weatherization work begins
- Carbon monoxide alarms must be installed immediately by the energy auditor.
- In either case, the client must be notified of the potential hazard.

TABLE 8

Combustion Safety Test Action Levels

CO Test Result*	And/Or	Spillage Results	Action
0 – 100 ppm	<i>And</i>	Passes	Proceed with work
0 – 100 ppm	<i>And</i>	Fails at worst case only	Repair the problem or recommend service call
> 100 ppm	<i>And</i>	Passes	<u>Stop Work</u> until system is serviced and problem corrected
> 400 ppm	<i>And</i>	Fails under any condition	<u>Emergency:</u> Shut off fuel to appliance and call for service

**CO measurements for undiluted flue gases at steady state*

Cooking Stove

- Ensure all existing pilot lights are lit.
- Visually inspect stove top burners for flame discoloration, flame impingement, or an irregular pattern or if burners are visibly dirty, corroded, or bent. If any of these issues are found, the client must correct the problem before weatherization may be started.
- Locate the oven exhaust vent. Normally the vent is centered at the back of the stovetop. Ovens with glass doors may also have a vent in the door. Look in the oven to see if there are any pans or aluminum foil. Remove before starting oven. Make sure self-cleaning features are not activated.
- Check the burners in the oven. Some have two burners, one for the oven and the other for the broiler. If the oven has two burners, each burner must be tested separately.
- Turn on the exhaust hood and open window to reduce the risk of elevated CO.
- Place the CO probe in the oven vent and turn on the oven. Allow it to run for 5 - 10 minutes or until the stack temperature stabilizes. Be sure the oven is still firing when taking CO test. Action levels are listed below:
 1. 100-224 PPM install CO detector and inform the client of the problem. Recommend they have the unit serviced. Weatherization work may continue.
 2. 225 PPM or more, the unit must be repaired or replaced. If the cost to repair or replace a cookstove causes the total cost of all necessary General Health & Safety Repairs to exceed the contract expenditure limit, contact the state office for further guidance. All other General Health & Safety measures are to be addressed prior to addressing the cookstove.

Solutions to High CO under Worst-Case Conditions

- If CO level is unacceptable, correct the problem by one of the following methods:
 - Check the gas pressure
 - Check the combustion volume (see [Section 2022](#))
 - Check for dirty burner
 - Air damper not set correctly
 - Improper venting
 - Check orifice size
 - Check for blocked heat exchanger

2044 Temperature Rise & Static Pressure Testing

FIELD GUIDE

Energy Auditor/Inspector

- The purpose of testing the temperature rise and total external static pressure is to identify potential problems with the furnace. Temperature rise is the temperature difference between the supply air ducts and the return air ducts. Static pressure is a measure of the differential air pressure between the air pressures inside an appliance versus ambient air pressure outside of an appliance. There is an inverse relationship between airflow and static pressure. As the pressure differential rises, airflow drops.

Documentation

- Pre- and post-weatherization temperature rise test results must be documented on the Client Home Energy Audit.

When Required

- Pre- and post-weatherization temperature rise testing must be done on all forced air heating systems in all dwellings.

Temperature Rise Test Procedure

1. Set up house in winter mode, all registers open and exterior doors and windows closed.
2. Tools needed for testing include two calibrated thermometers and drill with orbit or step bit.
3. Do not drill through the air conditioning coil in the supply plenum.
4. Drill a hole in a supply side trunk line one foot from plenum. If there is more than one trunk line, test both and average the two readings. If there are no trunk lines, drill the plenum as far away from the A-coil as possible (upper right or upper left corner of plenum is recommended).
5. Drill a hole in the return drop before the furnace filter.

6. If dirty, the furnace filter should be removed or replaced before testing.
7. Insert a calibrated thermometer in holes drilled in the supply plenum and the return.
8. When furnace has run for 5 minutes or steady state is achieved, record the supply temperature and return temperature.
9. Subtract the return temperature from the supply temperature. This is the temperature rise. Temperature rise should be according to the manufacturer's name plate or under 90°F.
10. If the temperature rise is out of the range specified by the manufacturer, determine the problem by consulting Tables 9 & 10.

TABLE 9

Typical Solutions for High Temperature Rise		
Problem:	Check For:	Remedy:
High Temperature Rise (>90°F)	Fan speed too slow	Set fan speed higher or replace motor
	Obstruction in ductwork	Remove obstruction
	Inadequate return or supply/distribution ductwork	Install proper ductwork
	Blower belt/filter/AC coil defective or dirty	Clean or replace belt/ filter/AC coil
	Unit over-fired	Adjust fuel pressure, change orifices
	Dirty/defective blower	Clean or replace blower
	Cycling on high limit	Clean or replace blower, install more or larger ductwork

TABLE 10

Typical Solutions for Low Temperature Rise		
Problem:	Check for:	Remedy:
Low Temperature Rise (<40°F)	Fan speed too fast	Set fan speed slower or replace motor
	Excessive air flow from blower	Adjust air flow or replace blower
	Unit under-fired	Adjust fuel pressure or change orifices
	Low stack temperature	Resize the vent pipe

Static Pressure Test Procedure

- Static pressure testing must be done on all forced air furnaces (new and existing).
- This test is similar to testing temperature rise. The setup is the same and the holes that were drilled in the supply and return air can be used.
- To test the static pressure, use a digital pressure gauge (or a water column gauge) with an L-shaped static pressure tube. The tube must face into the air flow.
- Most furnace manufacturer's nameplates will list the recommended static pressures in water columns. In most cases, the recommended maximum external pressure will be .5 water columns. When using a digital pressure gauge, Pascal must be converted to water columns (125 Pascal = .5 water column).
- Connect pressure hose from the return air to the "A" input tap of the digital gauge and the pressure hose from the supply air to the "A" reference tap of the digital gauge. With the furnace blower running, hold metal probe perpendicular to the airflow in the supply and return. The total of these two reading must be equal to or less than 125 Pascal (125 Pascal = .5 water column).
- If static pressure is higher than the manufacturer's recommendations, check the return and supply sides separately. The side that has the higher static pressure will have more restrictions to be alleviated. If either side is greater than 75 Pascal, the cause of the high pressure must be eliminated.
- Testing procedures for causes of high pressure could include:
 - Test pressure drop across the A-coil for blockage.
 - Check ductwork for proper sizing.

- Total system air flow may be measured by:
 - Temperature rise
 - Flow plate
 - Flow meter
 - Fan depressurization device (e.g., Duct Blaster, DucTester)

2045 Clocking the Meter

FIELD GUIDE

Energy Auditor/Inspector

- If an appliance is not burning properly or the temperature rise is outside the limits, clocking the meter might show possible problems.
- Clock the gas meter to measure gas input. Ensure that other gas appliances (water heater, dryer, range) do not fire when clocking the meter. Refer to Table 11 for input rates based on clocking the gas meter.
- If the results indicate improper gas pressure, contact HVAC professional to correct.

TABLE 11

Clocking the Gas Meter

Using a watch, measure the number of seconds for either the 1/2 cu ft. or the 1 cu ft. to make one complete revolution. Read the corresponding input rate in 1,000 of Btu/cu ft.

Seconds for One Revolution on Dial	1/2 cu ft.	1 cu ft.	Seconds for One Revolution on Dial	1/2 cu ft.	1 cu ft.
10	180	360	40	45	90
11	164	327	41	44	88
12	150	300	42	43	84
13	138	277	43	42	84
14	129	257	44	41	82
15	120	240	45	40	80
16	112	225	46	39	78
17	106	212	47	38	77
18	100	200	48	37	75
19	95	189	49	37	73
20	90	180	50	36	72
21	86	171	51	35	71
22	82	164	52	35	69
23	78	157	53	34	68
24	75	150	54	33	67
25	72	144	55	33	65
26	69	138	56	32	64
27	67	133	57	32	63
28	64	129	58	31	62
29	62	124	59	30	61
30	60	120	60	30	60
31	58	116	62	29	58

32	56	113	64	29	56
33	55	109	66	29	54
34	53	106	68	28	53
35	51	100	70	26	51
36	50	100	72	25	50
37	49	97	74	24	48
38	47	95	76	24	47
39	46	92	78	23	46

2046 Pressure Pan Testing

FIELD GUIDE

Energy Auditor/Inspector

- The purpose of pressure pan testing is to find ductwork leaks or disconnections that are connected to the outside. Pressure pan testing does not determine the amount of duct leakage, but determines whether there is duct leakage to the outside by reading the pressure at each register.

Documentation

- Pre- and post-weatherization pressure pan test results must be documented on Client Home Energy Audit Form.

When Required

- Pressure pan testing must be done in homes where the ducts are in unconditioned areas.
- It is important to determine if duct system has runs outside of the heated envelope, uses building cavities as ducts, or has ducts running within the building cavities.
- If a duct run is in a conditioned or an unintentionally conditioned area, and no air movement can be felt through the duct with the blower door running, it does not need to be tested.
- If air movement exists, the ducts must be tested.

Test Procedures

- Auditor must interview occupants to determine the location of over- or under-heated areas.
- Inspect duct system to determine location of ducts and registers.

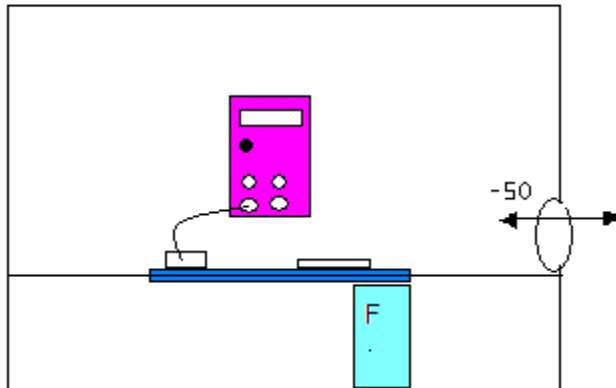
House Configuration

- Set up house in normal winter condition.
 - If the house has an interior basement or interior crawlspace door, leave it open.
 - If the furnace has a fresh air intake from the outside, seal the intake during the test.
 - If supply ducts are located in a garage or other unconditioned space, seal these registers so the register opening does not show up as a duct leak.
- Make sure the furnace burner and air handler are off and will not start during the testing.
- Remove the furnace filter.
- Ensure that all grilles, registers, and dampers are fully open in the conditioned space of the house.
- Before fully opening or changing the position of balancing dampers, mark their position so they can be returned to that position after the pressure pan testing.
- Set up blower door using established blower door testing procedures and precautions. (See [Section 2051](#))
- Depressurize the house to –50 Pascal and record the house to zone pressure.
- One at a time, cover each register with a pressure pan, masking tape, or tape and paper. Use the easiest method based on size, shape, and location of the register.
- Connect a hose from the covered register to the reference tap on the digital gauge (see Figure 11). This will provide a measurement of house pressure with reference to the duct at that register.

Leakage to Outside

- Record the pressure measurement across the register.
- Remove tape, paper, or pressure pan and move to the next register, record each reading.
- In homes with an interior basement door, a reading of 1 Pascal or higher may indicate duct leakage to outside.
 - Inspect the duct runs, boots and floor intersections for leakage from the outside.
 - Start looking near the register that measures the highest pressure and work back to the register with the lowest measurement.
 - Seal the largest holes first and keep testing and sealing until reading is under 1 Pascal per register.

FIGURE 11



Pressure-Pan Test Procedures in Unconditioned Areas

- Ducts located in the attic or unconditioned space must have a pan reading of 1 Pascal or less. Manufactured homes must have a pan reading of 3 Pascal or less.
- If unconditioned spaces in which ducts are located are not well connected to the outdoors or have very large connections to the house, then the unconditioned space will be at a pressure between the outside and inside house pressure during the blower door test. In this case, the pressure-pan reading will show an artificially low number. To correct this misleading number:
 - With the house at -50 Pascal, measure the pressure difference between the house and the unconditioned space. (For example, the house-to-zone pressure is 10 Pascal and the pressure pan reading is 2.0 Pascal.)
 - Multiply the pressure pan reading by the multiplier in Table 12 to get the adjusted reading. (For example, multiply the pressure pan reading of 2.0 Pascal by 5, resulting in a pressure pan reading of 10 Pascal.) Manufactured homes are exempt from this test.
- Repeat the test for each register and grille on ducts located in unconditioned spaces in a systematic fashion.
- If a grille is too large or supply register is difficult to access (under a kitchen cabinet, for example), seal the entire grille or register with duct-mask tape. Insert a pressure probe through the duct-mask tape and record reading.
- This is more time consuming than using the pressure-pan, but it gives an accurate reading.
- When two registers or grilles are closely connected to the same duct run (for example, two registers on opposite sides of the same partition wall), seal one and use the pressure-pan on the other unsealed register or grille.

TABLE 12

Pressure Pan Multipliers

<i>House/Zone Pressure</i>	<i>Pressure Pan Multiplier</i>
50	1
45	1.1
40	1.25
35	1.42
30	1.66
25	2
20	2.5
15	3.5
10	5
5	10

2047 Duct Leakage/Sealing

FIELD GUIDE

Energy Auditor/Inspector

- Ducts need to be tested for leakage prior to sealing or insulating them. (See [Section 2046](#) and [Section 2047](#))
- Duct sealing is to be entered in NEAT/MHEA for consideration when any of the following criteria is met:
 - There is leakage in the duct system to the outside or unconditioned area (this also applies to separate air conditioning systems). (See [Section 2046](#) Pressure Pan Testing), or
 - There are spillage problems caused by duct leakage, or
 - Either the furnace and/or water heater are an atmospheric draft appliance and there is a pressure reading in the CAZ with reference to the outside of -5 Pascal or greater (e.g., -6, -7, etc.) after subtracting the baseline with reference to outside, or
 - Both the furnace and water heater are induced draft appliances and there is a pressure reading in the CAZ with reference to the outside of -15 Pascal or greater (e.g., -16, -17, etc.) after subtracting the baseline with reference to outside, or
 - There are large openings or disconnected ducts, or
 - There are return air registers in the combustion air zone unless the CAZ is a lived-in, heated area.
- Seams and joints in the duct system shall be inspected. Seal all large openings and disconnected ducts.
- Seal all return air register leaks in the combustion air zone unless the CAZ is a lived-in, heated area.
- After duct sealing is done, the temperature rise, duct leakage to the outside, drafting, and CAZ WRT outside tests must be done again.

WX Worker

- When required by work order, duct sealing will be completed.
- Mastic shall have UL listing and conform to ASTM C557 and C919-79.
- Tape must be fiberglass mesh that is a minimum .006" thick.
- Mastic may be used without mesh tape if the gaps are ¼" or less.
- If existing ductwork is insulated, insulation will be returned or replaced after sealing.

New and/or existing ductwork

- Required duct preparation before sealing:
 - Cardboard or metallic cardboard panning is not allowed with new installation or to repair existing ductwork.
 - All existing cardboard panning material which is deteriorating must be replaced with metal panning materials.

- Metal to metal ducts
 - Round ducts will be mechanically fastened to maintain alignment.
 - Other shaped ducts will be securely fastened with welds, gaskets, or adhesives.
- Flex to metal
 - Joints will be fastened with tie bands using a tie band tensioning tool.
- Flex to flex ducts
 - Install a rigid metal coupling of the same size as the flex duct between the two sections
 - Fasten both joints with UL 181 approved tie bands using a tie band tensioning tool
- Plenum to air handler cabinet
 - Mechanically fasten plenum to cabinet.
- Boot to wood
 - Screws or nails will be used to fasten boot to wood.
- Boot to drywall
 - Boot hanger will be fastened to adjacent framing with nails or screws.
 - Boot will be connected to boot hanger with screws.
 - If inaccessible, fasten boot to drywall with UL 181 rated fiber tape and mastic
- If flexible ducts are plastic lined and leaky they must be sealed by:
 - Slipping a metal collar of at least 20-gauge metal inside the plastic liner. Clamps or cable ties shall be used to secure the liner over the collar.
 - Mastic and mesh tape on the connection.
 - Insulation must completely cover the collar and the plastic core. The vapor barrier shall be secured with cable ties or a minimum 2" wide of metallic tape.
- Duct support is addressed in [Section 2023.06](#)
- Duct Sealing SWS 5.0106
 - Select only UL 181 approved materials that:
 - are compatible with their intended surfaces
 - allow for differential expansion and contraction between dissimilar materials
 - meet the requirements of the applicable fire safety code (e.g., thermal or ignition barriers)
 - Select low volatile organic compound (VOC) sealants for use inside the pressure boundary that meet independent testing and verification protocols
 - Clear surrounding insulation to expose joints being sealed, salvage for reuse if possible
 - If duct must be cut open to gain access, position the hole to make repair with appropriate materials feasible
 - Remove loose debris using a vacuum
 - Remove any substance that will prevent sealant adhesion (tape, oil, etc.) using appropriate solvent.
 - Securely fasten all duct connections using appropriate mechanical fasteners according to the SWS detail "Ducts: Mechanical Fastening"
 - Seal leaks less than 1/4" using fiberglass mesh and mastic
 - Mastic alone is acceptable for holes less than 1/8" in size that are more than 10' from air handler if static operating pressure is less than 1" of Water Column
 - Seal leaks between 1/4" and 3/4" using a two-stage process:
 - Install temporary tape as a backing material
 - Seal with fiberglass mesh and mastic that extends at least 1" past the temporary tape on all sides
 - Repair leaks larger than 3/4" using a rigid duct patch
 - Mechanically fasten patch before applying mastic
 - Install fiberglass mesh and mastic over the seam, overlapping repair joint by at least 1" on all sides
 - Seal gaps between boot and surface connections using fiberglass mesh tape and mastic or appropriate flexible caulking
 - Ensure sealant is dry before reinstalling the register
 - Ensure the register can be removed and reinstalled by the dwelling occupant
 - Seal any joints, cracks, and holes that are not gasketed or weather-stripped and are not needed for proper function or service of the unit using removable sealant (e.g., foil tape, gaskets, etc.)

2048 Pressure Differential Testing

SWS 5.0104.1o

FIELD GUIDE

Energy Auditor/Inspector

- An understanding of the dynamic interaction between house pressure, airflow, and mechanical system operation (Mechanical Air Distribution and Interacting Relationship) is required to fully utilize the procedures presented below.
 - Air handler fans commonly move 500 to 2000 cubic feet of air per minute (CFM). This is sufficient airflow to pressurize or depressurize a room, the basement, or even an entire house if the supply and return flows are not balanced.
 - In addition to the increased infiltration, imbalanced forced air systems can contribute to moisture entry, and potential heating system back drafting.
 - Negative pressure as high as 30 Pascal have been measured in basements where the return air is all drawn from the basement.
- Heating system duct leakage to the outside can also cause household pressure imbalances.
- Duct leakage to the outside commonly results from leaky ductwork running through unconditioned space (attic, crawlspaces or garages).
- Significant leakage to the outside can occur when all ductwork is located within the building envelope.
- In these cases, leaky ducts passing through wall or floor cavities (or the cavities themselves may be used as supply or return ducts) create a pressure differential between the cavity containing the ductwork and other building cavities indirectly connected to the outside.
- If either the supply or return air ductwork has leaks to the outside, air will be forced through these leaks when the furnace fan is operating.
 - If the leaks are in the supply ducts, air will be exhausted through the leaks and will tend to depressurize the house.
 - If the leaks are in the return system, air will be sucked into the leaks and the house will tend to be pressurized.
 - If there are equal amounts of leakage in both the supply and return, no change in the house pressure will occur, even though large energy losses may result.
- The following test procedures are used to identify pressure imbalances caused by leaks between the duct system and the outside, and by imbalanced supply and return airflows throughout a house. These procedures include:
 - Room-to-Room Pressure Test,
 - Dominant Duct Leakage Test, and
 - Interior Doors Closed Test.

2048.01 Room-to-Room Pressure Test (required)

Purpose

- Room-to-room pressure testing measures the pressure difference between each room in the house and the main body of the house when the air handler is running. The test can indicate the degree to which:
 - There is an imbalance of air distribution resulting from closed interior doors. The doors can act as dampers restricting the flow of air within the dwelling.
 - There is an imbalance of air distribution resulting from airflow differences between the supply side and return side of the ductwork.
- By providing the room-to-room pressure balance, the return air to the furnace is unrestricted from inside the heated portion of the dwelling.

Documentation

- Document test results on the Client Home Energy Audit.

When Required

- Room-to-room pressure testing must be done when a dwelling has a dominate return. The test is also required for manufactured homes.

Test Procedures

- With all interior doors closed, stand in the main body of the house and place the hose from the pressure gauge input tap under each door.
- Record the pressure difference from each room WRT the main body.
- Pressure relief must be obtained by trimming the door by a maximum of 1½” or installing a transfer grille between rooms, when rooms are pressurized or depressurized by more than 3 Pascal (except for the bathroom).
- Return registers in exterior wall cavities on the second floor should be sealed off and the return air rerouted through the house by trimming the doors or installing transfer grilles. Return registers in exterior wall cavities on the first floor must be sealed directly above the register.

Manufactured Homes Room-to-Room Pressures

- Room-to-room pressure testing is necessary to ensure balanced airflow throughout the house.
- Measure room-to-room pressure differences and relieve pressure differences that are greater than 3 Pascal, except bathrooms and furnace closets, which may be higher.
- Pressure differences of greater than 10 Pascal in the furnace closets must be corrected.
- Turn on furnace blower and close all interior doors.
- While standing in the main body of the manufactured home, place the hose from the pressure gauge under each door.
- Record the pressure difference from each room WRT the main body on the Client Home Energy Audit.
- If there is a door that closes off the hallway, that door must then be closed and the hallway tested as a room itself.
- If the furnace is in a hallway closet, that hallway must be open to the main body of the manufactured home.
- Open the door slightly while measuring the pressure difference across the door.
- Open the door until the pressure difference is 3 Pascal or less and measure the square inches of opening.
- This is the number of square inches of opening needed for pressure balancing.
- Pressure balancing is achieved by one of the two following methods:
 - The door must be undercut. (Doors are not to be undercut more than 1½”.)
 - A direct grille, offset grilles, or jump duct must be installed properly to relieve the pressure imbalance caused by the distribution system when the door is closed.
- Return dwelling to the pre-test condition.

2048.02 Dominant Duct Leakage Test (optional)

Purpose

- This test measures whole house pressurization or depressurization caused by the air handler of the furnace. This is a quick way to determine if there is duct leakage to the outside, which would then require additional pressure pan testing.

Test Procedure

- Close all exterior doors and windows.
- Open all interior doors and ensure all exhaust fans and the air handler fan is off.
- Set up a pressure gauge to measure the pressure difference between the inside and outside the house.
- Using a digital gauge, record the baseline house pressure WRT outside (hose to the outside should be connected to the reference pressure tap).
- Record the baseline for future use.
- Turn on the air handler of the furnace and record the change in house pressure WRT outside.
- If the furnace fan pressurizes the house, there is air being drawn into the house through the return side of the distribution system.
- If the house is depressurized, look for leaks in the supply air system.
- Sometimes wall and floor cavities are used as part of the supply or return system.

- Even without any pressurization or depressurization of the entire house, there still could be leaks between the ductwork and the outside. In cold climates, pressurizing a house to 1 Pascal could lead to moisture problems caused by forcing warm, moist air into the walls and attic.
- In warm humid climates, depressurization by 1 Pascal can also cause severe moisture problems.
- Pressures may also be generated in individual rooms or in the basement when interior doors are closed.
 - Bedrooms and bathrooms often have supply registers but no returns.
 - When doors are shut these rooms get pressurized when the air handler fan is on.
 - The amount of pressurization of a room depends on how much supply air is delivered to the room and on the size of the leaks between both the room and the outside and between the room and the rest of house.
 - If there are large leaks between this room and outside, air will flow out and the rest of the house will be depressurized.
 - It has been found that the furnace fan often depressurizes basements and furnace closets because return air ducts tend to be leakier than supply air ducts.

2048.03 Interior Doors Closed Test (optional)

Purpose

- This test measures the added effect of closing all interior doors on the main body house pressure.

Test Procedure

- With the air handler still running, close all interior doors. Record the pressure difference from the main body of the house WRT the outside.

2050 Other Diagnostic Testing

STANDARD

Utilizing the blower door and pressure gauges, zone pressure testing is used to determine and align the thermal and pressure boundaries. If these are aligned, the amount of surface area through which heat loss can occur will be reduced, the effectiveness of the air reduction work, the performance of the thermal insulation, and the energy savings and comfort in a building will be increased.

2051 Blower Door Test

FIELD GUIDE

Energy Auditor/Inspector

Documentation

- Pre- and post-blower door tests at CFM50 are required for the file, the NEAT/MHEA Audit, Client Home Energy Audit and WAMS. The information reported in WAMS must be the test results from Tectite or RESNET.
- In order to receive credit for infiltration, the Effective Annual Average Infiltration Rate must be calculated using the normalized leakage calculated from measurements of envelope leakage using either ASTM E779 or CGSB 149.1. ASHRAE 62.2 standards (most recently adopted version) require the use of blower door testing (see [Section 2091.04](#)). In order to meet these standards, the program will use the Minneapolis Blower Door Tectite system or RESNET. If using Tectite a co-efficiency of .98 is required. The authority having jurisdiction may approve the use of other means of calculating the effective leakage area such as RESNET Mortgage Industry National Home Energy Standards which is a one-point reading using the DG-700.
- Tectite is an automated blower door test using the DG-700 and a computer with cruise control on the blower door.
- If using RESNET one-point reading with DG-700:
 1. Baseline pressure must be taken – if higher than 10 Pa (+ or -) the test will not be accurate and not allowed.
 2. House pressure must be at least four times greater than baseline pressure to be an allowable test. If not, you must use multiple blower doors to achieve 50 Pa.
 3. If temperature difference between indoor and outdoor is 40 degrees or more, indoor and outdoor temperature must be entered in REDCalc Advanced Blower Door Inputs to provide an adjusted CFM₅₀. The adjusted number should be used in the NEAT/MHEA audit and reported in WAMS.

When Required

- Pre- and post-weatherization blower door tests are required on all houses with the following exceptions:
 - Do not perform a blower door test if a solid-fuel heating unit is operational.
 - If vermiculite is present, operate the blower door in the pressurization mode.
- For multi-unit dwellings (less than five units), blower door tests must be done for either:
 - Recommend using multiple blower doors to depressurize the whole building.
 - Each different type of unit, or
 - The entire dwelling and divided among the units.

Test Procedure

House Setup

- Prepare the house for either depressurization or pressurization blower door test by performing the following steps:
 - Set up the blower door unit in a favorable location, such as the front door, in an area free from obstructions and wind interference.
 - Set the blower door up in a door with the least number of obstacles within 3 feet of the blower door fan. If the doorway leads to an enclosed area, make sure the space is open to the outside. Do not set up in a door facing the wind if an acceptable alternative exists.
 - Deactivate all vented combustion-type appliances prior to depressurizing the structure by turning the thermostat down or the appliance off.
 - A one-point pressurization test should be completed on structures with animal or bird feces in the attic that may be a health hazard if inhaled. (See pressurization test)
 - Prevent the ashes of wood/coal burning units from entering the living space by closing/sealing doors and dampers or by cleaning out or covering the ashes.
 - Inspect the house for loose or missing hatchways (scuttle hole or crawl door), paneling, ceiling tiles, or glazing panes. Secure any items that may become dislocated during the test and seal any missing hatchways.
 - Close all prime windows, self-storing storm windows (if possible), exterior doors and latch them, as they normally would be found during the winter.
 - Open all livable areas to the interior of the structure, even if the occupants close them off during the winter.
 - Open interior basement doors and crawlspace doors (if crawlspace is inside thermal boundary) during test.
 - Temporarily seal appropriate intentional fresh air openings (air ducted from the outdoors to the furnace, for example). Do not seal intentional exhaust air openings, such as combustion appliance flues, dryer vents or exhaust fans.
 - Inspect all pilot lights of combustion appliances to ensure that blower door testing did not extinguish them.
 - Reset thermostats of heaters and water heaters that were turned down or off for testing.

Using DG-700 Digital Gauge (Figure 14) Hose Hookup

- Connect hose from outside to bottom port of Channel A on digital manometer (house WRT outside).
- Connect 2nd hose to fan, press tab on blower door fan.
- Connect other end of 2nd hose to top port of Channel B on manometer (fan WRT fan location).
-

Manometer Setup

- Turn manometer on, press Mode Button (2 times) to set Channel A to Pascal and Channel B to CFM50.
- Device is already set for blower door Model 3 and configuration is set for open fan.
- With fan cover on, perform baseline test – press Baseline, Start and wait until number steadies then press Enter.
- Take cover off fan and slowly adjust fan speed to reach 50 Pascal on Channel A.
- Channel B will begin to estimate CFM50 once house pressure reaches a minimum of 15 Pascal. The CFM50 number will become more accurate as you approach 50 Pascal (+/- 1% when house

pressure reads between 45 and 50 Pascal). It will be even more accurate if the Time Average is changed to long term once house pressure nears 50 Pascal.

- Now read CFM50 once number has become steady.
- If CFM50 is less than 2400, turn blower door off and install ring A. Press Configuration button until it reads A1. Retake blower door reading.
- If house pressure does not reach 50 Pascal with open fan – the DG 700 will automatically estimate CFM50 reading once house pressure reaches 45 Pascal.

FIGURE 14



Performing a pressurization test – DG-3 and DG-700 Gauge set-up

- Connect tubing (red) to the B side input tap, the other end to the pressure tap on the fan.
- Connect tubing (green) on the A side reference tap running it to the outside.
- Connect another tube to the B side reference tap running it to the outside alongside of the fan, but not in the fan's airstream.
- If it is calm outside during the test, you can use the green tubing as the outside reference hose for both the building and fan. Use a "T" connector along with short pieces of tubing to connect the green hose to both reference taps on sides A and B.

Fan set-up

- When pressurizing the fan should be installed with the inlet side of the fan facing the outside (reverse of depressurization testing).
- Keep the fans direction switch in the same position so air will be blowing into the home pressurizing it.
- Secure the fan with the Velcro strap.
- Once the gauges and fan has been set up as described above the regular depressurization testing methods should be followed. For further description the Minneapolis Blower Door™ should be consulted.

2052 Zone Pressure Test

FIELD GUIDE

Energy Auditor/Inspector

- The purpose of zone pressure testing is to help align the thermal and pressure boundaries. If these are aligned, the amount of surface area through which heat loss can occur will be reduced, the effectiveness of the air reduction work, the performance of the thermal insulation, and the energy savings and comfort in a building will be increased.
- Zone pressure testing can also be used for:

- Air leakage/energy loss concerns. If after initial tightening of large leaks, the house still has significant, but not obvious, air leakage, performing ZPD can help identify whether leaks are in the attic floor, the house walls, or through the basement or crawlspace walls.
- Indoor Air Quality concerns. Examples include air movement from attached or tuck-under garages into a living area and moisture or soil gas movement from a crawlspace into the dwelling.
- Attic with potential or actual moisture-related problems. This might be the case if:
 - The attic has obvious moisture problems, or
 - The dwelling has evidence of high winter relative humidity or significant sources of uncontrollable moisture are evident, or
 - Ice dams are a concern.
- Secondary zones are zones with no access, such as porch roofs. Temporary hole between the zone and the dwelling or the zone and the outdoors cannot be created in secondary zones. Because of this, the flow between a secondary zone and the dwelling or outdoors cannot be determined. If possible, insert a pressure hose into the zone to measure the pressure difference between the zone and the dwelling or outdoors.
- Zone pressure testing can also be used to measure the size of the leakage paths to various house zones. Leaking air often takes a path that moves through two surfaces with a cavity or zone in between the surfaces. These zones include attics, basements, garages, knee-wall areas, and attached porch roofs.
- Zone pressure testing includes the measurement of pressure differences across air barriers (like the pressure difference between the house and the attic), while the house is depressurized by a blower door to -50 Pascal.
- The test also includes the calculation of flows across the air barriers. Once these flows are calculated, an estimate of the square inches of leakage through an air barrier can be determined.

Documentation

- If zone pressure testing is done, results must be recorded on the Client Home Energy Audit and in WAMS. For garage leakage tests, record CFM leakage house to zone.
- For attic by-pass leakage, record total CFM leakage path.

When Required

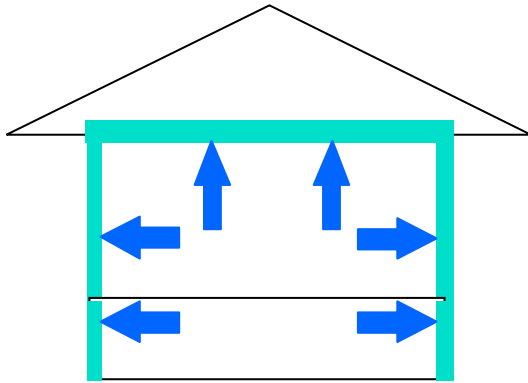
- Zone pressure testing must be completed on every house with an attached garage or a tuck-under garage.
- Garage leakage must be identified using smoke test or IR camera to determine leakage area for air sealing. All air sealing must be completed including weatherstrip and sweep on door.
- Attic by-pass leakage test is not required on every house. It is simply a tool that could indicate missed opportunities. Each Energy Auditor needs to know how to do pressure testing and use it as a tool to determine problem areas.
- If bat or animal feces prevent the attic by-pass sealing from being done
 - Conduct a pressure test in the attic.
 - Pressurize the house with the blower door to 50 Pascal,
 - if the house to zone (attic) pressure is 48 Pascal or more, do not do attic by-pass sealing or attic insulation; however, other work can be completed.
 - If the house to zone (attic) pressure is less than 48 Pascal, defer any work on the house. (We believe a pressure reading of -48-50 Pascal would indicate very little by-pass leakage; thus, other work could be done on the home without concern about the by-passes not being sealed.)

Test Procedure

Thermal Boundary

- The thermal boundary is the insulation. If the attic, walls, and the foundation are insulated, the thermal boundary of the house will look like Figure 15.

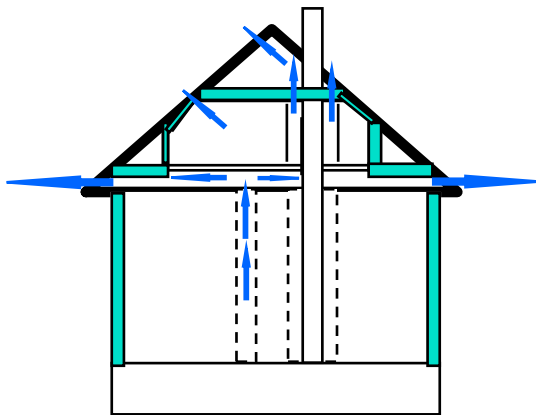
FIGURE 15



Boundary Alignment

- When the thermal boundary and the pressure boundary are not aligned, air escapes through breaks in the pressure boundary, making the insulation less effective. (See Figure 16) It can also cause moisture problems and ice dams.

FIGURE 16

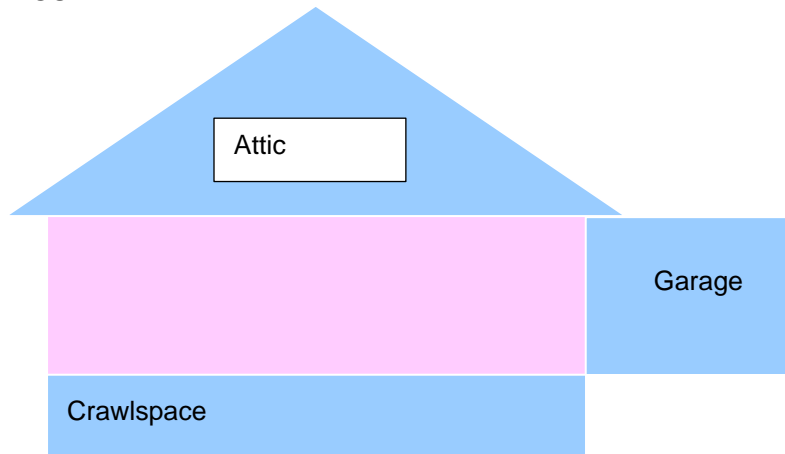


Figures 15 & 16 provided by Martha Benewicz, Wisconsin Weatherization Program

Buffer Zone

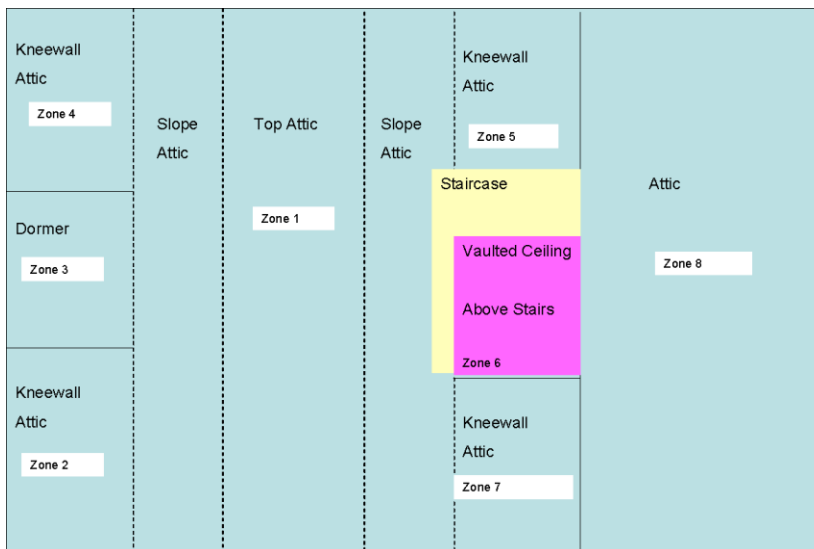
- The buffer zone is a space in a building that separates the heated interior of the building from the outside. Buffer zones include knee walls, crawlspaces, garages, attics, and floored cavities. (See Figure 17)

FIGURE 17



- Zone pressures can determine if there are leaks (thermal by-passes) between a house and a buffer zone connected to a house (e.g., attic).
- Methods used to determine by-pass leakage are: the “add a hole” or “open a door” (used for garage leakage).
- These methods are used to estimate the size of the hole between the zone and the house.
- Further calculations can turn the size of the hole into a CFM50 estimate. For example, estimating the amount of by-pass leakage may be used to help decide if it is cost effective to seal the leak in an attic or zone that is already insulated.
- Zone pressures only determine the relative size of the leaks between the zone and inside compared to the zone and the outside.
- To know whether the leakage rate is significant, determine the approximate leakiness of one side of the pressure boundary by using one of the measurement methods (i.e., add a hole, open a door).
- The first step to finding pressure boundaries is to identify the thermal boundary and identify and map the zones. (See Figure 18)

FIGURE 18



- To determine if there is an air-tight barrier (pressure boundary) between the heated envelope and the buffer zone, measure the pressure difference between the house and the zone.

- If there is a good pressure boundary between the house and the buffer zone when the house is at -50 Pascal, the zone pressure will be closer to -50 Pascal. (See Figure 19) In other words, the buffer zone is linked mostly to the outside. If there is a poor pressure boundary between the house and the buffer zone the pressure will be closer to 0 (the buffer zone is linked mostly to the house). (See Figure 20)

FIGURE 19

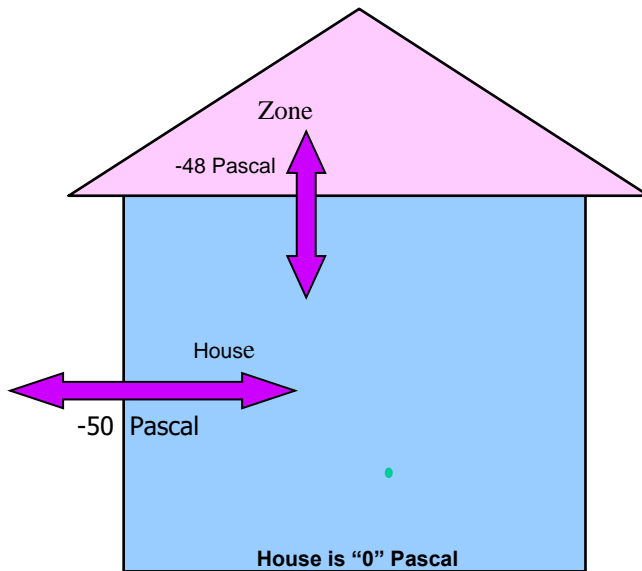
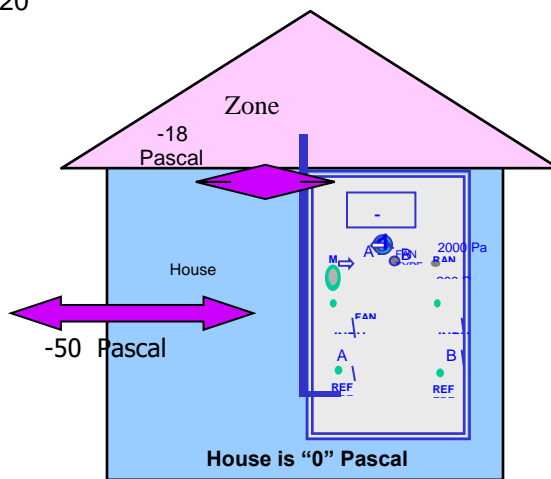


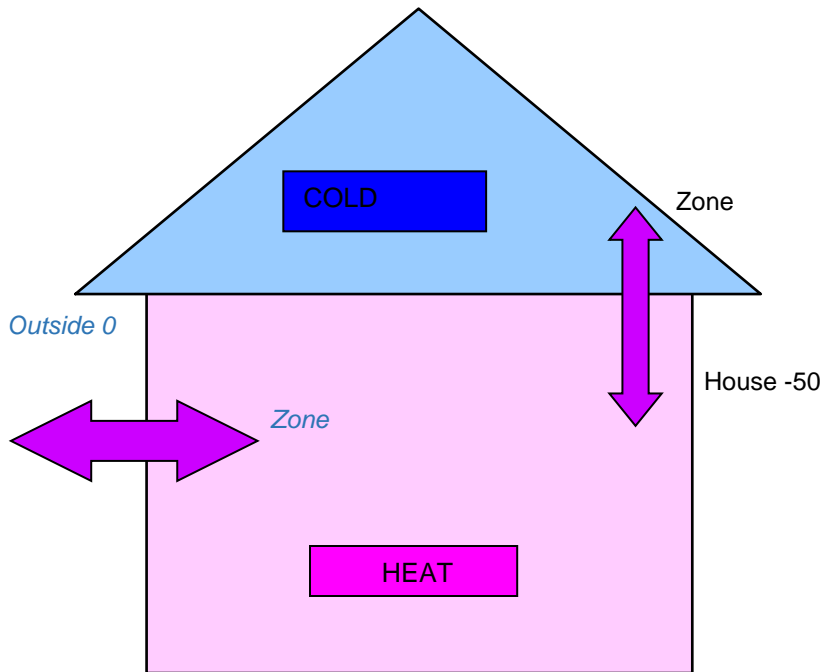
FIGURE 20



Figures 19 & 20 provided by Martha Benewicz, Wisconsin Weatherization Program

- The buffer zone should be linked to the outside not to the house. (See Figure 21)

FIGURE 21



Basic Zone Test

- Set up the blower door using established procedures and precautions. (See [Section 2051](#)) Run a hose to the outside of the house making sure it will not be affected by the blower door exhaust airflow.
- Run a hose to the zones to be tested making sure the end of the hose is beyond any existing insulation, flooring or false ceiling, and will not be subjected to air flow through surrounding leakage areas when the blower door is operating.
- Measure and record the baseline to adjust for stack and wind effects. Take a baseline reading with the blower door sealed and fan off using a digital gauge to take a reading of house with reference to (WRT) outside. Also take a baseline reading of house WRT to zone.

FIGURE 22

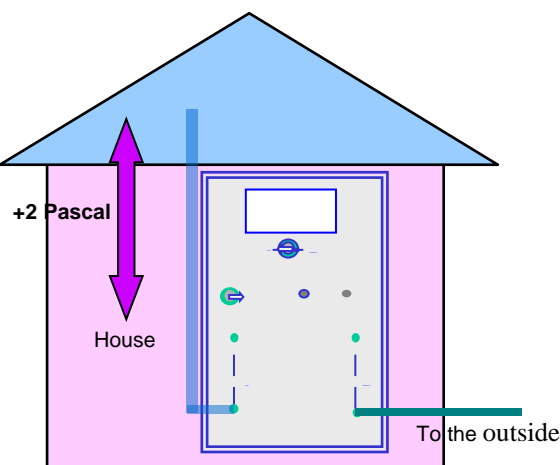


Figure 22 provided by Martha Benewicz, Wisconsin Weatherization Program

- Using the pressure gauge setup to record the house WRT outside, depressurize the house to -50 Pascal. It is important to check throughout the testing procedures to assure the house to outside pressure differential remains at -50 Pascal.

- Take a pressure measurement reading from the house WRT zone.
- After measuring zone pressure, adjust pressure of the house with reference to zone by subtracting the baseline. For example, in Figure 22 the baseline house WRT zone was +2 Pascal and in Figure 23 the house WRT zone pressure was -35 Pascal so the change in pressure was -37 Pascal.
- If baseline house WRT zone would have been -2 and house WRT zone pressure -35, the change in pressure in the zone would have been -33 Pascal.

FIGURE 23

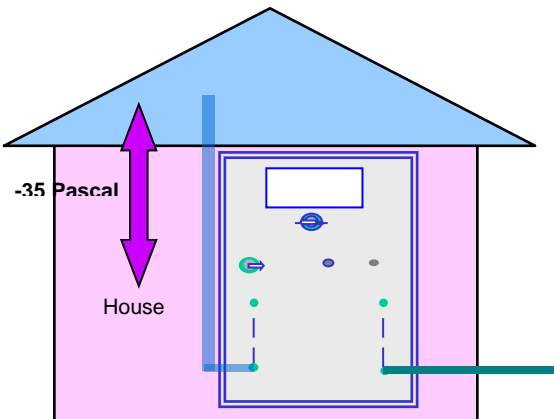


Figure 23 provided by Martha Benewicz, Wisconsin Weatherization Program

- Measuring the zone is the first step in estimating the leakage to the zone. It indicates the ratio of the size of holes on the interior to the size of the hole on the exterior. The size of one of the holes must be known or estimated to understand the pressure differential measurement.
- There are two methods to estimate leakage between house and zone:
 1. Add a hole to the zone and calculate the size of the hole.
 2. Open a door and close the door taking readings each time (used for garage leakage test).

2052.01 Add a Hole

- Keep the input tap open to the house. Place the hose on the reference tap in the zone to be tested, close the scuttle.
- Bring house to -50 Pascal and record the reading house WRT zone. Adjust all pressures for baseline. Subtract house WRT zone from -50 to determine zone to outside reading. Record this reading for later use in the TI-89.
- Add a hole to the zone (or slide scuttle door open), measure, and record opening size. Bring the house to -50 Pascal and calculate and record the house to zone reading again. Use the computer program in the TI-89 calculator to estimate leakage.

2052.02 Open a Door (Garage Leakage Test)

- There are two methods to test garage leakage. Which one you use depends upon the closed-door zonal pressure house WRT garage. Each method begins with the same setup:
 1. All doors to garage should be CLOSED (house in winter mode).
 2. Get Blower Door to -50 Pa WRT outside.
 3. Measure house CFM₅₀ for door closed.
 4. Measure closed door zonal pressure house WRT garage. (If closed door zonal pressure is greater than 25 Pa, use the Open Door from Garage to House Method. If closed door zonal pressure is less than 25 Pa, use the Open Door from Garage to Outside Method.)
- The TI-89 calculator may be used to estimate the leakage by recording all the blower door numbers from either method and entering into the calculator. Or use the charts and tables below to estimate the leakage.

Opening Door from Garage to House

1. Open the door from the house to the garage.
2. Get blower door back to -50 Pa WRT outside.
3. Measure house CFM₅₀ for door open.
4. Measure zonal pressure house WRT garage (should be 0).
5. CFM₅₀ difference = CFM₅₀ door open – CFM₅₀ door closed.
6. Look up closed door zonal pressure for house WRT garage on Table 14.
7. Enter the multipliers into labeled boxes on Table 13.
8. To calculate approximate square inches of leakage in each row, divide CFM₅₀ by 10.

TABLE 13

CALCULATE DIFFERENCE

Closed Door Pressure House WRT Garage	CFM ₅₀ Door Open	CFM ₅₀ Door Closed	CFM ₅₀ Difference

LEAKAGE FROM GARAGE TO HOUSE

CFM ₅₀ Difference	Multiplier (int.)	CFM ₅₀	Square Inches

LEAKAGE FROM GARAGE TO OUTSIDE

CFM ₅₀ Difference	Multiplier (ext.)	CFM ₅₀	Square Inches

TOTAL PATH LEAKAGE

CFM ₅₀ Difference	Multiplier (path)	Max CFM ₅₀ Reduction

TABLE 14

Open House Door to Garage					
	<i>Closed Pressure</i>		<i>Multiply CFM₅₀ change by:</i>		
	H/G	G/O	Int.	Ext	path
Check G/O	48	2	0.14	1.14	0.14
	47	3	0.2	1.19	0.19
	46	4	0.25	1.24	0.24
	45	5	0.31	1.29	2.9
	44	6	0.37	1.34	0.34
	43	7	0.43	1.39	0.39
	42	8	0.49	1.44	0.44
	41	9	0.56	1.49	0.49
	40	10	0.63	1.54	0.54
	39	11	0.7	1.6	0.6
	38	12	0.78	1.65	0.65
	37	13	0.87	1.71	0.71
36	14	0.96	1.78	0.78	
35	15	1.06	1.84	0.84	

34	16	1.17	1.91	0.91
33	17	1.29	1.98	0.98
32	18	1.42	2.06	1.06
31	19	1.56	2.14	1.14
30	20	1.71	2.23	1.23
29	21	1.88	2.32	1.32
28	22	2.07	2.42	1.42
27	23	2.27	2.52	1.52
26	24	2.5	2.64	1.64
25	25	2.76	2.76	1.76
below here you should probably use the other chart				
24	26	3.04	2.89	1.89
23	27	3.36	3.03	2.03
22	28	3.73	3.18	2.18
21	29	4.14	3.35	2.35
20	30	4.61	3.54	2.54
19	31	5.15	3.74	2.74
18	32	5.77	3.97	2.97
17	33	6.5	4.23	3.23
16	34	7.36	4.51	3.51
15	35	8.38	4.83	3.83

Opening the Door from the Garage to the Outside

1. Open the door from the garage to the outside.
2. Get blower door back to -50 Pa WRT outside.
3. Measure house CFM₅₀ for door open.
4. Measure zonal pressure house WRT garage (should be 50).
5. CFM₅₀ difference = CFM₅₀ door open – CFM₅₀ door closed.
6. Look up closed door zonal pressure for house WRT garage on Table 15.
7. Enter the multipliers into labeled boxes on Table 13.
8. To calculate approximate square inches of leakage in each row, divide CFM₅₀ by 10.

TABLE 15

		Open Garage Door to Outside				
		Closed Pressure		Multiply CFM ₅₀ change by:		
		H/G	G/O	int	ext	path
		2	48	1.14	0.14	0.14
		3	47	1.19	0.2	0.19
		4	46	1.24	0.25	0.24
		5	45	1.29	0.31	2.9
		6	44	1.34	0.37	0.34
		7	43	1.39	0.43	0.39
		8	42	1.44	0.49	0.44
		9	41	1.49	0.56	0.49
		10	40	1.54	0.63	0.54
		11	39	1.6	0.7	0.6
		12	38	1.65	0.78	0.65
		13	37	1.71	0.87	0.71
		14	36	1.78	0.96	0.78
		15	35	1.84	1.06	0.84
		16	34	1.91	1.17	0.91
		17	33	1.98	1.29	0.98
		18	32	2.06	1.42	1.06

Garage is leakier to the house than it is to the outside

19	31	2.14	1.56	1.14
20	30	2.23	1.71	1.23
21	29	2.32	1.88	1.32
22	28	2.42	2.07	1.42
23	27	2.52	2.27	1.52
24	26	2.64	2.5	1.64
25	25	2.76	2.76	1.76
below here you should probably use the other chart				
26	24	2.89	3.04	1.89
27	23	3.03	3.36	2.03
28	22	3.18	3.73	2.18
29	21	3.35	4.14	2.35
30	20	3.54	4.61	2.54
31	19	3.74	5.15	2.74
32	18	3.97	5.77	2.97
33	17	4.23	6.5	3.23
34	16	4.51	7.36	3.51
35	15	4.83	8.38	3.83

2053 Quick Field Test

- If an opening exists between the zone and the house, a quick test can be performed to give a visual indication of the size of hole to the zone. Measure the house to zone pressure with the house to outside pressure set at -50 Pascal.
- Open the hole until the house to zone pressure drops in half while keeping the house to outside pressure at -50 Pascal. Once the target differential is obtained, look at the size of the hole that was created. This hole is approximately equal to the size of the existing hole between the house and the zone. It will not be cost-effective to address leakage that is less than 20 in².

2060 Carbon Monoxide, Smoke, & Propane Alarms

STANDARD

Hardwired alarms will be UL 2034 listed. All alarms will be installed in accordance with manufacturer's specifications and authority having jurisdiction.

SWS 2.0102.1a,b,c,d 2.010.2a,b,c,d

FIELD GUIDE

Energy Auditor/Inspector

- The use of combination alarms (CO/smoke or CO/LP) does not change the requirements for separate CO alarms as described in this section because smoke alarms and CO alarms are not installed in the same location.

CO Alarms

- Carbon monoxide alarms may be purchased and installed using program funds.
- CO alarm, must be installed within 10 feet of all sleeping areas.
- CO alarms must be installed in all combustion zones.
- If there is an atmospheric drafting appliance CO alarms must be installed in combustion zones at time of audit. Kitchens are not considered a combustion zone.
- If a combustion appliance is accessible from a bedroom, a CO alarm must be installed in that room.
- Carbon monoxide alarms must be installed immediately by the energy auditor whenever an agency finds a combustion appliance that is putting off carbon monoxide at an unacceptable level. (See [Section 2043](#))
- A working carbon monoxide alarm must be present in every home. Program funds may be used to installed carbon monoxide alarms if one does not exist.
- If a home is determined to be incomplete, at the time of audit, CO alarms can be installed and paid for with program funds.

WX Worker

- Carbon monoxide alarms are to be installed between 4' and 6' from the floor.
- CO alarms installed by the program must have internal non-replaceable batteries.
- When installing new alarms, old existing alarms in the same area must be removed
- Do not install the alarm in the following areas:
 - Near bathrooms or in shower areas
 - In closets
 - Crawlspace or unheated areas where extreme hot or cold temperatures occur
 - Within five feet of fuel burning appliances
 - Close to adjacent walls or in corners
 - Near bathtubs or basins
 - Directly above or below return air registers
 - Behind drapes, furniture, or other objects that could block air-flow to the CO alarm
- Alarms must meet UL2034 standards. Alarms should be warranted for a minimum of TEN (10)years.
- Installed alarms must be labeled with the expiration date, as warranted by the manufacturer, written on the front of the mounting plate or back side of alarm in permanent ink or on the label provided on the alarm.
- Verbal and written instructions are to be given to the client as to the use and maintenance of the alarm.

Smoke Alarms SWS 2.0101.2a,b,c,d

Energy Auditor/Inspector

- Every house must have working smoke alarms on each level. Alarms may be purchased and installed using program funds. Alarms must be installed as required by local codes for single family residences.
- If a home is determined to be incomplete, at the time of audit, smoke alarms can be installed and paid for with program funds.
- Areas that alarms should be installed:
 - Install on basement ceiling level near basement stairs
 - Install within 15 feet of rooms used for sleeping purposes
 - Install on hall ceiling or wall centered as possible between bedrooms
 - Install in rooms having a space heater
 - Avoid placement near kitchen stoves or bathroom showers
 - Exclude unoccupied attics

WX Worker

Propane Gas Alarms SWS 5.0504.1h

Energy Auditor/Inspector

- Propane alarms are required by weatherization in all houses using propane.
- Manufactured homes are exempt from this rule.
- There are different types of propane gas alarms – some are just alarms, which sound when a leak is detected, others actually shut down the flow of gas into the house. The weatherization program will pay for propane alarms that detect the leak.
- All propane alarms must be connected to electricity, an outlet must be installed if necessary.
- Alarms are to be installed according to the manufacturer's instructions and meet the proper UL listing.
- LP alarms must be installed near the furnace or other propane appliances within 12 - 24" of the floor.

WX Worker

- Propane alarms must be installed according to the manufacturer's instructions and meet proper UL listing.
- When installing new alarms, old existing alarms in the same area must be removed
- All propane alarms must be connected to electricity, an outlet must be installed if necessary.
- LP alarms must be installed near the furnace or other propane appliances within 12 - 24" of the floor.
- Verbal and written instructions are to be given to the client as to the use and maintenance of the alarm.

2070 Moisture/Mold Assessment

STANDARD

All homes must be inspected for previous and existing moisture problems and for conditions that could lead to future moisture problems. When a moisture problem is identified, Energy Auditors must determine the cause of the problem and then determine a solution for mitigating the problem. A visual assessment of the home must be done to check for existing mold or mildew. The visual assessment must also include looking for situations that could result in mold growth.

SWS 2.0201.1, 2, 3, 4 2.0202.1,2,3 2.0203.1 2.0401.2a
2.0401.3

2071 Moisture and Moisture Assessment

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- Homes must also be inspected for existing mold.
- The Health and Safety Assessment Findings Form, Part 2 (a moisture/mold checklist) is used by all agency Energy Auditors to document existing moisture and mold problems.
- Photos or other visual documentation must also be taken of existing mold and available at the agency, preferably in the house file.
- The original Health and Safety Assessment Findings Form, Part 2 must be filed in the client/house file.
- Some moisture is needed in a home. The lack of sufficient moisture in winter air can irritate noses and cause drying of the skin. The ideal indoor relative humidity during the heating season in Iowa ranges between 30 and 40 percent.

2072 Moisture Problem Symptoms and Sources

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- As the moisture assessment is conducted, Energy Auditors use the following symptoms to find potential moisture problem areas:
 - Damp atmosphere and/or musty smell in house, basement, or crawlspace
 - Client complaint of allergy-like symptoms
 - Mold-like substance growth on walls and ceilings, especially in rooms with high moisture loads, such as bathrooms and kitchens, mold in corners or at the wall/ceiling junction (top plate)
 - Mold-like substance growth on attic roof sheathing
 - Signs of condensation on walls or windows
 - Water damage or mold-like substance on the underside of roof decking
 - Evidence of crawlspace moisture
 - Peeling paint, particularly on bathroom and kitchen walls
 - Rusted metal in basements, crawlspaces, bathrooms, and kitchens
 - Efflorescence (white, powdery deposits) on concrete or masonry surfaces
 - Water stains on foundation walls
- Table 16 references moisture problems, the potential causes of those problems, and solutions for mitigating the problems. Following the table is a more detailed explanation of ways to solve moisture problems.

TABLE 16

Moisture Problems	Causes	Solutions
Attic Condensation	<ul style="list-style-type: none"> ● The stack effect ● Plumbing, wiring and mechanical penetrations ● Recessed lights ● Hi-power roof exhaust fans ● Vapor barrier voids ● Compressed insulation ● Kitchen and bath fans exhausting into attic ● Leaky attic HVAC ductwork ● Excessively humid conditioned space below 	<ul style="list-style-type: none"> ● Attic air sealing ● Moisture control in conditioned space below ● Install appropriate insulation ● Air-tight recessed lights ● Air-tight ductwork ● Ducted exhaust fans to outdoors

	<ul style="list-style-type: none"> • Uninsulated ductwork • Insufficient or poorly installed insulation 	
Wet Walls	<ul style="list-style-type: none"> • Wind-driven rain • Flood, fire, plumbing break or other water disaster • Capillary openings between siding units • Contact with damp soil or masonry • Deteriorated window flashing and caulk • Vapor barrier penetrations • Cold interior wall surfaces • Improperly installed flashing • Insufficient or poorly installed insulation 	<ul style="list-style-type: none"> • Proper air sealing of exterior walls • Minor plumbing repairs • Insulation • Properly install flashing
Roof Leaks	<ul style="list-style-type: none"> • Complex rooflines • Poor selection of roofing material • Old or worn roofing • Ice dams • Improperly installed flashing 	<ul style="list-style-type: none"> • Appropriate insulation to correct ice dams • Installation of gutters • Minor roof repairs • Black jack • Properly install flashing
Wet Basement	<ul style="list-style-type: none"> • Plumbing • Plugged drains • Leaky foundation • Furnace condensation line • Washer draining on floor • Open sump basket • Poor grading, gutters, sidewalk/driveways sloped toward foundation 	<ul style="list-style-type: none"> • Minor plumbing repairs • Foundation caulk/concrete • Grading/banking • Furnace repair • Installation of gutters • Sump pumps and air-tight covers • Dehumidifiers
Crawlspace	<ul style="list-style-type: none"> • Leaky foundation • Lack of vapor retarder 	<ul style="list-style-type: none"> • Install vapor retarder • Foundation caulk/concrete • Installation of gutters • Sump pumps and covers • Dehumidifiers
Window Condensation	<ul style="list-style-type: none"> • High humidity level 	<ul style="list-style-type: none"> • Lower humidity level
Indoor Air Quality	<ul style="list-style-type: none"> • House too tight • Pressure imbalances • Unvented space heaters/appliances • Improper drafting of appliances • High moisture content • Hang-drying clothes inside house • Drying wood inside house • Excessive plants • Aquariums • Excessive showering • House over-crowding • Humidifiers • Boiling water to use for cooking 	<ul style="list-style-type: none"> • Exhaust fans/ dehumidistats • Remove unvented space heaters • Vent dryers outside • Client education on moisture problem causes • Pressure balancing • Removal of high moisture items

2073 Moisture Problem Solutions

- Identifying and solving the source of moisture problems should be the first priority when a moisture problem is found. Following are possible solutions to moisture problems.

2073.01 Mechanical Ventilation

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- One of the main strategies for solving moisture problems in a home is effective mechanical ventilation. Installing intermittent or continuous ventilation is allowed, provided the fan is built for controlling moisture.
- Moisture problems may be reduced or eliminated by ventilating areas that routinely generate large moisture loads such as bathrooms and kitchens.
- Clients should be reminded of the importance of using kitchen exhaust fans while cooking and the importance of using bathroom exhaust fans after showers or baths.

- Clients should also be educated about the proper operation and use of the fans.
- Refer to the [Section 2090](#) for detailed guidance and procedures on mechanical ventilation.
- Mechanical ventilation in basement areas must be on a dehumidistat (not on a timer).

2073.02 Site Drainage

- Poor site drainage is often the reason for wet foundations, basements, crawlspaces, and slabs. The ground around the foundation of the house should be sloped away from the house so water runs away from the house and not toward it. Ideally, the ground adjacent to the foundation should slope away from the house at a minimum 5 percent (six inches of fall in the first 10 feet).
- Check for the following site drainage situations:
 - Does the site direct rain and snow melt toward the foundation rather than away from it?
 - Are there depressions in the ground close to the house where water can collect?
 - Are sidewalks or paved driveways sloped so they direct water toward the foundation rather than away from it?
 - Does the house have an effective gutter/downspout system that collects and drains rain water away from the foundations?
- Agencies may improve grading around foundations as a General Health and Safety Repair, as long as the cumulative cost of the grading and any other general health and safety repair does not exceed the General Health and Safety Repair limit.

2073.03 Gutters and Downspouts

SWS 2.0201.1, 2.0201.2

- Agencies should note if the house has an existing effective gutter/downspout system.
- If the gutter system is in good condition, but is clogged with debris, they may be cleaned by the program if client is physically unable to do the job and all other options (such as family or chore services) have been exhausted.
- The cleaning can only be done at the time of weatherization services and cannot be repeated as needed.
- If gutters/downspouts are missing or are severely damaged, the agency may install or repair existing gutters/downspouts as a General Health and Safety Repair, as long as the cumulative cost of the gutter/downspouts and any other general health and safety repair does not exceed the General Health and Safety Repair limit. Gutters and downspouts should only installed/repared if it will help solve problems.
- Size gutters appropriately for the area drained. Gutters should be pitched to the downspouts. There should be no more than a 40-foot length of gutter without a downspout (i.e., a 70-foot ranch home must have two downspouts). Short gutters may be level. Slope all gutters towards downspouts $\frac{1}{4}$ per 10ft.
- Make all seams watertight using compatible sealant.
- In areas where tree leaves might cause clogging, gutters and downspouts should be oversized so that leaves and debris will be flushed more easily.
- Gutter hangers should be strong enough to keep gutters from sagging.
- Downspouts should be securely fastened to the house every 4 feet. Elbows and straight sections should be fastened together with pop rivets – screws that project into the downspout can lead to clogging.
- Assemble downspout sections so that the upper section is inside the lower section.
- Drain downspouts a minimum of 6' away from the structure.
- If water is allowed to dump close to the foundation, it might cause moisture problems in the dwelling. The good way to discharge the water away from the house is with downspout extenders (sections of straight downspout) or splash blocks. Both of these are often disturbed when lawns get mowed. A notched section of downspout that is hinged to the elbow at the base of the downspout can solve this problem.

2073.04 Plumbing Repair

- Minor repairs may be made to water pipes and sewer lines as a General Health and Safety Repair, as long as the cumulative cost of the plumbing repair and any other general health and safety repair does not exceed the General Health and Safety Repair limit.

- Cleanup of any unsanitary conditions due to plumbing leaks is the sole responsibility of the client. In some cases, weatherization work should be deferred due to unsanitary conditions.

2073.05 Sump Pumps and Drains

SWS2.0401.2b

- Sump pumps may be installed to control water in lower levels of the home.
- Pumps may be installed as a General Health and Safety Repair, as long as the cumulative cost of the pump installation and any other general health and safety repair does not exceed the General Health and Safety Repair limit.
- Sump pumps must be installed to meet manufacturer's instructions and all local codes.
- New sump pumps (not replacement pumps)
 - must be installed in a pit designed for that purpose and must be covered with an airtight cover unless installed in a dirt floor.
 - select the most energy efficient pump available, prefer Electrically Commutated Motors (ECM) when possible.
 - install a check valve to prevent water from reentering the sump well
 - discharge sump water a minimum of 10" away from building.
 - Verify safe operation and ensure that all operable floats are functioning as intended
 - Provide occupant with manufacturer's instructions and all manuals
- Sump pumps in pits designed for that purpose must be covered with an airtight cover manufactured for that purpose, unless installed in a dirt floor.
- Existing sump pumps in small pits (five-gallon buckets for example) do not need a sealed cover.
- Sump pits with a sealed cover must have a vent pipe extending to outside the thermal boundary.
- Interior grading will be sloped to the sump pump, if possible.
- New sump pump installations require a full SHPO review. Drains:
 - Install a one-way valve in all untrapped, below grade drain fittings that does not interfere with appropriate drain function
 - Seal with urethane caulk around the perimeter.

2073.06 Dehumidifiers

SWS 2.0203.1a-e

- Dehumidifiers may be installed, with client permission, to help control humidity in basements during summer months in homes with existing mold or moisture problems.
- All moisture source control methods must have been exhausted before installing a dehumidifier.
- Explain to the client that the dehumidifier might result in an increase in electric usage. Dehumidifiers must be ENERGY STAR® rated and installed to drain properly. If draining to a basement drain, the dehumidifier must be set on blocks to allow for proper drainage.
- If a drain does not exist, a dehumidifier may be installed by utilizing a dedicated condensation pump to an existing drain, sump pump, or sewer line.
- All condensate lines must terminate to a drain; they cannot terminate outside the envelope of the house.
- Ensure the drain line does not present a trip hazard for the client. Educate the client on proper usage of the dehumidifier including settings and summer/winter use.
- Dehumidifiers may be installed as a General Health and Safety Repair, as long as the cumulative cost of the dehumidifier and any other general health and safety repair does not exceed the General Health and Safety Repair limit.

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- Manufacturer specifications will be followed for size and use.
- Occupant will be educated on how and when to change filter and clean condensate drain of the dehumidifier in accordance with manufacturer specifications.
 - Equipment will have a minimum efficiency level of ENERGY STAR® or better
 - Equipment will have a fan-off option
 - Equipment will retain settings after power-off
 - Equipment will have features that reduce both peak electric use (e.g., internal and external timers) and absolute energy use
 - Equipment will have standby losses of 1 watt or less

- Controls will be labeled so they are understandable, readable, and accurate for occupant needs
- Systems located in a basement or crawl space will be rated for cold temperature operation

2073.07 Attic By-pass Sealing

- Attic by-pass sealing must be done on all homes. One of the most important benefits of attic by-pass sealing is that it prevents the migration of moisture into the attic where it could cause ice damming, wood rot, and mold-like substance growth. Refer to the [Section 4010](#) for details on attic by-pass sealing.

2073.08 Crawlspace Ground Moisture Barrier

- Crawlspace moisture can lead to condensation, mold, and rot.
- Air passing through the soil can contain radon and pesticides.
- It is important to prevent the moisture (water vapor), radon and pesticides (soil gasses) from entering the house.
- This can be done by covering the crawlspace ground with an airtight moisture barrier which establishes an air barrier and seals out water vapor and soil gasses. Refer to the [Section 5031.01](#) for details on installing moisture barriers.

2073.09 Incidental Repairs

- Incidental repairs are defined as repairs necessary (1) for the installation of weatherization measures and (2) to maintain the integrity of weatherization materials.
- Certain incidental repairs are allowed by the program but the repair cost is limited to what is allowed by the NEAT/MHEA Audit's Savings to Investment Ratio (SIR). Refer to the [Section 7000](#) for more information about this.
- Repair or replacement of missing or deteriorated windows that allow moisture or water to enter the house can be done but the cost is limited as described above.
- Minor roof and foundation repair may be done to prevent moisture or water from entering the house. The cost of those repairs is limited as described above.

2073.10 Client Education

- Agencies should always provide general education to clients about problems that can occur due to high indoor moisture levels or actual moisture penetration and how client practices can lead to moisture problems.
- It would be beneficial to explain to the client what relative humidity levels should be maintained in the house.
- Measures installed to eliminate moisture problems will be fully explained to the client. Instructions on maintaining any installed equipment will be provided to the client.
- It is particularly important for agencies to provide moisture education to clients if they identify client practices that have resulted in, or could result in, high moisture levels in the home. Following are client practices that can have an effect on the moisture levels in homes. Agencies should discuss these things with clients.
 - Use kitchen exhaust fans when cooking
 - Use bathroom exhaust fans when bathing and showering
 - Open closet doors and move furniture away from outside walls to allow for more air circulation
 - Do not overuse humidifiers
 - Do not have too many plants
 - Do not have uncovered aquariums
 - Do not store firewood indoors
 - Do not cover windows with plastic
 - Keep gutters clean
 - Fix leaky plumbing

2074 If Moisture Problems Cannot Be Resolved

- If moisture problems in a house are so severe they cannot be resolved under existing allowable health and safety measures and repair allowances, agencies must explain to the client that weatherization

measures that could make the situation worse (e.g., attic and wall insulation and high-efficient furnace installation) cannot be done until the moisture and mold situation is remedied by the client (or landlord).

- In this case, the Weatherization Deferral form must be completed. Weatherization measures that will not disturb the mold or exacerbate the existing moisture problem will be completed.

2075 Additional Moisture Information

FIELD GUIDE

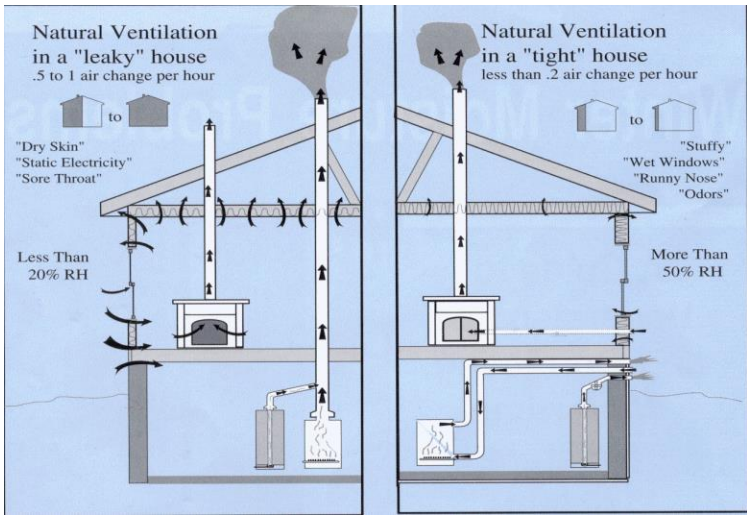
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TABLE 17

Amount of Moisture Produced by Different Sources in the Home	
Source	Moisture Produced
One person breathing	3 pints per day
Washing dishes	½ pint
Shower or bath	1 pint / 10-minute shower
Mopping 150 sq. ft. floor	4 ½ pints
Cooking (family of 4)	1.2 pints
Burning kerosene or propane (unvented)	7.6 pints / gallon burned
Wet crawlspace	Up to 80 pints per day
Clothes dryer (vented indoors)	5 pints per load
One pint can increase relative humidity by 8% in a 1500 square foot home	

- Because air tightening may cause an increase in relative humidity, Energy Auditors should educate the client about moisture problems and possible solutions.
- The underlying reason for high humidity is the reduced amount of outside air circulation through the structure.
- The amount of air moving into and out of a structure is called natural ventilation. The amount of this ventilation is affected by temperature, wind speed, leakage area and open combustion devices, so it is always changing.
- Figure 24 shows a comparison of a leaky house and tight house. The leaky house has an air change rate of .5 to 1 air change per hour (ACH). The tight house has an air change rate of less than .2 ACH.
- Generally, “leaky” homes have higher natural ventilation rates and lower indoor moisture levels. “Tight” homes have lower natural ventilation rates and higher indoor moisture levels. The recommended ACH for a house is .35, or a third of the air change per hour, according to the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE). To determine if a house is too tight, see [Section 2080](#) Ventilation Limits.

FIGURE 24

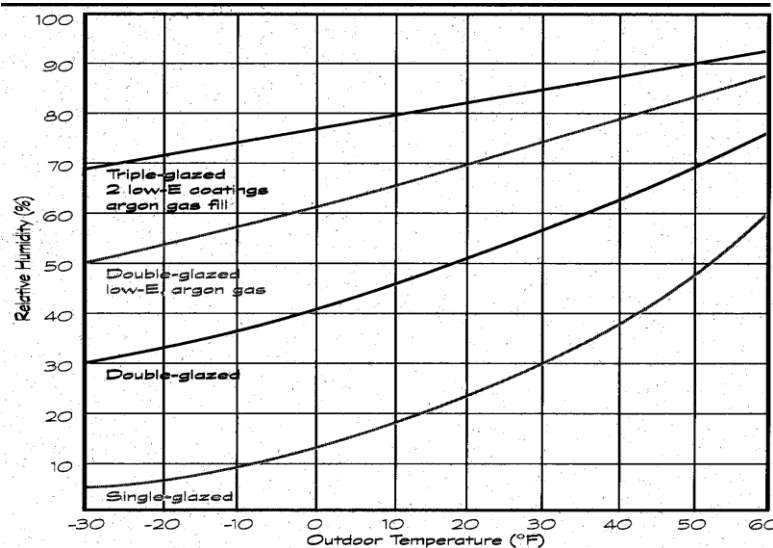


- Moisture, staining, or mold often indicates evidence of condensation on windows and walls. This graph shows condensation potential on the center of glass area (the area at least 2.5" from the frame/glass edge) at various outdoor temperature and indoor relative humidity conditions. Condensation can occur at any points that fall on or above the curves.
- Note that the thermal conductivity at the edge of a window is generally higher than at the center of the glass. For example, insulated glass with a low-e coating and argon gas may tolerate 61 percent humidity at 0°, but the edge may show signs of condensation at only 26 percent humidity.

U-Factors

(Approximates from National Fenestration Rating Council)

Description	Approx. U.-factor
Triple-glazed, 2 low-E coatings, argon gas fill	0.32
Double-glazed, low-E, argon gas	0.37
Double-glazed	0.52
Single-glazed	1.10



Source: Lawrence Berkeley National Laboratory

2076 Existing Mold

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- Every day, people are exposed to airborne mold spores from outdoor sources, sometimes at high concentrations. Mold spores drift through the indoor and outdoor air continually. When spores land on a damp surface that has food and oxygen available, and if the temperature is right, they will start to grow.
- When excessive moisture or water accumulates indoors, mold growth will often occur, particularly if the moisture problem remains undiscovered or un-addressed.
- There is no way to eliminate all mold and mold spores in the indoor environment (mold is everywhere).
- However, the amount of indoor mold can be controlled by controlling indoor moisture.
- The presence of mold in a dwelling does not mean workers or the occupants will have any health effects from it.
- There are no action thresholds established by regulatory agencies. Individuals have different sensitivity to mold exposure.
- Most people are not affected by exposure to mold unless they are exposed to high concentrations of it.
- Those who do have an allergic reaction to mold may only have “cold-like” symptoms such as a runny nose, congestion, cough, and itchy eyes.
- Although there is documentation of severe health effects of mold in humans, most of the problems are derived from ingestion of contaminated foods or in agricultural settings where inhalation exposure was very high.
- Such high-level exposures are not expected to occur while performing weatherization work.
- Exposure to mold will more likely result in severe reactions in persons with the following medical conditions.
 - Decreased immune function
 - HIV/AIDS
 - Respiratory problems
 - Asthma
 - Emphysema
 - Severe allergies
 - Persons having undergone recent surgery
 - Infants less than 12 months old
 - Other serious health conditions
- It is very important to document all existing mold/mildew and Red Flags. Good documentation can prove that mold was pre-existing in a home and that weatherization did not cause it.
- The Health and Safety Assessment Findings Form should be used to document Red Flags or existing mold/mildew. Agencies must also document existing mold and serious Red Flags with pictures which must be maintained in the house file.
- The following Red Flags, used to identify situations that are favorable for mold growth in a home, are items an Energy Auditor should look for and document during the assessment of the home.
- If the work can be completed without disturbing mold/mildew, cleanup will not be completed.
- If cleanup is required:
 - Costs to remove mold/moisture must be included in the cost of the energy conservation measure being installed.
 - If the energy conservation measure is not cost effective when the cost of clean-up is included, all work on the house must be deferred until the client is able to solve the issue.
 - If the Energy Auditor determines that the moisture problem cannot be satisfactorily eliminated, weatherization work will not be started and the house will be deferred.

Visual:

- Evidence of water penetrating the home (stains, moist areas).
- Evidence of conditions that might allow water in the home (poor grading, bad flashing, bad/missing gutters).
- Actual construction defect or deterioration that allows water into the home (roof, decks, windows, concrete slabs, lack of vapor barriers).
- Plumbing defects (leaking drains, pipes or toilet seals, missing caulk on sinks or tubs).
- HVAC problems (dirty, moist filters, poor condensation drainage).

- Dryer vented indoors, inadequate ventilation for a kitchen, bath, or other high moisture area.
- Any source of condensation.
- Visible mold-like substance growth.

Human senses:

- If the Energy Auditor or the client thinks there is a musty odor, there may be mold present.
- If the Energy Auditor or the client feels a room has a damp atmosphere, there may be conditions for mold-like substance growth.
- If the clients complain of allergy-like symptoms in a specific area of the subject property, this could be associated with mold and should be considered a red flag.
- The following areas must be checked for mold/mildew:
 - bathrooms,
 - kitchen,
 - laundry area,
 - basement walls,
 - crawlspace,
 - attic, and
 - ceilings next to exterior walls.
- Agencies should develop a plan to remedy mold/moisture problems. If existing mold covers more than 30 square feet per affected area, agency management must review and approve the plan.

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Clean Up

- If the work can be completed without disturbing mold/mildew, cleanup will not be completed.
- If cleanup is required, the following cleanup procedures must be followed.
- These procedures for the remediation of building materials that contain mold-like substances or will likely contain mold-like substances are from the U. S. Environmental Protection Agency (EPA) and New York City Department of Health Bureau of Environmental and Occupational Disease Epidemiology.
- The procedures are designed to protect the health of the occupants and cleanup personnel during remediation.
- These procedures are based on the area and type of material affected by water damage and/or mold-like substance growth.
- Visual documentation, such as pictures of the red flag situations, should be taken before and after the remediation process and kept in the client file.
- Spending limits for cleanup are described in the *Iowa Weatherization General Appendix*.
- Non-porous (e.g., metals, glass, and hard plastics) and semi-porous (e.g., wood and concrete) materials that are structurally sound and visibly moldy can be cleaned and reused. Cleaning can be done using a detergent solution.
- Porous materials (e.g., ceiling tiles, insulation, and wallboard) that can be cleaned can be reused. Some porous material cannot be cleaned and should be discarded.

Small Isolated Areas (10 sq. ft. or less per affected area)

Recommended personal protection:

- Respiratory protection (e.g., N95 disposable respirator), gloves, and goggles.
- The work area should be unoccupied.
- Containment of the work area is not necessary. Vacating people from spaces adjacent to the work area is not necessary but is recommended in the case of children less than 12 months old, persons recovering from recent surgery, immune suppressed people, and people with chronic lung diseases (e.g., asthma, severe allergies).
- The mold-like substance should be cleaned with a detergent solution.
- Discarded material should be put in a sealed plastic bag. There are no other special requirements for the disposal.

Mid-Sized Isolated Areas (10 – 30 sq. ft. per affected area)

Recommended personal protection:

- Respiratory protection (e.g., N95 disposable respirator), gloves, and goggles.
- The work area should be unoccupied. Vacating people from spaces adjacent to the work area is not necessary but is recommended in the case of children less than 12 months old, persons recovering from recent surgery, immune suppressed people, and people with chronic lung diseases (e.g., asthma, severe allergies).
- The work area should be covered with plastic sheets and sealed with tape before cleaning to contain any dust or debris.
- Misting surfaces (to suppress dust) should be done prior to cleaning.
- The work area should be HEPA vacuumed and the mold-like substance should be cleaned with a detergent solution.
- Discarded material should be put in a sealed plastic bag. There are no other special requirements for the disposal.

Large-Sized Isolated Areas (30 – 100 sq. ft. per affected area)

Recommended personal protection:

- Respiratory protection (e.g., N95 disposable respirator), gloves, and goggles.
- The work area and areas directly adjacent to the work area should be unoccupied.
- The work area should be covered with plastic sheets and sealed with tape before cleaning to contain any dust or debris.
- Heating/cooling system registers in the work area should be sealed with tape or other material.
- Misting surfaces (to suppress dust) should be done prior to cleaning.
- The work area should be HEPA vacuumed and the mold-like substance should be cleaned with a detergent solution.
- Discarded material should be put in a sealed plastic bag. There are no other special requirements for the disposal.

Extensive Areas (greater than 100 sq. ft. per affected area)

Personnel trained in the handling of hazardous materials should do the clean-up.

2080 Ventilation Limits

STANDARD

To assure the house has safe indoor air quality, ASHRAE 62.2 2016 standards will be met

SWS 6.9901 SWS 6.0101

FIELD GUIDE

Energy Auditor/Inspector

Purpose

- The purpose of DTL is to establish a CFM50 minimum, below which the back drafting/spillage of conventionally vented combustion appliances is likely to occur.
- The purpose of ASHRAE 62.2 is for pollutant source control and defines acceptable ventilation levels.

Documentation

Document results on the Client Home Energy Audit.

When Required

- DTL is not required, but recommended as a reference tool
- Most current ASHRAE 62.2 is required on every home.
- The most recently adopted ASHRAE 62.2 will be used when determining ventilation requirements.

Test Procedure

Depressurization Tightness Limit (DTL)

- If the dwelling has atmospheric vented combustion appliances, the Depressurization Tightness Limit (DTL) must be calculated before weatherization work begins.
- The use of the DTL should never be used as a substitute for performing the worst-case draft test procedure.

Calculation Procedure

Use the DTL program in the ZipTest Pro 3™ software package loaded in the TI-89 calculator or REDCalc to calculate the dwelling DTL.

- In the ZipTest Pro 3™ software package, select the program “DTL”.
- Select a solution for “CFM₅₀”.
- Measure the actual flow of existing exhaust fans. Then enter the total effective flow for all other appliances that cannot be measured. Include any appliances that are not yet installed, but will be during weatherization work. For example, include the CFM exhaust rate of an electric or gas dryer that is not vented to the outdoors now, but will be vented as part of weatherization work. Refer Table 18 for guidance.
- Table 19 is a reference tool. Select and enter the appropriate building depressurization limit based on Table 19. If more than one appliance is located in a CAZ, use the lowest magnitude building depressurization limit for the existing CAZ appliances (for example, -5 Pascal is a lower magnitude than -15 Pascal).
- Enter the appropriate flow exponent for the house. If the actual flow exponent is unknown, enter the default value, 0.65.
- The ZipTest Pro 3™ software calculates the CFM50 tightening limit for combustion safety, the Depressurization Tightness Limit. Use this as a low limit to house tightening.

Remember, the DTL is a pre-weatherization guideline only. It must never be used to replace the worst-case draft test procedure.

TABLE 18

ESTIMATED EXHAUST POTENTIAL			
Devices	Approximate Duct/Flue Size (inches)	Typical Rated Flow CFM	Effective Flow CFM
Bathroom and range hood fans	3	85	53
	3¼x 10	85	53
	4	106	64
	7	212	127
	8	318	223
Exterior mounted kitchen fans	10	424	297
	10	636	445
Clothes dryer	4	85-127	106
Central vacuum			117
Jenn-Air or similar range or counter-top /ext.vent	5	800	300
	6	800	500
	¾ x 10	800	600
Wood-burning Fireplace			300
Open wood/solid fuel stove			65
Airtight wood/solid fuel stove			50
Atmospheric or induced draft, gas, oil, or propane appliances (water heaters, boilers, furnaces)	3		21
	4		38
	5		47
	6		72

TABLE 19

Building Depressurization Limits for Various Appliance Types (Used to calculate the Depressurization Tightness Limit)	
Appliance Type	Building Depressurization Limit, Pascal
Atmospheric water heater (orphaned)	-2
Atmospheric water heater and furnace	-5
Atmospheric furnace or boiler	-5
Oil or gas unit with power burner	-5
Induced draft appliance (fan at point of exit at wall)	-15
Direct-vent appliances	-50

2081 Energy Recovery Ventilation (ERV)

SWS 6.6202 6.0303.1

FIELD GUIDE

Energy Auditor/Inspector

- **Prior to installing an ERV, the agency is to submit a proposal to the DCAA which includes the reason for installation, cost justification, and why it is the most feasible alternative.**
- ERV's installed must:
 - Have a plastic core.
 - May not have or need an electric element or a drain for defrosting the unit.
 - Be able to transfer both heat and humidity.
 - Be rated by the Home Ventilating Institute (HVI).
 - Be sized by ASHRAE 62.2.
- The units' installation should be necessitated by depressurization/drafting problems caused by exhausting appliances and the cost-effectiveness of the available measures to remedy the problem.
- The unit is to be easily accessible to allow the client to perform necessary maintenance on the unit. The ERV should not be installed if it is unlikely to be maintained.
- Record the efficiency percentage and CFM flow setting for reporting in WAMS.
- Manufacturers' information for installation, maintenance, warranty, and any other pertinent information is to be left with the client. The client is to be educated concerning maintenance and operation of the controls.
- The Ventilation and Your Home form must be completed and provided to the client.

WX Worker

- Select Energy or Heat Recovery Ventilators (ERV/HRV) that are ENERGY STAR®, equivalent, or better
- Follow manufacturer's installation instructions.
- A hole no greater than a 1/4" greater than the fitting will be cut to accommodate intake fitting.
- Collar will be at least the same diameter as the duct; if collar is larger than duct, a rigid metal transition will be used.
- Fitting will be appropriate for regional weather conditions and installation location on house so as not to be rendered inoperable.
- Intake fitting will be labeled "ventilation air intake".
- Occupant will be instructed to keep yard debris and other contaminants clear of the intake.
- The damper will be installed to open in the direction of the desired flow. A backdraft damper will be installed between the energy recovery ventilator (ERV) and the exterior, unless the system operates continuously. Ensure fasteners do not inhibit intake damper operation.

- Outdoor air intakes and exhausts will be equipped with automatic or gravity dampers that close when the ventilation system is not operating.
- Damper will close when system is off.
- Duct to intake fitting will be connected and sealed as follows:
 - Round ducts will be mechanically fastened to maintain alignment.
 - Other metal-to-metal or metal-to-PVC connections will be securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic-plus-embedded-fabric systems, or tapes.
 - Flexible duct-to-metal or flexible duct-to-PVC will be fastened with tie bands using a tie band tensioning tool.
 - Flexible duct between tie band and end of metal or PVC duct will be screwed into place.
 - PVC-to-PVC materials will be fastened with approved PVC cement.
 - Other specialized duct fittings will be fastened in accordance with manufacturer specifications.
 - In addition to mechanical fasteners, duct connections will be sealed with UL181B or 181B-M listed material.
- Air to be exhausted to the outdoors will not be taken directly from the forced air system.
- Gaps between registers or grilles and interior surfaces, that define conditioned space, will be sealed.
- Sealants will be compatible with their intended surfaces and will be continuous and meet fire barrier specifications.
- Supply ducts attached to the return side of forced air systems will be:
 - Attached as close to the HVAC system's fan as possible while remaining in compliance with manufacturer specifications.
 - Set up to provide filtration of outdoor ventilation air before reaching the HVAC system with minimum MERV8 filter.
 - Connected to the intake fitting.
 - Connected and sealed in accordance with the supply duct detail.
- Exterior termination fitting will be flashed or weather sealed.
- Water will be directed away from penetration Installation will not inhibit damper operation.
- Manufacturer specifications will be followed.
- Corrosion resistant screen, louver, or grille material no less than ¼" and no greater than ½" hole size in any direction will be used, or as specified by authority having jurisdiction.
- Screen will be installed so it does not inhibit intake damper operation.
- Air flows will be measured and adjusted to match to the system's intent.
- Exterior Intake will be installed according to the following:
 - A minimum of 6" from grade.
 - A minimum of 10' from contaminant sources or exhaust outlets.
 - Above local snow or flood line.
 - A minimum of 18" above an asphalt-based roof.
 - Air intakes are to be located away from driveways, laundry and furnace vents and gas meters.
 - Never on a flat roof.
 - As required by authority having jurisdiction.
- Exterior exhaust ducts are to be insulated to R-8. Rigid metal ducts are preferred with as few elbows as possible.
 - Terminate exhaust system to the outdoors, which does not include unconditioned spaces such as attics and crawl spaces that are ventilated with the outdoors
 - Install terminations: A minimum of 3' away from any property line; A minimum of 3' away from operable opening to houses; A minimum of 10' away from mechanical intake; Above the snow-line
 - If the termination is at the soffit, seal soffit vents within 6' of the termination
 - Intake and exhaust inlets and outlets must be a minimum of 10' apart.
- Interior Intake locations:
 - If an air intake is located in the kitchen, it must be at least 10' away from the cooktop or oven.
 - Air intakes are to be located away from driveways, laundry and furnace vents and gas meters.
 - Grilles installed are to be neat in appearance.
- Interior supply locations
 - Inter fresh air supply must be installed near high traffic areas and occupied spaces but not within 10" of interior exhaust intakes

- Occupants will be educated on how and when to change filter and clean drain pan, if applicable, according to manufacturer specifications.

2090 Mechanical Ventilation

STANDARD

Effectively move the required volume of air as determined by prescribed by ASHRAE 62.2 2016 testing procedures providing healthy living environment for the client.

SWS 2.0401; 6.6002; 6.6003; 6.6004; 6.6005; 6.6102; 6.6103; 6.6202; 6.6204; 6.6205; 6.6288; 6.9901

FIELD GUIDE 6.0101.1 6.0201.1,2,3,4 6.0301 6.0302 6.0304 6.0305 6.0306.1

New section 6.0101.4 controls/ 6.0101.5

Energy Auditor/Inspector

2091 Ventilation Systems for Acceptable Indoor Air Quality

- The most current ASHRAE 62.2 adopted by authority having jurisdiction or adopted by the State of Iowa (whichever is stricter), Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings, shall be used for the installation of ventilation systems, both local ventilation and whole-building ventilation. This ASHRAE standard is for building of three stories or fewer.
- This standard does not apply for buildings with four or more stories.
- Living space is defined as including finished basements in the floor area
- New fan intake grille will be installed in the space where odor, moisture vapor, or other contaminants are generated.
- Existing operable fans that will remain in place and serve as part of the ventilation system shall be measured for CFM airflow. This airflow shall be recorded on the appropriate form.
- Inform the client of the importance of using the kitchen exhaust fan while cooking and using the bathroom exhaust fan after showers or baths.
- A ventilation system guide designed for the occupants (non-professionals) to explain why the system was installed and how to operate and maintain the system is to be distributed.
- Controls shall be labeled as to their function, unless that function is obvious (such as on-demand bathroom exhaust switches).
- Photos of fans and fan ducting, before insulating, must be included in the house file.
- The client must sign the 2-part NCR Ventilation and Your Home form for each exhaust fan installed, attesting to the fact that they have been informed about the importance and proper use and maintenance of the installed ventilation devices.
- In case of a rental unit, the landlord must receive a copy of the Ventilation and Your Home form or receive verbal information on the function of the fans.
- The certified QCI must be the agency representative who signs this form because this individual is adjusting the switches to meet ventilation requirements.
- This form is supplied by DCAA.
- Manufactured Homes Mechanical ventilation for manufactured homes should meet the requirements.
 - Clearance of the fan based on size and for adequate head clearance must be considered.
 - Power source must be determined adequate.
 - Consideration will be given to:
 - Adequate head clearance
 - Vent termination location
 - Amount of space for duct run
 - Roof condition
 - Type of roof (e.g., shingle, bow string, flat, etc.)
 - Duct insulation
 - Fan must be secured to a structural component.
 - Structural integrity of the manufactured home will be maintained.

2091.01 Bathroom Ventilation (ducted and through the wall installation) 6.0201.1a

- Should have on-demand fans that exhaust at least 50 CFM to a maximum of 80 CFM and are controlled by an on/off switch or a time-delay-shutoff switch; or

- Should have continuously operating 20 CFM fan.
- A continuously operating bathroom fan or a programmed intermittently operating fan may serve as the whole-building ventilation.
- If a bathroom does not have this amount of ventilation stated above, it must be provided, or Appendix A of most current adopted ASHRAE 62.2 must be used for sizing whole-building ventilation.
- If installing a new bathroom fan to meet ASHRAE 62.2 requirements, the pressure across the door must not exceed 3pa.
- Installed fans must have a back-draft damper at the fan and at the duct termination.
- The duct termination must be outdoors.
- Install fan near the center of the space where odor, moisture, or other contaminants are generated but not inside a shower unless fan is rated for wet location installation
- Fan flows of existing bathroom fans that are to be left in place must be measured or the flow rate shall be determined by the fan label according to most current adopted ASHRAE 62.2 requirements (see most recent adopted ASHRAE 62.2, Section A4.2).
- Dehumidistats must not be used in bathrooms if fans are used to meet ASHRAE 62.2.
- Dehumidistats may be used in bathroom fans if it is a self-contained module switch and the fan is used for moisture control only.

2091.02 Kitchen Ventilation (ducted and through the wall installation)

- Local kitchen ventilation has two different categories:
 - Enclosed – permanent opening to adjacent space not to exceed a total of 60 sq. ft. (approximately three doorways)
 - Non-enclosed – opening to adjacent space is greater than 60 sq. ft. Open to the rest of the house
- Kitchen fan requirements
 - **Kitchen fans to be installed must be rated for use in the kitchen.**
 - Enclosed kitchen
 - Range hoods of 100 CFM or greater controlled by an on/off switch (preferred method) and has a minimum efficacy of 2.8 cfm/watt
 - Other kitchen exhaust fans of 300 CFM or greater
 - Continuous fans must have a volume of 5 air changes per hour
 - Some level requirements listed in Table 20 must be met
 - Non-enclosed kitchen
 - Range hoods of 100 CFM or greater controlled by an on/off switch (preferred method and has a minimum efficacy of 2.8 cfm/watt. Other kitchen exhaust fans of 300 CFM or greater
 - Some level requirements listed in Table 20 must be met
- If a kitchen does not have the amount of ventilation stated, it must be provided, or Appendix A or ASHRAE 62.2 must be used for sizing whole-building ventilation.
- Installed fans must have a back-draft damper at the fan and at the duct termination.
- The duct termination must be outdoors.
- Fan flows of existing kitchen fans that are to be left in place must be measured or the flow rate shall be determined by the fan label according to ASHRAE 62.2 requirements (see ASHRAE 62.2, Section A4.2).
- Outdoor make-up air should be provided for kitchen fans in accordance with most current adopted ASHRAE 62.2 requirements.

NOTE: Most current ASHRAE 62.2 (Section A4.2 Airflow Rating) adopted by authority having jurisdiction or adopted by the State of Iowa (whichever is stricter).

- If airflow ratings do not exist or the duct sizing requirements of ASHRAE 62.2, Section 5.4 cannot be verified, the airflow rate shall be measured.
- The alternative procedure in Section 5.4 (using the airflow rating at 0.25 in. WC (62.5 Pa)) may not be used.
- But, if airflow ratings for the existing equipment are available at 0.1 in. WC (25 Pa) but not at 0.25 in. WC (62.5 Pa), those values may be used, provided they are reduced by 25%.

Exception: The airflow rating, according to ASHRAE 62.2, Section 7.1, at a pressure of 0.25 in. WC (62.5 Pa) may be used, provided the duct sizing meets the prescriptive requirements of Table 22 (see [Section 2091.07](#)) or manufacturer's design criteria.

2091.03 Garage Exhaust Fans

SWS 6.0201.4k

- Garage exhaust fans may be installed in certain cases with state approval.
- Select a fan that has an electrically commutated motor (ECM) has an efficacy of 3.8 cfm/watt or more
- Be sure there are no heating/cooling supply or return air in the garage area.
- Ventilation for garages will be exhaust only and provide a minimum installed capacity of 100 CFM of ventilation per vehicle bay and will vent directly outdoors.
- Garage exhaust fans will be wired for continuous operation or installed with automatic controls that activate the fan whenever the garage is occupied and for at least 15 minutes after the garage has been vacated.
- If a ducted fan (not through-the-wall) is used, measure and verify the minimum air flow and adjust as necessary.
- Air leakage between the house and garage will be prevented by sealing and weatherstrip.
- Pressure effects caused by fans will be assessed and corrected when found outside of combustion safety standards.
- Exhaust fans and other exhausting systems shall be provided with makeup air or other pressure relief in accordance with the most current adopted ASHRAE 62.2 requirements.
- Terminate exhaust venting a minimum of 15' from any doors, windows, or outside air intakes

2091.04 Whole-Building Ventilation 6.0302.1F

- Whole-building ventilation operating continuously shall be determined by the most current adopted ASHRAE 62.2. REDCalc or similar program will be run at time of audit (using target CFM) and again at inspection (using final actual CFM reading).
- This will determine whole house ventilation needed.
- If the house is too tight, the ventilation requirement must be met.
- A copy of both tests showing ventilation requirements and program inputs must be in the house file.
- REDCalc will be run at time of audit to consider what effect estimated tightness will have on the house.
If the temperature difference between indoor and outdoor is 40 degrees or more, the REDCalc Advanced Blower option must be used.
- This ventilation may operate intermittently, but
 - The CFM airflow must be increased accordingly while the fan is operating. For example, a flow rate of 25 CFM for continuous operation would be increased to 50 CFM for 30 minutes-on/30-minutes-off operation.
 - The fan must operate at least once every 3 hours.
 - The fan must be controlled automatically.
 - The fan control must be appropriately labeled.
- If the bathroom and/or kitchen fans do not satisfy the requirement of 50 CFM and 100 CFM airflow rates, respectively, the most current adopted ASHRAE 62.2 (Alternative Compliance Supplement) must be used when sizing the minimum whole-building airflow rate.
- The whole-building ventilation may be a single exhaust fan; multiple exhaust fans controlled appropriately; a balanced system, such as an energy recovery ventilator; or part of the furnace air-handling system.
 - Local bathroom and/or kitchen exhaust fans are permitted to be part of the whole-building ventilation system.
 - Energy efficient in-line fans may also be used to ventilate two or more rooms
 - In line fans must be installed in the attic
 - Select a fan that has an electrically commutated motor (ECM) has an efficacy of 3.8 cfm/watt or more
 - If the fan does not contain an integrated damper, install a damper that opens in the direction of the desired flow and closes when the system is off
 - Diffusers for in-line fans may be in hallways, bathrooms and bedrooms.
 - In-line fans must be installed to manufacturer's instructions

- In-line fans may not be used to exhaust kitchen
- Minimum 6" hard pipe or PVC
- 150 CFM maximum
- Sone rating do not apply to in-line fans
- In-line fans must be wired by properly licensed electrician
- All duct work must be sealed and insulated to R-8
- Diffusers must be designed to work with in-line exhaust fans
- The system must be designed to operate during all occupied hours.
- A readily available override control must be provided to the occupant.
- The infiltration credit shall be calculated as part of the inputs in REDCalc or similar program.
- One example of how to utilize the furnace air handling system follows:
 - ASHRAE 62.2, Section 4.2 allows for outdoor air connected to the return ducts side of the mechanical heating or cooling system for makeup air as long as the manufacturers' air temperature requirements are met (temp. rise).
 - Air flow measurements may be done by measuring of the return duct in the location where the outside air duct connection will be installed.
 - Air flow then can be estimated using the Table 2 in [Section 2022](#) of the *Iowa Weatherization Work Standards Manual* or using an air flow hood, or other airflow measuring device.
 - The supply duct to the return must be a minimum of six feet away from the heat exchanger in the heating system.
 - This method may be useful for homes that don't require a lot of continuous ventilation. Caution should be taken with homes that have high moisture content with high positive pressures.

2091.05 Whole-Building Ventilation, Discretionary Threshold

- If the whole-building minimum ventilation requirement is 15 CFM or less, the Energy Auditor may decide to install a whole-building ventilation system or not. The reasons for not installing a ventilation system when the minimum CFM requirement is between 1 and 15 shall be documented in the client file. This decision shall be based on:
 - The moisture assessment of the dwelling,
 - The indoor air quality assessment of the dwelling,
 - The health of the occupants, and
 - Other factors deemed significant by the Energy Auditor.
- If the whole building minimum ventilation requirement is greater than 15 CFM, a system supplying the minimum ventilation airflow must be installed.

2091.06 Fan Sound Ratings

Fan sound ratings shall be equal to or less than the ratings in Table 20.

TABLE 20

Maximum Fan Sound Ratings	
New Replacement Fans	Maximum Sound Rating for New Replacement Fans
Local bath, on-demand	1.0 sone
Local bath, continuous	1.0 sone
Local kitchen range hoods, on-demand	3.0 sones
Local kitchen range hoods, continuous	1.0 sone
Whole-building (site built and manufactured home)	1.0 sone
Manufactured home kitchen (wall or range hood)	3.0 sones
Manufactured home bath	1.0 sone

2091.07 Exhaust Fan Venting

Energy Auditor/Inspector

- Any existing operational kitchen or bathroom exhaust fans must be vented to the outside using proper termination.
- If not vented to outside, install rigid (galvanized, PVC, or aluminum) or metal flexible vent duct to a proper termination on outside of the house.
- Ensure the vent duct is properly sized (see Table 22), insulated with at least an R-8 material and, if possible, covered with the insulation blown into the attic, and is pitched to the outside.
- The size of the duct must not be reduced from the outlet of the fan.
- All flex ducts must be installed with minimal sagging.
- Do not insulate over an existing fan with a light or heat source that is not Type-IC rated, install damming material around it in the manner described in [Section 5014.05](#).
- Ensure that flow and static levels are met.

WX Worker

- Install all electrical wiring according to manufacturer specifications and applicable code
- Ducts outside of the thermal envelope shall be sealed and insulated to a minimum of R-8.
- Select duct insulation with a flame spread/smoke development index of 25/50 or less when tested according to ASTM E84 or UL 723
- Rigid ductwork with a smooth interior surface is recommended over flexible ductwork. Rigid PVC may be used for ventilation ductwork unless local code will not allow.
- The radius of turns in ductwork will not be less than the diameter of duct.
- Duct support:
 - Flexible ducts are to be installed with minimal sag and supported at intervals of 2 feet or less.
 - The maximum amount of drop between supports shall be ½ inch per foot of horizontal run or less.
 - Supports shall have a width of at least 1 ½ inches.
- There must be a straight run of at least 2 feet before any elbow or turn.
- Duct diameter will be equal to or greater than the exhaust fan outlet. For example, a 4" exhaust can be vented out with a 5 or 6" diameter duct and can be reduced back down to 4" diameter duct at termination.
- Duct runs shall be as short as possible.
- Kitchen fan ductwork must be rigid, smooth metal of at least 28-gauge wall thickness.
- Kitchen range hoods must be installed within at least 5' of the primary cooking surface (e.g., range, oven, stove).
- Rigid duct requirements:
 - Round ducts will be mechanically fastened to maintain alignment.
 - PVC-to-PVC joints shall be joined with approved PVC cement.
 - Rigid ductwork shall be sized according to Table 21.
 - Rigid ducts must be 28 gauge or thicker.
 - Kitchen rigid duct must be 28-gauge metal.
- Insulated flexible or metal flexible duct requirements:
 - Shall not be bent around framing members of other objects.
 - Flex duct will be UL 181 listed or Air Diffusion Council approved.
 - When a flex duct is run through confined spaces, do not reduce the diameter of the flex duct in order to fit it within the space.
 - Attach sections of flex duct according to the manufacturer's recommendations.
 - Flex-to-metal or flex-to-PVC joints shall be fastened with tie bands.
 - Flexible ductwork shall be sized according to Table 21.

TABLE 21

PRESCRIPTIVE DUCT SIZING

Duct Type	Flex Duct				Smooth Duct			
Fan rating CFM@ 0.25 in. w.g.	50	80	100	125	50	80	100	125
	Maximum Allowable Duct Length							
Diameter	Flex Duct				Smooth Duct			
3"	X	X	X	X	5'	X	X	X
4"	70"	3"	X	X	105'	35'	5'	X
5"	NL	70'	35'	20'	NL	135'	85'	55'
6"	NL	NL	125'	95'	NL	NL	NL	145'
7"	NL	NL	NL	NL	NL	NL	NL	NL

2091.08 Duct terminations, exhaust/intake 6.0101.2a

- The termination collar shall be at least the same equivalent size as the exhaust fan outlet.
- Termination fasteners shall not inhibit damper operation. PVC Venting
- Exterior termination will be flashed or weather sealed.
- Terminations shall be at least three feet from any property line.
- Terminations shall be at least three feet from any operable opening to a house.
- Terminations shall be at least 10 feet from any mechanical inlet.
- If the termination is at the soffit, seal all soffit vents within 6' of the termination
- All existing mechanical exhaust ventilation systems should terminate outside the building shell by extending the ventilation duct through the roof, sidewall, foundation, or skirting.
- Installed fans must have a back-draft damper at the fan and at the duct termination.
- Exterior termination fitting will be flashed or weather sealed.
- Water will be directed away from penetration.
- Termination fitting installation will not inhibit damper operation.
- Manufacturer specifications will be followed.

2091.09 Exhaust grille location

- For local bathroom or kitchen exhaust, the fan and/or grille shall be installed in the space where contaminants are generated.
- For whole-building ventilation when other local bathroom and/or kitchen ventilation is present, the grille should be located in a central location within the main body of the dwelling, or in high moisture areas.

WX Worker

- Exhaust fans will be installed and ducted as required by work orders.
- A hole no greater than a 1/4" greater than the assembly will be cut to accommodate fan assembly.
- Wiring will be installed in accordance with original equipment manufacturer specifications, and local and national electrical and mechanical codes.
- Fan outlets will be oriented toward the final termination location. Fan will be oriented so the equivalent length of the duct run is as short as possible.
- Kitchen exhaust fans will be ducted using 28 gauge smooth wall metal duct.
- Fan will be mounted securely in accordance with manufacturer specifications.
- **A backdraft damper** will be installed between the outlet side of the fan and the exterior.
- Duct-to-fan outlet will be connected and sealed as follows:
 - Round ducts will be mechanically fastened to maintain alignment.
 - Other metal-to-metal or metal-to-PVC connections will be securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic-plus-embedded-fabric systems, or tapes.

- Flexible duct-to-metal or flexible duct-to-PVC will be fastened with tie bands using a tie-band tensioning tool.
- PVC-to-PVC materials will be fastened with approved PVC cement.
- Other specialized duct fittings will be fastened according to manufacturer specifications.
- In addition to mechanical fasteners, duct connections will be sealed with UL Underwriters Laboratories 181B or 181B-M listed material.
- Gaps and holes in fan housing will be sealed with caulk or other sealants in accordance with manufacturer recommendations:
 - Sealants will be compatible with their intended surfaces.
 - Sealants will be continuous and meet fire barrier specifications.
 - Leakage to the house from other spaces will be prevented (e.g., garages, unconditioned crawl spaces, unconditioned attics).
- Air flows in cubic feet per minute (CFM) will be measured and adjusted to meet the whole house upgrade design requirements.
- Photos or other visual documentation of fans and fan ducting must be available at the agency, preferably in the house file.
- Ensure flow and some levels are met.

2100 Lead Paint

- The Iowa Department of Public Health (IDPH) is responsible for applying the notification requirement in Iowa. IDPH has promulgated rules for the application of the EPA notice requirement for Iowa. The IDPH rules are contained in Chapter 69 of the Iowa Administrative Code (IAC). Chapter 69 is titled, “Renovation, Remodeling, and Repainting – Lead Hazard Notification Process.” IDPH officials have told us that the requirements in Chapter 69 of the IAC are at least as stringent as the EPA requirements contained in 40 CFR Part 745. Therefore, the weatherization program only needs to be concerned with compliance with Chapter 69 of the IAC.
- Refer to the *Iowa Weatherization General Appendix*.

2110 Slate Siding

- Homes with insul-brick or slate siding will be presumed to have asbestos.
- A certified Asbestos Building Inspector may, with client permission, remove a piece of the siding from under a porch or some area that will not be visible to send to a lab for testing.
- Written test results must be provided to the client.
- If the test results show less than 1% asbestos, the siding may be removed and the house insulated as usual.
- If the test results show 1% or more asbestos, the following procedures will be implemented.
- Homes with insul-brick or slate siding which contain asbestos may receive sidewall insulation only if:
 - The siding can be removed and replaced by an asbestos abatement contractor who has a current permit from the Iowa Division of Labor.
 - The cost of removal/replacement must be included as an additional cost for wall insulation in the NEAT audit. The individual measure SIR must be ≥ 1 or the measure is not eligible.
 - A list of qualified contractors for Iowa can be found at the Iowa Workforce Development website <https://www.iowadivisionoflabor.gov/>.
 - Walls may be insulated from the interior if all work protocols are followed including:
 - Client permission
 - Walls are drilled using shroud and HEPA vacuum
 - Lead safe confinement and clean up
 - Wall repair (described in [Section 5000](#)), etc.,
- Agency crew members may also complete the siding removal/replacement if:
 - The agency has a current permit issued by Iowa Division of Labor; and
 - The individual crew members (who will be working with the siding) have a current asbestos abatement license issued by Iowa Division of Labor.
 - A file with all required permits and licenses must be maintained by the agency.
- These costs (crew or contractor) must be reported in sequence number 2870 Slate siding removal.
- **Siding must not be removed by the client.**

- If slate or insul-brick need to be drilled in order to vent furnaces, water heaters, or exhaust fans, a licensed abatement contractor must complete the work.
- This work must be bid out to qualified contractors and contractor files with all required insurance, licenses, permits and trainings, etc. must be maintained by the agency.

2120 Unsanitary Conditions

- Any unsanitary conditions, including insect pests, animal or bird feces/carcasses or sewage leakage in the work area must be recorded on the Health & Safety Assessment Findings Form.

FIELD GUIDE

Energy Auditor/Inspector

Animal Feces or Raw Sewage

- If animal feces or raw sewage are in the way of doing work or pose a health threat to workers, the feces/sewage must be removed by the client before work is begun or continued. If the client refuses to do this, the agency must defer work on the job. This must be documented on the Health and Safety Assessment Form Part 1.

Bird/Bat Droppings

- Unlike birds, bats can become infected with the organism that can cause histoplasmosis. They can excrete the organism in their droppings. However, the incidence of histoplasmosis being transmitted to humans from bat droppings occurs infrequently.
- Exposure to bat droppings only pose a risk if the droppings are dry and are disturbed so the spores become airborne and are inhaled. As a precautionary measure, Energy Auditors should wear a NIOSH-certified respirator (a N95 respirator is sufficient) when entering attics until they have had a chance to determine whether bat droppings are present.
- If bat droppings are present but will not prevent attic by-pass sealing and attic insulation from being done, work may proceed. However, protective clothing including a NIOSH-certified respirator that can filter particles as small as 0.3 microns, disposable gloves, overalls, and boots must be worn. The bat droppings should be misted with water to prevent the spores from becoming airborne.
- If the bat feces will prevent attic by-pass sealing and attic insulation from being done, do not do those measures. Do a one-point pressurization test and conduct a pressure test in the attic.
 - With the blower door @ 50 Pascal, if the house to zone (attic) pressure is 48 Pascal or more, other work on the house may be done.
 - If the house to zone (attic) pressure is less than 45 Pascal, defer any work on the house. A pressure reading of 48-50 Pascal would indicate very little by-pass leakage, thus other work could be done to the home without concern about the by-passes not being sealed.
 - A reading of less than 48 Pascal indicates there is enough by-pass leakage to possibly be a problem. Therefore, all work on the house should be deferred.

2130 Electrical Safety

SWS 2.0301.1

Correcting electrical wiring problems is generally not an allowable weatherization measure. Wires are inspected to ensure they are not bare or frayed. Service boxes are inspected to ensure they have secure covers.

FIELD GUIDE

Energy Auditor/Inspector

- Fuses and breakers are inspected to ensure they are properly sized.
- If it is determined a hazardous situation exists, the problem must be corrected before weatherization work is started.
- Enclose all wiring splices inside a location-appropriate (e.g. wet-location, outdoor, indoor, etc.) UL listed electrical enclosure per the NEC
- Program funds may be used to correct minor electrical problems but spending must be within the General Health and Safety Repair cost limits.

- A Department of Public Safety appropriately licensed electrical contractor will be used to perform electrical work needed to correct a problem.
- Electrical hazards will be eliminated and inspected in accordance with NFPA 70 National Electric Code.

Knob & Tube Wiring

- Unless prohibited by local codes, S-type fuses must be installed in homes having knob and tube wiring, to provide over-current protection.
- If S-type fuses will not work because of overloaded circuits, a new service panel must be installed and the house brought up to code.
- Agencies may use General Health and Safety Repair funds (within limits) to complete this work. Weatherization funds may be used from the weather head or mast down. Service to the weather head is the client's responsibility.

Manufactured Homes

- Known electrical problems may be corrected within the General Health and Safety Repair program spending limit.
- If manufactured home has aluminum wiring, it must be inspected and determined to be safe by a licensed electrician. Aluminum wiring can be a fire hazard if it is corroded, loose, or exposed. Take special care when working in a manufactured home with this type of wiring.
- Frames of home sections will be bonded with copper wire.
- Bonding lug will be selected to prevent corrosion due to dissimilar metals.
- Homes will have a four-wire service entrance to the panel box to ensure a wiring system that is nominally rated at 120/240 volts and allows for proper grounding.
- Grounding at the service entrance will be checked to determine proper grounding of the home.
- In units that are receiving insulation measures, electrical wiring and the electrical circuit breaker/fuse box must be assessed for adequacy as follows: #12 aluminum or #14 copper wiring must be protected with 15 amp fusing or breakers.
- Care must be taken to ensure the electrical wiring was not damaged during insulation work. This can be done by testing electrical outlets and switches following completion of work.

2140 Section reserved

2150 Suspected Asbestos

2151 Friable Asbestos

STANDARD

Weatherization measures will not be installed if they will disturb suspected friable asbestos.

FIELD GUIDE

Energy Auditor/Inspector

- Clients will be provided with the Asbestos in Homes handout anytime materials with presumed asbestos are present in the house.
- The handout can be found on the Weatherization Program Members Only page of <https://humanrights.iowa.gov/>.
- Minor asbestos removal, such as asbestos tape on furnace ductwork and on boiler pipes, is allowable under the General Health and Safety Repair limits described in the *Iowa Weatherization General Appendix* and must be performed by a licensed asbestos abatement contractor.
- Minor asbestos removal is the minimum amount necessary in order to perform weatherization work.

2152 Slate-Sided Dwellings see [Section 2110](#)

2153 Vermiculite

STANDARD

If vermiculite is found in a home, there is no way to tell if it contains asbestos without testing it. If an agency is not willing to collect a sample to test for asbestos, the agency may hire an outside contractor to collect the sample.

FIELD GUIDE

Energy Auditor/Inspector

- EPA and OSHA regulations define asbestos containing materials as material containing 1% or more asbestos. Therefore, if the test results show the vermiculite sample contains less than 1% asbestos, the vermiculite is considered to be non-asbestos containing material and the attic or walls can be insulated.
- Vermiculite testing may be completed at laboratories that are accredited by either the National Voluntary Laboratory Accreditation Program (NVLAP) or by the American Industrial Hygiene Association (AIHA) Laboratory Accreditation Industrial Hygiene Program (IHLAP) for the Field Testing (FOT) of polarized Light Microscopy.
- If vermiculite is present, operate the blower door in the pressurization mode.
- Test vermiculite for presence of asbestos.
- If test results indicate there is asbestos in the vermiculite:
 - Work required by NEAT that will not disturb vermiculite may be completed.
 - To reduce the risk of moisture, the attic must be properly ventilated (one square foot of venting for every 300 square feet of attic).
- If the test results indicate there is no asbestos in the vermiculite complete all work required by NEAT.
- In all cases, a copy of the test results will be provided to the client and maintained in the file. If the client refuses to receive the test results, defer work on the home.

2160 Volatile Organic Compounds (VOCs)

- Volatile Organic Compounds (VOCs) are widely used as ingredients in many household products, such as paints, varnishes, fuels, and many cleaning, disinfecting, cosmetic, and hobby products.
- These products can release the organic compounds as vapor when they are used and, to some extent, when they are stored.
- Formaldehyde is a volatile organic compound found in many building materials and household products, such as new carpets and plywood.
- These products release the organic compounds over time.
- Organic compounds sometimes have adverse health effects on people.
- Because of the potential for adverse health effects, local agencies must take this into consideration when determining air tightness limits of dwellings and whether installing ventilation may be needed.
- Client must be informed of the hazards of VOC's.

2170 Radon

SWS 2.0401

STANDARD

To complete all measures without increasing occupant exposure to radon and possibly reduce occupant potential exposure to radon.

FIELD GUIDE

Energy Auditor/Inspector

- Every county in Iowa is considered a high radon threat. Therefore, every weatherization house will be treated as if radon is present.
- Sealed sump covers will be installed for sump pumps meeting requirements in [Section 2073.05](#).
- Crawlspace will be covered with vapor retarder as described in [Section 5031.01](#). Each client will receive the EPA booklet "A Citizens' Guide to Radon".

- Each client will sign the Health and Safety Notification form. One copy of the form must be left with the client and one maintained in the client file.
- Radon abatement is not an allowable activity under the program. Where there is a previously identified radon problem in a home, work that may exacerbate the problem should be limited.
- Houses with previously identified radon problems should not be left with an increased negative pressure in the contaminated area than existed before weatherization work began.
- This is determined by setting the house up in worst-case. [Section 2041](#) describes worst-case testing methods.
- Major radon problems should be referred to the appropriate local environmental agency.

2180 Building Structure

STANDARD

Provide a safe and stable work environment that will support and sustain work to be performed by ensuring the work area and associated building assemblies are suitable for the proposed work.

FIELD GUIDE

Energy Auditor/Inspector

- Weatherization services should not be performed on dwellings whose structural integrity is in question, which could pose a safety hazard to workers, or are in such a state of disrepair that failure is imminent and the conditions cannot be resolved in a cost-effective manner.
- Minor repairs to stairs, steps, railings, etc., are allowed if necessary to complete weatherization work.
- For example, broken steps to the basement where the furnace is located may be repaired in order to complete furnace work.
- Broken boards on the front porch away from the door may not be repaired because it will not interfere with weatherization work.
- Minor repairs made to remedy the issues are allowed within the Incidental Repair expenditure limits.
- Repairs must be identified with an ECM.
- Keep in mind that the weatherization program is not a fix-all service. There will be cases where work required is beyond the scope of the program. STOP ALL SERVICES.

2190 Animals

STANDARD

Provide a safe and stable work environment.

FIELD GUIDE

Energy Auditor/Inspector

- If there is an animal in the house or on the house grounds that is menacing, or if a worker is uncomfortable being around the animal, require the client to restrain the animal before proceeding with any work. If the client refuses to do this, defer work on the house. Document this on the Deferral Documentation Form.
- Any bite from an animal, particularly a wild animal, should always be considered a potential for rabies exposure.
- If a worker is bitten by an animal, the worker should immediately and thoroughly wash the bite wound and then seek medical care.
- If a worker is bitten by a bat, an attempt should be made to kill the bat without destroying the head. The bat should be placed in a cloth or plastic bag and then shipped under refrigeration to the nearest health laboratory for examination for rabies.
- Any animal bite should be reported to the appropriate local agency personnel.

WX Worker

- If there is an animal in the house or on the house grounds that is menacing, or if a worker is uncomfortable being around the animal, require the client to restrain the animal before proceeding with any work. If the client refuses to do this, contact the agency.

- Any bite from an animal, particularly a wild animal, should always be considered a potential for rabies exposure.
- If a worker is bitten by an animal, the worker should immediately and thoroughly wash the bite wound and then seek medical care.
- If a worker is bitten by a bat, an attempt should be made to kill the bat without destroying the head. The bat should be placed in a cloth or plastic bag and then shipped under refrigeration to the nearest health laboratory for examination for rabies.
- Any animal bite should be reported to the appropriate local agency personnel.

2200 Refrigerants

STANDARD

To prevent reuse of inefficient equipment and components and to protect the environment from hazardous waste.

SWS 7.0101.1

FIELD GUIDE

Energy Auditor/Inspector

- Refrigeration appliances that are replaced must be disposed of according to the environmental standards in the Clean Air Act (1990), Section 608, as amended by the Final Rule, 40 CFR 82, May 14, 1993. The party recovering the refrigerant must possess an EPA-approved Section 608 Type II license or an approved universal certification.

WX Worker

- Appliances replaced by new units will be recycled or disposed of in accordance with federal, state, or local regulation

SECTION 3000 FIELD EVALUATION

3010 OVERALL BUILDING SHELL

The energy audit and inspection of a home involves several equally important activities.

- The first activity involves the health and safety assessment where existing or potential health and safety problems are identified.
- A second activity involves the energy efficiency assessment, where energy savings opportunities are identified, with the help of a computerized energy audit.
- The third activity, and one that should be done throughout the entire energy audit process, involves communicating with the client. Good communication with the client can help the Energy Auditor identify existing or potential health and safety problems, comfort issues, and weatherization opportunities. It is also a good opportunity to provide energy education to the client.
- It is highly recommended that pictures are taken of existing furnaces, water heaters, refrigeration appliances before and after weatherization. It is strongly recommended that photo documentation is taken of problem areas before, during, and after weatherization measures are installed.
- All on-site weatherization workers, including energy auditors, crews, contractors, and inspectors are expected to follow OSHA safe work practices as well as any practices spelled out in these standards.

3011 Recommended Energy Audit Procedures

- The following is a summary of procedures Energy Auditors should follow when evaluating homes.
 - [Section 2000](#), [4000](#), [5000](#), and [6000](#) provide more detailed information on required tests, documentation, etc.
 - These procedures are NOT to be considered all inclusive.
 - Every house is different and Energy Auditors might find unusual situations not addressed here.
 - When auditing a house, it should be emphasized to new Energy Auditors, to take one step at a time.
 - Solve each task or problem as you get to them and don't try to do them all at one time.
1. Upon arriving at the property, while walking to the door, scan the house and surrounding area for anything that may cause a deferral situation such as "For Sale" signs, extensive remodeling, etc.
 2. Introduce yourself and briefly discuss the energy audit procedure and approximate length of time procedure will take.
 3. Throughout the energy audit process, be aware of existing or potential health and safety problems (electrical, CO, drafting problems, leaks in gas lines, unsanitary conditions, etc.) and Red Flag situations (mold, moisture problems, plumbing defects, evidence of water penetrating the home, etc.). The Health & Safety Assessment Forms Part 1 & 2, Health and Safety Notification Form, and the Client Home Energy Audit are to be completed throughout the energy audit process documenting health and safety problems and red flags. Take pictures of the problems/red flags to document that they were pre-existing conditions. ([Section 2010](#))
 4. Walk through the house to review the arrangement of rooms (makes it easier to draw the house from the outside). Also check for any problem areas that will need to be dealt with or possibly cause a deferral situation. ([Section 1020](#))
 5. Obtain client signature on the Release of Liability Form: Release of Liability and Waiver of Claims and any other forms required by the agency. ([Section 2010](#))
 6. Ask about number and location of refrigerators and freezers. Plug in the meters to the refrigerators and freezers. Write down make, model number, size, etc. of each appliance.
 7. Outside the house

- Proceed outside and draw each side of the house. Start at the front, far left of the house (side facing the street or road) and continue to the right each time (counter-clockwise).
 - Move to the right around the house to look at the windows (also measure them for NEAT) and number each one (this will help keep track of the windows), as well as each door; foundation (look for cracks and drainage problems); measure the length of the walls; check for any roof, gable & soffit vents; note siding type; and look at the gutters for any problems. Record size, type, glazing type and existing storm windows. Also record type and condition of all exterior doors. If there are grade entrance doors, one must be made airtight, preferable the lower door. Do this on all four sides. Note any Red Flags according to the health and safety forms, such as drainage problems, gutters, or lack thereof.
 - Go back around the house with a digital camera and take pictures of the house and any particular problems the crews/contractors need to address. Looking at everything again may bring something to your attention that was missed the first time around.
 - Check sidewalls for insulation by either drilling a pilot hole on the outside of the house or by removing an outlet cover on the interior of the house. Drill small hole on inside wall in area that is out of the line of sight of home owner (closet, under cabinet, etc.). Do not drill through the siding.
 - Document any incline in the yard or obstructions which would require special ladders or other safety equipment. Determine appropriate measures needed to assure worker safety.
 - **MANUFACTURED HOMES**
 - If the home has an installation deficiency that may affect worker safety, corrections must be made before beginning work.
 - Structural problems affecting insulation measures must be corrected prior to installing insulation.
 - Inspect belly rodent barrier it must be repaired if insulation will be installed or if significant air leakage is occurring.
 - Check for depths of insulation in sidewalls, attics, and underbelly. Refer to [Section 3000](#)
8. Inside the house
- Go back in the house and start with the very first window and go the same direction as on the outside. While looking at the windows and doors, also look for any other concerns, such as, holes in the walls, lowered or suspended ceilings that may need to be looked above (missing plaster, holes in lath, leaking areas, etc.), and any other problems that may need attention.
 - While walking around, be sure all windows are closed and all registers are open
 - Look in the attic or attics for amounts and kinds of existing insulation for required work to be done. Measure any knee wall, slants, and attic areas to calculate required insulation. Check for by-passes in both the knee wall and attic areas (such as floor joists, rafter runs and open stud runs). Note all attic accesses and required treatment. Obtain a sample of vermiculite if existing.
 - Note any exhaust fans and dryers and whether they are adequately vented outside.
 - Note the location and condition of the main service entry box. Note if it is properly mounted in the appropriate location. Determine the type and amp rating of the main service box. This information should be available on the main service box. If the Energy Auditor determines that a hazardous situation exists, the client must correct the problem before weatherization work is started.
9. Proceed to the basement and/or crawlspaces. Check band joists and crawlspaces for needed insulation and vapor barrier. Also check outside basement doors and basement windows. While doing this, look for any problem moisture areas caused by outside water or inside plumbing problems. Measure the basement and crawlspaces for area and height for the NEAT audit.
10. Check the water heater and furnace.
11. Take pictures of the furnace and water heater and all problem areas that may need attention.
12. Document the type and size of combustion appliances. Record model number, serial number, Btu's, temp rise, type of furnace (forced-air, boiler, etc.), etc.
13. Document the volume of the CAZ and whether there is adequate combustion air. ([Section 2022](#))

14. While downstairs, count the number of supply air registers. Proceed upstairs and look for all of the supply and return registers, ensuring they are open and unobstructed. Note any supplies and returns in the CAZ.
15. Any supply registers in garage must be truncated and sealed as close to the supply as possible.
16. Check all gas lines for leaks, drip legs, proper flex lines, and shut off for each appliance.
17. Set up the house in worst case scenario. ([Section 2041](#))
18. Test furnace for CO, static air pressures, and temperature rise. Test the water heater for CO, and spillage. The order of testing the water heater and furnace will be determined on-site based on whether the appliances are induced-draft or atmospheric burning. ([Section 2042](#))
19. While the furnace is on and running, check all the supply registers for airflow. Perform room-to-room air pressure testing if needed. ([Section 2048.01](#))
20. Check oven for CO. ([Section 2043](#))
21. Set up the blower door in the exterior door that is easily accessible and has the fewest restrictions in front of it (restrictions, such as, basement doors, small entry hallways, etc.) and outside of it (restrictions, such as, enclosed porches, etc.).
22. Run hoses to any attics, knee walls, garages, etc. to be tested.
23. Test supply runs or returns that may be run through an area outside of the thermal boundary.
24. Calculate the DTL using procedures in [Section 2080](#).
25. Install or note any required lighting and water heating measures.
26. Document the meter readings and duration of readings (minimum 2 hours) for the refrigerators and freezers. Run the readings through the TI-89 or utilize the look-up chart. If any appliances need to be replaced, complete the Client Refrigeration Appliance Agreement. ([Section 6011](#))
27. Finish completing the Health & Safety Assessment Findings Forms Part 1 & 2 Health and Safety Notification Form, and the Client Home Energy Audit Form.
28. Install required CO and smoke alarms. ([Section 2060](#))
29. Collect all gauges and equipment. Ensure the water heater and furnace is returned to normal operating condition.
30. Review the energy audit with the client. Explain what the program can do and tell the client why the program cannot do the other things the client wants done.
31. Give the asbestos and radon information to the client.
32. Give the Lead Poisoning Pamphlet to the client and obtain their signature on the sheet showing they received it (if the agency distributes the pamphlet).
33. Obtain client signatures on all state and agency forms. State forms include: Client Home Energy Audit, Lead Paint Notification, Health & Safety Assessment Forms, Part 1 & 2, Health and Safety Notification Form, Release of Liability Form, Deferral Documentation Form if necessary, and the Client Refrigeration Appliance Agreement if necessary.

34. Answer any further questions the clients may have and give them a business card. If possible, give the client an approximate time when the work may be completed. Explain that an inspection of the work will be done and to call with any questions.

3012 Recommended Inspection Procedures

1. Look at the house from the exterior as approaching the door to get an idea of attic locations, sidewall insulation, chimney locations, and general layout of the house (porches, overhangs, potential knee wall locations, foundation types, etc.).
2. After introduction to the client, ask about materials installed, furnace work done, and if the client had any problems with the work done or not done. Also ask if any insulation came in anywhere. If there are suspended ceilings, ask the condition of the ceiling above and if any repairs were done to it. The upper ceiling should be visually checked.
3. Determine the thermal or air boundary of the home. If different from the Energy Auditor's determination, try to ascertain why, giving benefit of the doubt to the Energy Auditor. If the thermal boundary is not air-sealed and insulated it must be corrected. If the Energy Auditor clearly made the wrong choices, it must be corrected. If the Energy Auditor extended the thermal boundary beyond what is necessary (i.e., heating a porch for plants or animals, or a double ceiling) it should be noted and corrected if possible.
4. During the inspection process, always be looking for any hazardous situation as well as health and safety problems. This would include wiring, plumbing, mold, ventilation, and other issues. Determine whether a smoke alarm or CO alarm should be installed. The dryer needs to be checked to ensure it is properly vented to the outside. Confirm that all exhaust fans, both new and existing, are in working order and exhausted to the outside. New exhaust fans must meet the same requirement.
5. Inside the home
 - All measures installed must be according to standards.
 - Verify all required materials have been installed including light bulbs and appliances.
 - If new appliances were installed, verify they are working properly and the client is satisfied.
 - All areas of the house must be visually checked for holes in ceilings and walls. Leakage of any holes can be checked at the time of the blower door test.
 - The client's comments about any insulation coming into the home should be taken into consideration at this time and any other comments about air coming into the house should also be checked.
 - While walking around the home with the blower door operating, you should feel the registers for air movement. Pan pressures should be checked whenever there is a possibility that they are over 1 Pascal.
 - Verify that registers are open to the house and not covered. Check rooms for returns. Check baseboards to see if exterior walls were used as return ducts. If the house has a central return, room pressures must be checked.
 - Make note of construction details that might be linked to attic by-passes to be checked when the attic.
 - The windows and doors of the home should be checked for major leakage or safety problems.
6. In the attic
 - Check the attic for insulation. Note depth, level and consistency throughout the attic with all heated areas being insulated.
 - Insulation barrier is to be around all potential heat sources with a three-inch clearance.
 - Recessed lights are to be boxed around with drywall and a lid installed. If the box cannot be built, metal insulation shielding or damming material should be used around the recessed light.
 - Existing exhaust fans with lights should be shielded unless they are Type-IC rated.
 - Ducts from exhaust fans need to be checked to make sure they go to the outside and are installed and insulated to standards.
 - If there is ductwork in the attic, it should be sealed and insulated.

- Slopes of attics are to be dense packed. If they cannot be dense packed, they need to be hard sealed at the top and bottom or at least from either the top or bottom if both cannot be done.
 - Check the by-passes noted on the audit and during inspection walk through. All by-passes must be sealed or dense packed. Pictures must be taken prior to and after sealing bypasses and maintained in the client file.
 - Any chimney that passes through the attic must be inspected to make sure it is intact. If the brick around a liner terminates in the attic, the opening between the liner and brick must be sealed with proper materials.
 - In attics that have been insulated, an Insulation Installation Requirements certificate must be filled out by the installer and attached the box of each attic access so it is clearly visible from the attic access. An empty bag must also be left in each attic, where it is clearly visible from the attic access. It must not come in contact with the insulation. Staple one corner to the rafter so it hangs freely.
 - Certificates for wall insulation, crawl space insulation, any sealed (non-accessible) attic and band joist insulation must be attached within one foot of the electrical panel in the basement.
 - A barrier is to be installed securely around the attic access door unless the slope of the roof does not allow it. This barrier must remain secure and solid as the Inspector goes in and out of the attic.
 - All attic doors need weatherstrip. Caulking the access door shut is only permitted if there is another entrance.
7. In the basement
- Fiberglass insulation must be applied according to standards (snug fit in band joist box, proper size and complete).
 - Crawlspace insulation must be complete and meet standards (snug fit in the box and secured in place).
 - Vapor barrier must be installed according to standards.
 - Crawlspace vents are to be sealed, closeable or have removable covers.
 - If the floor is insulated, the batts must be un-faced fiberglass, secured in place or dense-packed cellulose.
 - Any heat ducts in unheated areas must be sealed and insulated.
 - Grade doors or exterior basement doors are to be built according to standards.
 - Foundations are to be as tight as possible to minimize the need for duct sealing and to eliminate infiltration.
 - Check for allowable repairs for moisture problems.
8. Combustion appliances
- The furnace must be visually inspected to ensure the blower and burners are clean.
 - Other work performed by the furnace contractor must be verified and inspected.
 - Check for signs of carbon in the flue opening.
 - Spillage and CO tests must be completed on all combustion appliances in accordance to the standards under worst case conditions.
 - All required tests must be completed and properly documented (temperature rise, static pressure, spillage, etc.).
 - Any client comments about furnace problems should also be checked.
 - Check for gas leaks.
 - Check for adequate volume of combustion air.
 - New furnaces must meet the same standards as existing and meet code requirements (local codes or the United Mechanical Code). All replacements must meet Iowa Weatherization Standards as well. There are a few standards that are unique to Iowa Weatherization: The unit must be installed $\frac{3}{4}$ " off the floor; there must be a fused switch on or within 24" of the furnace; a filter rack must be outside of the furnace cabinet with a cover; and, the old unit must be removed. The new furnace must be properly sized. The same tests performed on existing units, must also be run on new units.
 - Visually inspect the duct system for large openings and disconnected ductwork. Large openings, holes and open return registers must be sealed. The cold air drop should not have any sign of insulation in it. If it does, ascertain the origin of the insulation.

- Duct pressure testing must be completed with the blower door at 50 Pascal and no pan pressure on the supply and return duct should be greater than one with the basement closed to the outside and interior door to the basement open (unless there are ducts that are totally inaccessible).
 - Whenever possible, ducts are to be in the heated thermal boundary. Ducts in unheated areas are to be insulated (i.e., garages, attics or unheated crawlspace).
 - With the furnace air handler running, the basement WRT outside should meet the guidelines in [Section 2041](#). When there is a central return or a suspicion of high room pressures, the room pressures must be checked with reference to the main body with the air handler running. The room pressures WRT main body must be less than 3 Pascal.
 - Pipe wrap is to be properly size and secured. It must be 3" away from flue and draft hood unless the unit is power-vented.
 - New installation of water heaters must meet all codes and standards.
 - While inspecting the furnace and water, the flue must be checked to make sure they are connected, in good condition and secure. The chimney must be inspected to make sure it has no opening into the basement.
9. Blower door testing is required, including garage leakage tests if there is an attached or tuck-under garage. The garage leakage test results must be reported in the database.
 10. When the blower door is used, zone leakage testing can be done to ascertain the by-pass leakage or tightness in the basement and/or attics. If the leakage in the attic is high, by-passes should be checked again. It could create a moisture concern in the attic if the air barrier is the roof rather than the ceiling. If moisture problems exist and by-pass leakage is significant, more by-pass sealing should be done.
 11. All CO and smoke alarms (existing and new) must be in proper location and installed correctly.
 12. Outside the house
 - Wall insulation should be checked to make sure it is dense packed and complete. The infrared camera should be used to check wall insulation. Use the infrared prior to using the blower door as air currents around windows and doors can be misleading concerning the insulation. Using the blower door with the infrared will help find air leakage sites and by-passes. If there are questions about what you are seeing with the camera, test holes should be drilled to make certain there are no problems with the insulation. Pressure points are to be dense packed. There should be no lifting of carpet or other flooring caused by air coming into the rooms. If holes are drilled in the siding, they should be neat in appearance and in a level line with a minimum of three (3) holes per 8' stud cavity. Drilling the siding should be a last resort. Removing siding to insulate is preferable. Removed siding needs to be properly reinstalled and neat in appearance. There should be no structural damage that will allow moisture into the walls.
 - Check the exhaust terminations, dryer vent termination, furnace and water heater venting.
 - Check attic ventilation.
 - Check structural condition of the exterior wall.
 - Check for cracks in the foundation.
 - Check any newly installed wood. New wood is to be painted or varnished, unless it is pressure-treated wood.
 13. Client needs to be informed about any new appliances in the home. The operation of the new furnace, water heater, and/or refrigerator might require some explanation to the client. The thermostat may also need to be explained. The reasons for using the exhaust vent may need to be explained. When possible, the furnace filter should be looked at with the client. They should know how to replace the filter and the size that is needed.
 14. The client final inspection sign-off needs to be completed. If available leave information concerning agency contacts. Also leave any printed energy savings tips.
 15. The paperwork in the file (audit, NEAT/MHEA, etc.) must be reviewed for completeness and accuracy.

Remember – we are to leave the house in better condition than when the job was started.

3020 NEAT/MEHA AUDITS

- The computerized National Energy Audit (NEAT) must be completed for all homes and multi-unit dwellings of less than 5 units.
- The computerized Manufactured Homes Energy Audit (MHEA) must be completed for all manufactured/mobile homes.
- The agency must use the NEAT/MHEA Audit version authorized by the State.
- The agency must have copies of the Input and Recommended Measures Reports in the client file.
- Instructions for installation and navigation of the audit are contained in the National Energy Audit Manual developed by the Oak Ridge National Laboratory.
- Refer to the *Iowa Weatherization General Appendix* for NEAT/MHEA Audit procedures.

3030 INFRARED CAMERA PROCEDURES

- The infrared camera should be used as a tool like pressure diagnostics. It may be used to show contractors/crews areas where they may have missed insulation. When the camera indicates an area is missing insulation, the Energy Auditor/Inspector should visually verify the empty cavity prior to sending a crew or contractor back to the job.
- The camera should be used to troubleshoot problem jobs and look for missed key junctures. The camera should also be used in conjunction with an infrared thermometer and a blower door.

Using a Blower Door with the Infrared Camera

- The ideal technique for finding hidden air leaks in a building is to use a blower door along with the infrared camera. This procedure usually involves performing two infrared scans from the interior of the building; one before turning on the blower door and one after the blower door has been depressurizing the building for 5 to 10 minutes and drawing air in through the leaks. As long as the air being sucked in through the leaks is either warmer or colder than the interior of the building, the area surrounding the leakage path will change temperature and show up on the infrared video display screen as streaks.
- Even if there is little temperature difference between the inside and outside of the building, an infrared scan may still be possible if the attic space has been warmed from solar radiation on the roof or the crawlspace has been cooled from the ground. A temperature difference of about 5 to 10 degrees is sufficient to expose the important leaks. Significant leaks are often found without having to enter the attic or crawlspace by using this technique.
- Note: Pressurizing the building and inspecting from the outside, or in the attic, can also be useful.
- Helpful Tip: It's best to start at a lower depressurization number (10-15pa) and work your way up to the 50pa, rescanning after each pressure increase. This will help pinpoint the leak(s).

SECTION 4000 GENERAL HEAT WASTE

4010 AIR SEALING / INFILTRATION

In order to prevent air leakage and moisture movement between the conditioned and unconditioned space in chases and open stud runs air sealing is required. The air leaks at the building's high and low points are the more important leaks, because they are larger or because they are under a greater pressure by being located in attics and basements. Infiltration is generally smaller leaks around windows and doors. By separating the leaks into different categories, air sealing and infiltration, a higher priority is given to air sealing than infiltration. Materials used for air sealing and infiltration must conform to Appendix A standards

SWS 3.0101.1 3.0101.5 3.0102.6 3.0102.9 3.0102.10 3.0102.11-e 3.0103.3 3.0105.1 4.0104.1c

FIELD GUIDE

Air Sealing

Energy Auditor/Inspector

- Document the existence of any penetrations through the attic floor, including:
 - Open interior or exterior walls
 - Utility penetrations
 - Recessed light fixtures
 - Exhaust fan housings
 - Chase ways
 - Chimney chase way
- Document any chimneys which do not go through the roof. They must be sealed at the top with appropriate materials.
- Document existence and condition of firewalls in duplexes up to four-plexes Document the existence and location of knee wall floor cavities, ceiling height changes, stairwells, etc. Figure 1 shows split level air leaks. Figure 2 shows by-passes in the floor, and roof rafter connections.
- Document the existence of any tongue and groove ceilings. These ceilings must be backed with a continuous air barrier and permanently sealed. Talk to agencies
- Document the existence of any whole house fans. The fan must either be disconnected with client permission or removed with client permission and the ceiling area finished matching the surrounding area or an insulated box must be built as a cover for these fans during winter weather.
- Document existing fiberglass insulation or loose-filled cellulose in sloped areas or rafter runs. These must be sealed at the top and bottom of each cavity, if possible, instead of re-insulating. If both the top and bottom of each cavity cannot be sealed, one or the other must be sealed to prevent convective looping in the cavity. (See [Section 5014](#))
- Attic thermal by-passes result in heat loss and must be sealed. Recessed lights may be changed to surface lighting or air-tight IC rated recessed light by a qualified electrician to reduce air leakage into the attic. The cost of this would be an electrical repair under the General Health and Safety Repair limit. Non-IC rated recessed lights must be covered and sealed in the attic. See [Section 5014.05](#) for more detail
- Attic by-pass sealing must be verified in the client file by use of photographs taken before insulation is installed. These photos may be taken by either the crew/contractor or other agency staff. Whenever possible, attic by-pass sealing should be checked by the agency prior to the installation of insulation.

FIGURE 1

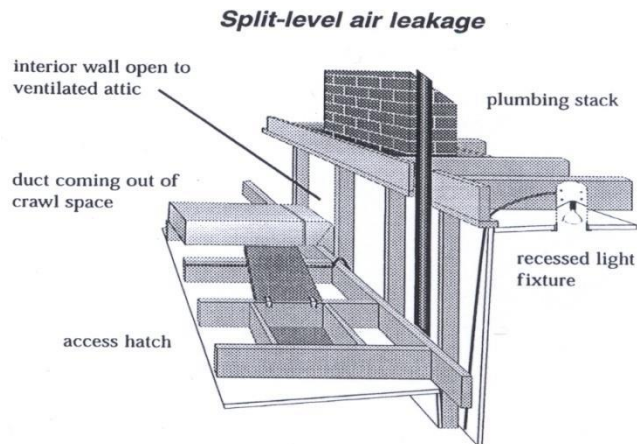


FIGURE 2

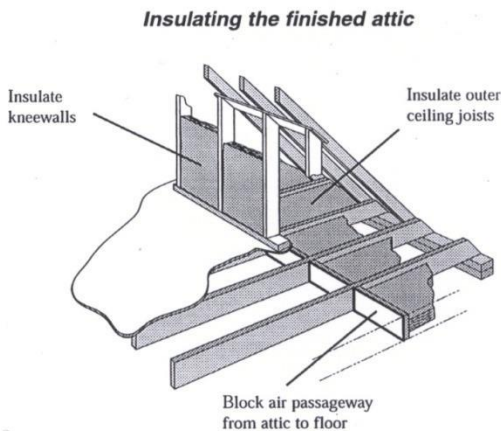


Figure 1 & 2 provided by Saturn Resources

WX Worker

- Unfloored knee wall (outer ceiling joists) shall be sealed between each joist at the wall joint with a rigid air impermeable material and seal. The remainder or exposed portion of the knee wall floor shall be insulated as if it were an attic floor according to NEAT. (See [Section 5014](#))
- Material used for attic air sealing includes, but is not limited to, rigid foam, liquid foam, sheet metal, dry wall, and caulk.
- Material used to seal around heat sources include: sheet metal, fire rated liquid foam, and caulk that will withstand at least 400°.
- Seal all major attic by-passes such as vent pipes, open interior and exterior wall stud runs, wire penetrations, chimney chase ways, area between brick chimney and flue liner, etc. (check local building codes on chimney chase ways).
- Open stud cavities and holes smaller than 6" in diameter shall be sealed with a moisture resistant air impermeable material.
- Fiberglass is not to be used as an air sealing material, but may be used to stuff the top of wall cavities which will be dense-pack insulated. Plastic bags, stuffed with fiberglass, are not an acceptable air sealing material.
- Holes larger than 6" in diameter in the attic floor, such as those above bulkheads or open stairwells, must be covered with a material strong enough to support the installed attic insulation; such as plywood, drywall, 1/2" double foil-faced foam board or 3/4" or thicker foam board (not bead board). Support

materials will be installed for spans wider than 24", except when air barrier material is rated to span greater distance under load (e.g., wind, insulation).

- Air sealing materials, such as rigid foam board must be in alignment with the attic's pressure boundary, must be sealed in place with caulk or non-expanding foam to make them air tight.
- When required, an insulated box must be built to cover (during winter weather) an existing whole house fan. An option to this would be a magnetic cover designed to attach to the face of the fan which then could be removed to operate the fan.
 - The box must be built of ¾" plywood deep enough to protect the fan housing and motor from insulation. Weatherstrip the box to ensure a tight fit.
 - Non-compressible insulation equal in R-value to surrounding attic floor will be permanently attached to the top and sides of the box.
- Any opening that has a heat source in it must be sealed with caulk that will withstand at least 400° or if the hole is larger than ¼", sheet metal and high temperature caulk or fire rated liquid foam must be used.

Recessed Lights – Non-IC Rated fixtures

- A fire-rated air-barrier system constructed of 5/8 fire code gypsum wallboard will be used to separate recessed lights from insulation. (See Figure 1)
- Provide a minimum 3" clearance between the box and the side of the fixture.
- The box must be constructed to be 3" above the final level of insulation
- Cover the box with drywall lid and seal to sides of box.
- The top of the box is not to be covered with insulation.
- Caulk, mastic, metallic tape, or foam will be used on all edges, gaps, cracks, holes, and penetrations of closure material only.
- If there is insufficient clearance to install the box, use metal material to keep insulation 3" away from fixture.
 - Lay cardboard over damming installed around recessed lights while installing insulation.
 - Be sure to remove it after the insulation is complete.
 - Pictures of the metal damming must be in the file

FIGURE 1

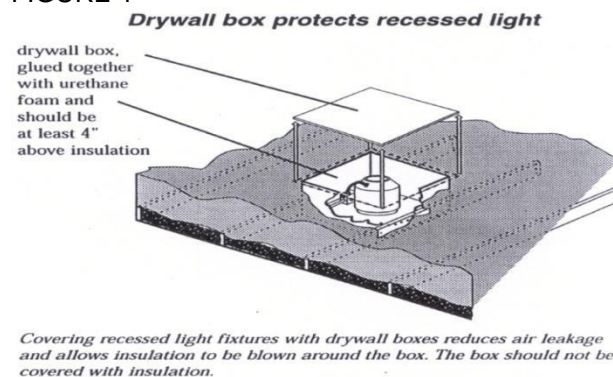


Figure 1 provided by Saturn Resources

Infiltration

Energy Auditor/Inspector

- Infiltration materials include weatherstrip, caulking, glass, glazing, mortar mix, and thresholds.
- The blower door should be used to assess the problem areas and determine where the greatest need for infiltration reduction exists.
- The estimated cost for infiltration reduction must be entered in the NEAT/MHEA Audit in the Duct & Infiltration Screen and included in the SIR.
- General infiltration measures may be done only if found to be cost effective as determined by the NEAT/MHEA Audit.

- Attic air sealing and needed house-to-garage door weatherstrip must be completed in all cases.
- Attached garage leakage infiltration must be completed in all cases:
 - Weatherstrip is to be installed on all house-to-garage doors (if none existing) or when there is significant air leakage around the exterior door.
 - Sweeps are to be installed on all house-to-garage doors (if none existing) or when there is significant air leakage at the bottom of a door and a threshold already exists.
 - Thresholds are to be installed when there is significant air leakage at the bottom of a door and a sweep will not work properly or when the exterior door rubs the floor.
 - All light fixtures, wiring, plumbing, venting, ducting, and gas piping penetrations in an attached or tuck-under garage must be sealed.
 - All cracks in house and garage separation wall will be sealed.
 - Client will be educated on the need to keep door from garage to house closed and not to warm up vehicles or use any gas engine or grills in the garage.
 - All penetration points must be tested with smoke pencils or an infrared camera and sealed.

WX Worker

Weatherstrip and Sweeps

- Door weatherstrip
 - All existing weatherstrip is to be removed from the door if installing new.
 - Door trimming and adjustments, including hinge tightening and strike plate adjustments, may be necessary and must be done before installing weatherstrip.
 - If available, the color of the weatherstrip should match the color of the jamb.
 - Installation is to be in accordance with the manufacturer's instructions.
 - Weatherstrip is to consist of a semi-rigid strip with vinyl or neoprene flap. A bulb-type weatherstrip is also acceptable if the bulb is made of siliconized rubber and a minimum of ¼" diameter. A third type that can be used is a tough vinyl tear-resistant skinned material enclosing cellular foam.
 - New weatherstrip must form a tight seal, be neat in appearance, shall not interfere with the operation of the door, and be fastened in such a way as to prevent buckling or gaps.
 - A small bead of caulk is to be applied to make the weatherstrip and the door stop airtight.
 - Nails or other fasteners are to be made of a non-rust material.
 - Staples used for fastening weatherstrip must be at least 9/16" long, 1/8" crown and galvanized.
- Sweeps
 - Sweeps are to be a metal strip with a vinyl or neoprene insert, or a brush type installed with screws on the interior side of the door.
 - Sweeps are to be cut to the same width as the door.
 - Sweeps shall be secured within 2" of the door edge on each end.
 - Sweeps shall have a threshold or carpet bar to seal against.
 - Installation is to be neat in appearance, form an airtight seal and not interfere with the operation of the door.

Thresholds

- Except for lower grade and attic access doors, half thresholds (bumper type) are not to be installed.
- Thresholds are to fit snugly between the jambs and fasten to the sill and the floor with screws.
- All thresholds are to be wood with metal and vinyl insert, unless the work order lists otherwise.
- Thresholds are to be caulked on both the interior and exterior to form a tight seal with the doorsill.
- Thresholds are to be set entirely on the sill or a continuous shim from end to end so no gap exists between the threshold and doorsill.
- All unfinished wood installed is to be painted or varnished to a smooth finish, unless the wood is pressure-treated.

Caulk

- Caulk shall be applied according to the manufacturer's instructions. Caulk shall be applied to a smooth, clean, dry surface. Caulk shall be applied in a continuous bead and free of voids, with a smooth and neat appearance.

- All openings 3/8" to 7/8" wide shall be filled to within 1/2" of the surface with an appropriate packing material specifically manufactured as a packing material, such as closed cell polyethylene rod prior to caulking. All packing material shall be compatible with the type of caulk used.
- Excess caulk shall be removed before it cures.
- Silicone caulk to be used on metal joints or two different materials shall have an elongation rating of at least 200%.
- For interior application:
 - Caulk shall be non-toxic, low VOC, clear, paintable, or a color complimentary to the surface to which it is to be applied. Remove any material from the sealing area that will prevent full adhesion of the selected sealant
- For exterior applications:
 - All exterior cracks or openings wider than 1/4" must be packed with a material (flexible polyurethane, oakum, neoprene, butyl rope, or sponge rubber) specifically manufactured as packing or stuffing material. The crack is to be sealed with caulk to make it air and watertight. Any existing loose or brittle material must be removed before caulking.
- Caulking compound conformance
 - Acrylic F.S. TT-S-00230C(ASTM834)
 - Latex ASTM 834-76(1986)
 - Butyl Rubber F. S. TT-S-001657
 - Chlorosulfonated Polyethylene F. S. TT-S-00230C
 - Polyurethane or Polysulfide F. S. TT-S-227E
 - Elastomeric joint sealants (including polysulfide, polyurethane and silicone) ASTM C920-87
 - Oil and Resin Base caulks are not acceptable.
- All caulking compounds must meet 15-year warranty minimum.

Spray Foam

- Must be neat in appearance – trim if necessary
- May not be used on exterior surfaces unless painted to protect against deterioration.

Skirting

- 90 lb. Mineral surfaced rolled roofing, or 45-mil rubber roofing material must be used when skirting the foundation on site-built homes. Other material designed for this purpose may be used when specified by the Energy Auditor.
- The skirting is to be neat and constitute an air-tight seal around the foundation.
- The color of the skirting material is to be white, unless the color of the siding can be matched or complimenting color can be found.
- Where possible, the top of the skirting is to be placed under the siding and nailed. If not, the top of the rolled roofing is to be held in place with 1x2 furring strips and all joints in the roofing are to overlap by a minimum of 6", and be covered with furring strips and sealed.
- All wood installed is to be painted to match the house prior to its installation, unless the wood is pressure-treated.
- The bottom of the skirting is to be dug 4" into the ground or banked with earth to hold it in place.
- Manufactured home skirting installation and/or repair is not an allowable program cost.

Glass

- Glass shall not be less than "B" grade single strength.
- Glass will be sized 1/8" – 3/16" smaller than opening to allow for movement of frame.
- Glass over twenty-five (25) inches in either dimension shall not be less than "B" grade double strength.
- Glass shall be secured with glazing points (2" from each corner and not more than 8" apart) and puttied with latex or oil-based glazing compound, or sealed with plastic or vinyl glazing strips.
- Glass set in metal frames is to have metal-glazing clips no more than 12" apart and within 4" of each corner and the joint between the two surfaces puttied.
- Safety glass is required in windows located within 12" of a door when the bottom edge is less than 60" above the floor or if panes are larger than 9 sq. ft. when the bottom edge is less than 18" above the floor.

- Safety glass is not required for windows protected with 1½” mullion or guard rail located 2 to 3 feet above the door. It is required in all windows located in entrance doors, in fixed and sliding panels of sliding doors and in panels in swinging doors other than wardrobe doors.
- Safety glass must be permanently labeled.
- Plexiglass may also be used in lieu of safety glass on doors and windows; however, discoloration may occur.

Glazing

- Caulk may not be used in lieu of a glazing compound.
- Glazing compound must conform to F.S. TT-P-00791B ASTM C669-75(1989).
- Glazing is not to extend above the rabbet edge of the sash.
- Glazing is to be tooled smooth to form a concave surface and be neat in appearance.
- Glazing compound will be applied in accordance with manufacturer’s specifications.

Drywall (may also be a repair cost in some cases - Energy Auditor decision)

- Only ½” drywall shall be used when installing on the entire wall or ceiling (if ceiling joist is on 16” center). If the ceiling joist is on 24” center, 5/8” drywall will be used.
- 5/8” Fire-rated drywall must be used over or between a garage and the house.
- Drywall installed on ceilings must be installed perpendicular to the ceiling joist.
- Whenever possible, drywall installed on walls should also be installed perpendicular to the studs.
- Drywall is to be installed using 1¼” drywall screws.
- Screws shall be placed no more than 12” apart on each stud or ceiling joist. Screws shall be countersunk into the drywall without breaking through the paper.
- Metal corner beads are to be installed to all outside corners. Inside corners must be taped with perforated paper tape. If fiberglass tape is used for other seams, be sure to use the proper joint compound to ensure against cracking.
- All gaps wider than ¼” must be filled with a non-shrinking compound manufactured for that purpose prior to taping.
- If installing drywall in order to ready it for wall insulation, one (1) coat of joint compound is to be applied and made ready for a second coat.
- If existing drywall must be sealed, one coat of joint compound is to be neat in appearance and made ready for a second coat.
- Drywall repairs shall be made with the same thickness material as existing.
- The hole should be squared and a properly sized patch nailed or screwed in place.
- The drywall patch shall receive tape and joint compound and be applied to make a neat patch.
- If repairing drywall due to damage caused by the weatherization crew or contractor, the drywall shall receive three (3) coats of joint compound, textured and painted to return it to its original appearance.
- All work is to be neat in appearance.

Manufactured Homes Infiltration, Air Sealing, Air Leakage Reduction Requirements

Air sealing activities should comply with the mechanical ventilation limit procedures and calculations in [Section 2080](#). 3.0102.7b, d, e, f; 3.0102.8d, e, f

Additional manufactured home specific guidelines are listed here.

- Intentionally ventilated walls will not be sealed at vent locations (weep holes).
- Openings in the ceiling need to be sealed with appropriate materials. Sealing holes and cracks in the ceiling should be considered by-pass sealing and completed..
- In visible areas sealing material should be similar to the existing material, especially for a large area.
- When accessible, all holes and penetrations in top and bottom plates will be sealed.
- When accessible, sewer and drain vents need to be sealed where they penetrate the ceiling.
- Furnace and/or water heater vents need to be sealed with metal where it penetrates the ceiling.
- Caulk or other sealants should be used for small cracks and blend with surface applied to.
- Air Sealing through Bottom Board (underbelly)
 - Patching material will be provided as needed to meet the specific characteristics of the bottom board material and the characteristics of the hole
 - Install patching material over all holes lapping a minimum of 3" over the surrounding material

- Apply a continuous bead of sealant under the patch that creates an airtight seal
- Attach patches using outward clinch staples ("cinch staples") spaced no more than 2" apart
- Rigid patching materials used to patch any hole larger than 1 square foot must lap over the sub-framing on at least two edges
- For rigid patching materials, attach patches using mechanical fasteners spaced no more than 6" apart and use mechanical fasteners that incorporate washers/caps that prevent fasteners from being pulled through belly material
- Patch will have a service life of a minimum of 20 years
- Patching will be provided as needed to meet both the specific characteristics of the bottom board material and the characteristics of the hole
- Patch will not bend, sag, or move once installed
- Combustion air supplies will be labeled for identification and will not be blocked or sealed
- Penetrations will be sealed to meet both the specific characteristics of the bottom board material and the characteristics (hole size and type) of the penetrations (e.g., electrical, PVC, gas line, dryer vent)
- Air sealing Large Sections through Bottom Board (underbelly)
 - Select materials that adequately support applied load and are permanent air barriers, and meet the requirements of the applicable fire safety code (e.g. thermal or ignition barriers).
 - Attach belly material at opposite ends of spanned section using rigid support material (i.e., wooden furring strips)
 - Attach belly material to rigid support material by wrapping it around the rigid support material a minimum of 2 times and mechanically fastening every 6"
 - Attach rigid support material to belly at every joist or at a maximum of every 2' with mechanical fasteners that penetrate the substrate a minimum of 1-1/2"
- Air Sealing through the floor
 - Floor repair material will meet or exceed strength of existing floor
 - Repair will span from joist to joist and blocking added as needed to support the floor (patches smaller than 144 sq. inches will not require joist to joist).

Manufactured home skirting installation and/or repair is not an allowable program cost.

4020 WATER HEATER MEASURES

STANDARD

In order to achieve a safe and reliable hot water delivery system that meets the needs of the occupant/building management/building operations staff at the lowest possible life-cycle cost, the domestic water heater and pipes will be inspected for possible upgrade.

SWS 7.8101; 7.8102; 7.0201.1

4021 Water Heater Turn-Down

Energy Auditor/Inspector

- Savings can be achieved by reducing the temperature setting.
- Examine the temperature setting on the gas valve or thermostat.
- Consult with the client to determine if the temperature can be lowered to 120°F without affecting the client's lifestyle.
- Provide consumer energy education to the client regarding the management of hot water usage.

4022 Water Pipe Insulation

SWS 7.0301.1

Energy Auditor/Inspector

Pipe Insulation

- Determine if there is insulation present on the hot and cold-water lines leading to the water heater.
- If pipe insulation is not present on the first six feet (6') of the hot and cold-water lines, it should be installed if determined cost effective by NEAT/MHEA (6' on the hot water line and 6' on the cold-water line).
- Do not insulate leaky pipes.

Heat Tape

- Heat tape is an allowable program expenditure; however, it is not recommended.
- If the client does not have heat tape applied or has heat tape that is deteriorated or unsafe, then it is preferable to install new.
- The agency must obtain the client's permission, in writing, to install the heat tape, an acknowledgement that the heat tape is not permanent, or guaranteed to stop frozen pipes, and the agency is not liable for any damage caused by the heat tape installation.
- Heat tape is only to be installed outside the structure from the ground to the structure underbelly (under no circumstances should it be installed inside the structure).
- These general guidelines apply:
 - Do not install heat tape on leaking pipes.
 - Heat tape should not be used over thermal insulation.
 - Instruct the client to check the heat tape at least once a year.
 - Check for existing ground fault circuit interrupter receptacle (GFCI). If none, one must be installed.

WX Worker

Pipe Insulation

- All material must have a flame spread rating of 150 or less and a smoke density of 50 or less.
- All materials used must be capable of withstanding continuous 180° operation.
- Pipe insulation must be pre-formed to fit standard pipe diameters and be appropriate for the pipe being insulated. Insulation must be R3 with vapor retarder
- Insulate the first six (6) feet each of cold and hot water pipe.
- Drain lines, valve handles, or control and safety devices must not be covered. Water heater pipe wrap that is installed shall not interfere with the temperature pressure relief valve or any other safety devices.
- Position slit downward on horizontal pipe.
- Insulation must not be compressed or allowed to gap open.
- Secure with non-slipping plastic ties. Locate ties 1" from each end and a maximum of 12" between.
- Self-adhesive pipe wrap is allowed within set expenditure limits. Non-slipping plastic ties are not required when self-adhesive pipe wrap is installed.
- Pipe wrap shall not be installed within 6" of flue or draft hood, unless the unit is power-vented

Heat Tape

- In every case, follow the manufacturer's installation instructions.
- Install according to instruction. Not all heat tape can be used over plastic pipes.
- Heat tape must be plugged into a ground fault circuit interrupter receptacle (GFCI). Some manufactured homes will have a factory installed GFCI outlet under the home, near the water inlet.
- Start at the plug end, next to the GFCI outlet.
- Use the correct size (length) for the job – do not wrap the heat tape over itself and no 90° bends.
- Unless the instructions indicate otherwise, the maximum length is 40'.
- Use a laboratory tested heat tape. If installing for a manufactured home, use one authorized for a manufactured home.
- Use only an automatic thermostatically controlled heat tape.
- Run the heat tape along one side of the pipe or wrap the heat tape around the pipe as you go (follow installation instructions for spacing).
- Attach the heat tape according to instructions or if not in the instructions, use electric tape.
- Do not install heat tape on leaking pipes.
- Do not cross the heat tape over itself.

- Try to install the heat tape on all exposed pipe, ending as close to the ground as possible.
- If instructions allow, insulate the pipe and heat tape per instructions.

4023 Low-Flow Showerheads and Faucet Aerators

SWS 7.0201

Energy Auditor/Inspector

- Examine plumbing fixtures to determine whether low-flow devices are present.
- Consult the client to determine whether low-flow devices can be installed in the shower and at sink fixtures.
- Features will be selected that meet any special needs of the occupant (e.g., shut off, swivel, handheld showers).
- Faucet aerators do not need to be included in the NEAT audit as a measure.

WX Worker

- Low-flow showerheads shall be rated at a maximum of 2.0 gallons per minute at 80 pounds per square inch.
- Aerators shall be rated at a maximum of 1.5 gallons of water per minute.
- Care must be taken not to mar the finish of the showerhead or any connecting pipe.
- Aerators are to be installed finger tight.
- Once installed, high-efficiency showerheads or faucet aerators will be tested to determine if equipment is tightened adequately to prevent leakage at the point of connection.
- Specific information about proper maintenance of the equipment will be provided to the occupant.
- Warranty information, operation manuals, and installer contact information will be provided.

4030 Windows and Doors

SWS 3.0102.3 3.0201

Energy Auditor/Inspector

- Doors and windows which are missing or severely deteriorated should be considered for replacement by using NEAT/MHEA.
- Pictures showing the reason for replacement must be included in the house file. If pictures are not in the file, the measure will be considered a disallowed cost.
- All houses should have two operating doors (doors that open and close). If a home has only one door, weatherization will not cut a hole for a second door.
- Some measures may require a SHPO review.
- Manufactured houses must have two operating doors.
- Materials for manufactured housing will be selected to comply with manufactured housing rules and regulations (e.g., Manufactured Housing Institute).
- All manufactured house egress doors and windows will be operable as required by local code.
- Manufactured Home Interior Storm Windows
 - Fixed interior storm windows will not be installed in egress locations.
 - Operable interior storm windows will be installed in accordance with manufacturer specifications.
 - Interior storm windows will be operable and egress rated in egress locations.
- Manufactured Home Window and Door Replacement
 - Replacement windows will be designed for manufactured home use and will be ENERGY STAR® qualified.
 - Window and door units will be installed in accordance with manufacturer specifications
 - Egress windows will only be replaced with egress windows.
 - Replacement doors will be designed for manufactured home use or be pre-hung steel door and ENERGY STAR® rated.

Some measures may be considered by NEAT/MHEA for ECM or entered as infiltration. The energy auditor must identify, for reporting purposes, which category is to be charged for these items.

WX Worker

Windows

All replacement windows must be thermal pane units, if allowed by SHPO, except in manufactured homes. Individual sash replacements may be ordered to match the existing sash.

Basement

- 2"x8" or other wood is to be used to replace rotting or missing basement window jambs.
- All wood installed for framing is to be treated lumber to prevent rot.
- All wood is to be securely fastened to the foundation.
- Basement window replacement shall include sash, hinges, latch, weatherstrip, and stops to make the window airtight.
- A small, smooth bead of caulk shall be applied around new window frames.
- All window work is to be neat in appearance.
- Caulking a basement window shut or covering it with plywood is only allowed with written permission from the client. If covering a window, treated plywood must be used.

Sash Replacement

- Replacement sash may be either wood or vinyl replacement installed as per manufacturer's instructions.
- The wood forming the sash must conform to ASNI/NWWD 1.S. 2-97.
- The lower sash must have the same bevel on the bottom rail as that of the sill.
- The top sash is to be caulked in place if the old top sash was caulked, painted shut or with client permission.
- Sashes are to be painted or varnished to match the existing sashes.
- New sashes are to be installed in a manner as to allow the lower sash to stay in an open position when raised and down when closed. The client should be able to open and close sash easily.
- MANUFACTURED HOME
 - Replacement windows will be designed for manufactured home use and will be ENERGY STAR® qualified.

Doors

Exterior

- All exterior replacement doors shall have a solid core of wood, wood particle, or foam. Whenever possible, 1¾" thick doors are to be used.
- All new wood doors are to operate smoothly, be sanded, and be painted or varnished to a smooth water-repellent finish. Pressure-treated wood is to be left unpainted.
- Doors shall have a 5° bevel cut on the bottom to form an airtight seal between the bottom of the door and the vinyl gasket of the threshold.
- When the inner core of any door (exterior or interior) is exposed during cutting or planing, the door must be re-cored. The newly installed stile or rail must be glued in place, sanded, and the edges of the veneer rounded.
- MANUFACTURED HOME
 - Replacement doors will be designed for manufactured home use or be pre-hung steel door and ENERGY STAR® rated.

Pre-Hung

- If a pre-hung door is needed, either a wood or steel foam-filled door may be used.
- All doorjambs must receive at a minimum, shims behind each hinge and lockset and any other area needed to support the doorjamb and ensure the reveal is the same all around the door.
- New jambs must be trimmed out to match any existing interior and exterior trim.
- Galvanized casement nails must be used, countersunk, and filled.
- All doorsills installed must be flush with the floor of the house.

Door Lights

- Door lights should only be installed when the client asks for them. Whenever possible peepholes should be used instead of door lights.
- Door lights should be installed to the height of the client. If the glass is more than 100 square inches it must be insulated glass.
- The glass in the door light must be tempered glass.

- Door lights are to be installed so the screws are to the inside of the home.
- WX Worker is to place a small bead of caulk around the frame of the door light to make it air and watertight.
- Door lights are to be installed in accordance with manufacturer's recommendation.

Locksets

- New locksets & passage sets may only be installed on doors that determine the thermal boundary of the house.
- New doors shall have a new lock installed (whenever possible a 2³/₄" backset should be used unless using a pre-hung door that is pre-drilled for a 2 3/8" lockset). The client is to receive all keys. Minimum of two keys for the lockset.
- Lockset is to be installed between 36" and 39" from the floor.
- A passage set may be used for interior doors being installed.
- The (rose) cover plates are to completely cover the hole drilled for the lockset cylinder.
- Faceplate and strike plates are to be mortised flushed with the wood of the door and jamb. Screws are to be installed straight and be flush with the face and strike plates.
- Strike plates must be installed to allow the door to latch easily but with minimum play between the door and stop.

Grade Entrance SWS 3.0102.3c

- Openings wider than three feet or longer than eight feet shall have two doors installed instead of one large door.
- Grade entrance doors are to be made of shiplap, car siding or 1" x 4" tongue and groove lumber. Doors more than 6 square feet must be framed on the bottom side of the door using a 1" x 4" or 1" x 6" across the entire width of the top and bottom, then the two sides, then the center, forming what looks like two square frames, after which a 1" x 4" or 1" x 6" is placed in each of the two square frames on diagonal from the hinge location to the center of the opposite edge.
- All framing lumber is to be installed with glue and screws. The vertical joints of the car siding are not to be glued.
- Grade doors are to receive three new "T" hinges (minimum of 5") and a handle.
- Where possible, some form of a drip cap should be installed at the top of the door to help shed water.
- Steel doors at grade level are still considered a grade door.

Lower Grade Add SWS 3.0102.3c

- Lower grade entrance doors are to be made of shiplap, car siding or 1" x 4" tongue and groove lumber or 3/4 inch treated plywood. Doors more than 6 square feet must be framed on the bottom side of the door using a 1" x 4" or 1" x 6" across the entire width of the top and bottom, then the two sides, then the center, forming what looks like two square frames, after which a 1" x 4" or 1" x 6" is placed in each of the two square frames on diagonal from the hinge location to the center of the opposite edge. Any door over 6' in height needs at least 3 hinges equally spaced.
- A flush surface must be touching the weatherstrip.
- All framing lumber is to be installed with glue and screws. The vertical joints of the car siding are not to be glued.
- Steel or solid core slab doors may also be used.
- A lower grade entrance door must have a latching device. Keyed locksets are preferred but barrel bolts or hook & eye are acceptable. If there is an entrance to the basement from the lived-in portion of the house, a keyed lockset must be used.
- All doors are to operate smoothly, be painted or stained to a smooth water-resistant finish, and be neat in appearance. Pressure-treated wood is to be left unpainted.
- Steel doors at grade level are still considered a grade door.

Hinges

- New 1³/₄" doors shall receive three (3) new 4"x4" butt hinges. New 1 3/8" doors shall have three (3) new 3¹/₂" x 3¹/₂" butt hinges that are mortised into the door and jamb.

- When installing a new door and jamb, the hinges are to be placed at 7" from the top of the door, 11" from the bottom of the door, and the third hinge centered between the top and bottom hinge.
- The veneer shall not be removed from the back edge of the hinge gain.

SECTION 5000 INSULATION MEASURES

5010 ATTIC

STANDARD

A consistent thermal boundary between conditioned and unconditioned space controls the heat flow. Attic insulation serves to control heat transfer through ceiling. Insulation will be installed to maximum depth allows by NEAT.

SWS SWS2.0301.1,2 3.0102.2 3.0102.9 3.0103.1 3.0104 4.0101,2,3,4 4.0188.2a;

5011 Attic Air Sealing

- Verify the presence of an effective air barrier and thermal boundary between the attic and living space
- All attic by-passes must be sealed before insulating the attic. (See [Section 4010](#))
- Photo or other visual documentation must be taken of **all** by-pass sealing work and any other measures that will be covered by insulation.
- Photos must be taken prior to and after weatherization measures are installed and must be maintained in the house file.

5012 Attic/Roof

- Rigid fill tubes will be made of a material that will not hold an electric charge, such as Schedule 40 PVC Electrical Conduit, or be grounded.
- For an additional level of protection, the metal coupler on the hose will be connected to a grounding wire.
- Grounding wire will be connected to the grounding rod.

Energy Auditor/Inspector

EXTERIOR:

- Identify the exterior roofing material type(s) (asphalt shingles, roll roofing, metal, slate, etc.).
- Examine for missing, damaged, or worn surfaces.
- Note obvious damage.
- Examine the building for moisture problems. Note any obvious damage and determine if the weatherization program can repair it or if the damage is beyond the scope of the program.
- Inspect the gutter and downspouts, if present. Determine whether the lack of an effective gutter system is causing moisture damage to the home. This may be remedied using the General Health and Safety Repair funds within program cost limits.
- Note the presence of existing attic ventilation (roof vents, soffit vents, gable vents, ridge vents). Based on minimum venting of one (1) square foot of free airflow for every 600 square feet of attic floor space, determine if additional vents are needed. Natural ventilation may be considered as part of the free airflow.
- Diagram where vents are to be installed and list types. Do not install vents on steel, rubber, or slate roofs or slate siding.
- Vents should be installed to allow for high and low ventilation. Soffit vents should be installed as first choice if possible, with gable and roof vents as second choice. Turbine and power vents are not allowed.

HOUSE INTERIOR

- Note any interior plaster or drywall damaged due to moisture from roof leaks. Do not specify insulation where it may come in contact with any moisture until the problem is solved.
- Determine if the circuits are properly fused.
- Note the location and size of any existing attic access, interior or exterior. If there is no access, the Energy Auditor must call for an opening large enough to access (see [Section 5013.02](#)). The Energy Auditor must determine where the access needs to be located and obtain client approval to build it.
- There are two options for insulating walk-up attics. The Energy Auditor will need to make this decision. The first is to install an attic lid at the top of the stairs putting the stairway inside the thermal boundary. The other is to consider the stairway and walls part of the thermal boundary and insulate.

- Note any stored boxes or objects that may obstruct the weatherization work. Consult with the client about removing obstructions. If the client is unable or unwilling to remove the obstructions, determine if it is feasible for the weatherization workers to remove the obstruction and obtain permission from the client. A deferral may be needed if the obstructions cannot be moved.
- Document the presence and location of interior soffits, wall height changes, pocket doors, drop ceilings, open closets or cabinets, or other construction details that would require alternative installation methods.
- Note the existence of recessed lighting which will require damming materials or enclosures.

ATTIC INTERIOR

- Record the type and amount of existing insulation in all attic areas. If existing insulation is vermiculite, see [Section 2153](#) for procedures.
- Note all voids and areas with incomplete coverage and average the total amount.
- Measure the floor area and enter the area and the amount of existing insulation in the NEAT Audit.
- Note existence and dimensions of any floored attic areas.
- Require additional insulation based on NEAT audit results.
- Note all possible heat sources which will require damming materials. All damming materials must be installed at least 3" from the heat source.
- All damming materials must be higher than the level of the surrounding attic floor insulation.
- Damming material around a heat source must be at least 4" greater than the insulation.
- Note other areas which will require damming materials (e.g., attic access).
- Insulation will not be allowed between the damming and a heat-generating appliance.
- Examine the chimney for soundness. Note all chimney structural problems and inform the client. Minor repairs must be completed by the program.
- All disconnected non-functioning chimneys in the attic which have been taken down below the roof line must be sealed using proper materials.
- Examine all metal flues for soundness. Record any loose or disconnected sections for repair. Check stabilizing devices for effectiveness.
- If soffit vents exist, note the presence of existing soffit vent chutes and note how many will need to be installed.
- Note the type of wiring present in the attic.
- Note all exposed electrical junctions and whether they are enclosed in covered junction boxes. Junction boxes must be covered. It is required that a flag protruding from insulation is installed to easily identify the location of a junction box.
- Determine the overall integrity of the wiring and insulation or any other electrical condition which must be corrected before installation of insulation.
- Houses with knob & tube wiring:
 - Must have S-type fuses installed to provide overcurrent protection. A rule of thumb is to use 15-amp fuses for 14-gauge wire and 20-amp fuses for 12-gauge wire. Explain to the client the importance of properly fused circuits.
 - Live knob and tube will not be covered or surrounded.
 - A dam that does not cover the top will be created using unfaced fiberglass batt to separate insulation from the wire path. A distance of 3" away from the wiring must be maintained.
 - A dam shall be created using un-faced fiberglass batts at least 14 inches in width and equivalent to the R-value of surrounding attic floor to prevent attic insulation from covering the wiring.
 - The balance of the attic may be blown to required insulation depth without covering any knob & tube.
 - If the knob and tube wiring goes through the joists, do not insulate below the wiring, just create the dam as described earlier.
 - If the knob and tube wiring goes above the joists, insulate under it if possible to maintain 3" separation.
- Record all electrical devices which will require safety clearance shielding (damming), e.g., recessed lights and vent fans.
- Determine the condition of the attic floor. Note any rotted, molded, or otherwise damaged joists or ceiling components.

- Check the integrity of the ceiling surface.
- Determine if the ceiling can hold the weight of the insulation.
- Inspect the sheathing and rafters for discoloration, mold, or rot. Note the location of any damage.
- Do not specify insulation where it may come in contact with any moisture until the problem is solved.
- If there is existing plumbing running through the attic, it needs to be isolated from the attic as well as possible and insulated.
- Record on the Health & Safety Assessment Form the presence of any animal, insect pests, animal or bird feces that may be in the attic which will pose a health threat. (See [Section 2120](#))
- Determine measures or personal protective equipment necessary to ensure safety of the weatherization workers in the attic. Refer to the Deferral Policy (See [Section 1020](#)) if the health threat is severe.
- Blown fiberglass insulation is not to be installed from the interior of the home.
- Document the location of chase ways containing utility runs or ductwork in the sidewalls, if any.
- Document the type of construction, whether it is balloon or platform framing.
- Document with photos problems areas or unusual issues.
- Setup a dust control enclosure for all interior access locations that limits insulation and construction dust exposure to the occupant and occupant belongings
- Install airtight, rigid, blocking material at all cavity openings that aligns with the pressure boundary and will not fail under dense pack pressures
- Interior will be masked and dust controlled during drilling when accessing from the interior. Shrouds and containment devices are required.
- In attics insulated by the program, an Insulation Installation Requirements certificate must be filled out by the installer and attached to the box of each attic access so it is clearly visible from the attic access. An empty bag must also be left in each attic, where it is clearly visible from the attic access. It must not come in contact with the insulation. Staple one corner to the rafter so it hangs freely.

Manufactured Homes

- During the energy audit of manufactured homes, if the energy auditor cannot physically gain access to the sidewalls and attics to determine the existing R-values, the energy auditor should use the information from the manufactured home nameplate to make the determination. If unable to physically verify existing R-values and unable to obtain information from the manufactured home nameplate, use the chart provided in [Section 5020](#) to estimate insulation R-values. Iowa is in Zone 3.
- The ceiling and roof condition must be inspected and assessed before installing insulation. Ceilings that appear weak shall be repaired or reinforced within repair cost limits.
- Verify existing insulation levels in the attic.
- All holes in the ceiling must be sealed.
- Ceiling insulation should be done when determined by the MHEA Audit, unless there are other documented circumstances that won't allow additional insulation.
- Blown fiberglass insulation is not to be installed from the interior of the home.
- Insulation shall be installed only in areas of the manufactured home envelope that separate conditioned from unconditioned space. Insulation measures can only be installed when insulation is included in the MHEA Audit and the cumulative SIR calculation is 1.3 or greater.
- If moisture problems are present in the ceiling, underbelly, or sidewalls, insulation should not be added until the moisture source and/or site of penetration, including leaks, is identified and eliminated.
- All insulation installed in manufactured housing must be fiberglass

WX Worker

5013 Attic Access

SWS 3.0103.1h

5013.01 Pull-Down Stairs

Where feasible, pull down stairs shall have a 1"x12" or 3/4" plywood or OSB box that is higher than the level of the surrounding attic floor insulation built around them to act as damming for the insulation.

- The exterior of the damming box must be insulated with 2" rigid insulation or equivalent.

- The damming box will be covered with a lid made of 1/2" (minimum) plywood or OSB with 1"x2"s on the edges to come down on the outside of the 1"x12" damming.
- Weatherstrip is to be installed either on the inside of the damming box next to the cover or on the outside of the damming box so that the cover box 1"x2"s will sit on the weatherstrip.
- Counterweights should be considered to ease accessibility for excessively heavy hatches.
- The back of the lid will be insulated to the maximum R-value structurally allowable up to the R-value of the adjoining insulated assembly.

5013.02 Attic Access Hole

- Attic hatches rough opening will be at least the width between ceiling joists and a minimum of 24" long.
- It must be surrounded with a durable insulation dam that is higher than the level of the surrounding attic floor insulation.
 - 1"x12's, 3/4" plywood, or OSB board shall be used whenever possible for the box of the scuttle hole.
 - The box must be constructed to support the weight of a person entering the attic.
- The access must be built in an area without obstructions, such as slants, chimneys, etc.
- The lid of the attic access hole shall be made of 3/4" plywood, and door stop material with coped or mitered corners used to support the lid.
- Access hatch frames will be sealed using caulk, gasket, weatherstrip, or otherwise sealed with an air barrier material. The access lid will be secured with a latch or lock.
- Window casing should be used as trim around the scuttle hole next to the ceiling.
- The casing shall be caulked with a small smooth bead of paintable caulking.
- The back of the lid will be insulated to the maximum R-value structurally allowable up to the R-value of the adjoining insulated assembly.
- The insulation must be permanently attached to the scuttle lid. No loose-fill insulation will be installed over an accessible scuttle hole.
- Fiberglass insulation must not be compressed
- New scuttle holes must have a finished opening at least the width of the ceiling joist and be a minimum of 20" long.

5013.03 Knee Wall Doors/Crawl Space doors

SWS 3.0104.2b,c,e,f,h

- Doors must be made of 3/4" plywood.
 - Access openings through the floor will be a minimum of 18" by 24" or as constrained by existing framing members
 - Openings through a perimeter wall will be not less than 16" by 24" or as constrained by existing framing members
 - When any portion of the through-wall access is below grade, an area way not less than 16" by 24" will be provided
 - Under-floor spaces containing appliances will be provided with an unobstructed access large enough to remove the largest appliance but not less than 30" high and 22" wide and no more than 20 feet away from the appliance measured along the center line of the passageway from the opening to the appliance
- The back of the door will be insulated to the maximum R-value structurally allowable up to the R-value of the adjoining insulated assembly. The insulation must be permanently attached to the door. The door must be trimmed (including paint or stain) to match the existing window and door trim.
- Door frames will be sealed using caulk, gasket, weatherstrip, or otherwise sealed with an air barrier material, suitable film, or solid material.
- Crawl space exterior door must be pest-resistant materials that are rated for ground contact anywhere they are in contact with the exterior foundation walls, piers, or bare earth
- The access door will be secured with latches.
- The plywood door must have the edges rounded, be sanded, finished or painted to match existing trim.

5013.04 Walk-Up Attic Doors

Door at Bottom of Stairs

- There are two options for this type of walk-up attic access. The Energy Auditor will determine which is to be completed.
 1. Install an attic lid at the top of the stairs putting the stairway inside the thermal boundary.
 2. Consider the stairway and walls part of the thermal boundary.
 - Weatherstrip, sweep and insulate the door.
 - Dense pack the stairway walls.
 - If back side of stairway is open, finish with ½" drywall and dense pack insulation.

Door at Top of Stairs

- The stairway walls above the level of the conditioned area will be treated as knee walls and insulated as such.
- Weatherstrip, sweep and insulate the door.
- Insulate the ceiling above the stairway as an attic.

5014 Attic Insulation – All Types

WX Worker

- Rigid fill tubes will be made of a material that will not hold an electric charge, such as Schedule 40 PVC Electrical Conduit, or be grounded.
 - For an additional level of protection, the metal coupler on the hose will be connected to a grounding wire.
 - Grounding wire will be connected to the grounding rod.
- Photo or other visual documentation must be taken of all work completed in the attic area.
- Photos must be taken prior to and after weatherization measures are installed and must be maintained in the house file.
- Insulate the attic according to the work order.
- Attic insulation is not to be installed in non-repairable attics with water leaks or damaged wiring.
- Insulation is to be installed so as to be uniform in depth throughout the attic area and installed in accordance to the R-value of the settled density on the bag.
- Insulation should be installed to cover the top plate of the outside walls without going into the soffit area, using a damming material such as fiberglass, soffit chutes, etc.
- In attics insulated by the program, the Insulation Installation Requirements certificate must be filled out by the installer and attached to the box of each attic access so it is clearly visible from the attic access.
- An empty bag must also be left in each attic, where it is clearly visible from the attic access. It must not come in contact with the insulation. Staple one corner to the rafter so it hangs freely.
- If the attic is inaccessible, the certificate must be attached within one foot of the electrical panel in the basement.
- **One certificate for each differently treated attic (left in individual attic).**
- All ventilation holes are to be cut before the installation of insulation. Whenever possible, the insulation hose should be run through a vent opening rather than through the house.
- Screens of existing vents are to be cleaned after the insulation is installed.
- Insulation dams and enclosures will be installed as required. See [Section 5014.05](#)
- Exposed open electrical junctions will have UL listed cover installed per NEC.
- All exposed electrical junctions will be marked with a flag to indicate their existence.
- Enclose all wiring splices inside a location-appropriate (e.g. wet-location, outdoor, indoor, etc.) [UL](#) listed electrical enclosure per the [NEC](#).
- Seal all major attic by-passes such as vent pipes, open interior and exterior wall stud runs, wire penetrations, chimney chase ways, area between brick chimney and flue liner, etc. (check local building codes on chimney chase ways).
- Open stud cavities and holes smaller than 6" in diameter shall be sealed with a moisture resistant air impermeable board and caulked or foamed. See [Section 4010](#) for more information on air sealing.
- Holes drilled from the interior shall be filled with non-shrinking compound and returned to a paint-ready surface
- Knob & tube wiring will be isolated from blown cellulose

- A dam that does not cover the top will be created to separate insulation from the wire path.
- Maintain a minimum of 3" of clearance around live knob and tube wiring.
- A dam shall be created using un-faced fiberglass batts at least 14 inches in width and equivalent to the R-value of surrounding attic floor to prevent attic insulation from covering the wiring.
- The balance of the attic may be blown to required insulation depth without covering any knob & tube.
- If the knob and tube wiring goes through the joists, do not insulate below the wiring, just create the dam as described earlier.
- Mark all live knob-and-tube wiring with caution tape that is visible from at least 5' away and post appropriate signage.

5014.01 Open Attic

Cellulose Insulation

SWS: 4.0103.2d; 4.0103.3,4

- Priority is given to cellulose insulation as a recycled material.
- Cellulose insulation containing ammonia sulfate must not be used because it will give off an odor if wet.
- If cellulose cannot be used because of client allergy, weak ceiling, or other reason, fiberglass may be used. See Blown Fiberglass Section
- Insulation will be adequately marked for depth a minimum of every 300 square feet of attic area, with measurement beginning at the air barrier.
- All insulation will be installed to the depth indicated on the manufacturer coverage chart for desired R-value.
- If installed over existing insulation, install to prescribed R-value in every joist bay in full contact with the existing insulation or the air barrier without gaps, voids, compressions, or misalignments
- A signed and dated attic Insulation Installation Requirements certificate attached to the 1x12 box must include:
 - Insulation type
 - Installed thickness and settled thickness
 - Coverage area
 - R-value
 - Number of bags installed in accordance with manufacturer specifications

Fiberglass Batt Insulation

- Fiberglass batt insulation will only be considered in case of a weak ceiling.
- If using fiberglass batt insulation, it will be installed in accordance with manufacturer specifications without gaps, voids, compressions, misalignments, or wind intrusions.
- Insulation will be installed to the prescribed R-value.
- When installing over existing insulation,
 - If the top of the existing insulation is below the top of the framing, new batts will be installed parallel to and between framing members.
 - If the top of the existing insulation is above the top of the framing, new batts will be installed perpendicular to framing members.
- A signed and dated Insulation Installation Requirements certificate attached to the 1"x12" box must include:
 - Coverage area
 - Thickness
 - R-value
- Clients will be informed of the type of material and R-value installed.

Blown Fiberglass

- Blown fiberglass insulation will only be considered in site-built houses in case of a weak ceiling or manufactured housing.
- These issues must be documented in the file.
- Blown fiberglass will not be used in site-built homes unless justified by the energy audit.
- If blown fiberglass is to be installed, the attic access must be closed and hoses run through a vent opening to prevent fibers from getting in the house.

- All insulation will be installed to the depth indicated on the manufacturer coverage chart for desired R-value.
- A signed and dated Insulation Installation Requirements certificate attached to the 1x12 box must include:
 - Insulation type
 - Installed thickness and settled thickness
 - Coverage area
 - R-value
 - Number of bags installed in accordance with manufacturer specifications
- Blown fiberglass insulation will be adequately marked for depth at a minimum of every 300 square feet of attic area, with measurement beginning at the air barrier.

5014.02 Floored Attic

SWS 4.0103.6

- Check for possible heat-producing sources going through the ceiling and the floor. Care should be taken not to insulate over and around heat producing sources when tube insulating attic areas unless using blown fiberglass.
- If cellulose is used, it must be dense packed under 100% of the floor (3.5 lbs. /ft³). Dense-pack insulation must be done by using the tube-fill method if there is existing insulation floor. If floorboards are removed they must be reinstalled.
- Blown fiberglass will only be installed if justified on the audit. Blown fiberglass material will be installed and will be specifically approved for air flow resistance to a minimum density of 1.5 to 2 pounds per cubic foot.
- The one-inch hole method can be used when there is no insulation under the floor. When using the one-inch hole method, holes are not to be more than 3 ft. apart, and all the holes must be plugged with wood or plastic plugs.
- No insulation may be added over the floor of a floored attic.
- On a case-by-case basis, with prior State approval, agencies may be allowed to blow over floored attics, if the floored attic has K&T under the boards. Floor boards must be pulled up in order to seal the ends and the bypasses. Photo documentation must be taken prior to and after sealing below the floorboards. This work should be entered into the NEAT Audit as open blow.
- The first priority with a floored attic is to seal by-passes and dense-pack under the floor. By-passes such as open stud runs must be found and sealed at the air barrier prior to insulating under floored attic. See [Section 4010](#) for more information on air sealing.
- If the entire attic is floored, the ends of the joist cavity must be stuffed or sealed to prevent the dense-packed insulation from blowing into the soffit area.
- A signed and dated Insulation Installation Requirements certificate attached to the 1x12 box must include:
 - Insulation type
 - Installed thickness and settled thickness
 - Coverage area
 - R-value
 - Number of bags installed in accordance with manufacturer specifications

5014.03 Knee Wall

SWS 4.0104.1d,e,f,g,h;

- The un-floored portion (outer ceiling joist) of the knee wall area shall be insulated to the R-value called for by work order. (See [Section 5014.01](#))
- Un-floored knee walls (outer ceiling joist) must be sealed between each joist at the wall joint with a rigid air impermeable material and sealed.
- The remainder or exposed portion of the knee wall floor shall be insulated as if it were an attic area. (See Attic Insulation)
- Floored knee wall areas shall be insulated by either removing the necessary number of boards to allow tube-filling or the floor may be drilled with 1" holes every 3' and insulated, using a 1" nozzle, and plugged with wood or plastic plugs.
- All wood removed for tube-filling, must be reinstalled. (See [Section 5014.02](#))

- Acceptable methods to insulate wall areas of the knee wall include: fiberglass batts, rigid foam or reinforced poly with dense pack cellulose or two-part closed cell polyurethane foam. These methods are described below.

Method 1 - Fiberglass Batt/Repair

Fiberglass batt is only allowed in knee walls up to 3 feet tall

- Wall area shall be insulated with R-11 OR GREATER faced fiberglass batts. If there is drywall with plastic behind it, use unfaced fiberglass batts instead.
- The batts must be installed so the vapor barrier is toward the winter heated side of the wall.
- Existing batt insulation must be adjusted to ensure it is in full contact with the interior cladding and top and bottom plates.
- Fiberglass batt insulation must be secured to prevent settling or moving.
 - Pre-existing fiberglass batts installed backwards should have the vapor barrier slit.
 - Fiberglass batts must also be backed with moisture permeable materials, such as house wrap, with the label to the outside to allow moisture to escape.
 - Prior to installing house wrap, photo documentation must be taken of the insulation and maintained in the house file.

Method 2 – Dense Pack Cellulose Using Rigid Foam or Reinforced Poly (PREFERRED METHOD)

Dense pack insulation must be installed in all knee walls over three feet tall

Rigid insulation board material or reinforced poly/house wrap will be installed to cover 100% of the surface of the knee wall.

- It is then drilled or slit and cellulose is dense-packed into the knee wall stud cavities.
- If foam sheathing is used, sheathing will be listed for uncovered use in attic, or covered with a fire barrier
- Reinforced poly or a material similar to house wrap may be installed to the studs of the knee wall area. The poly will be secured according to manufacturer's specifications or with furring strips on every wall stud before dense packing.
- Fill 100% of each cavity with insulation to the correct density that prevents air movement
- Install closure system over all access holes that is airtight and permanent

Method 3 - Two-Part Closed-Cell Polyurethane Foam

Only use if local codes permit

- Manufacturer's guidelines must be followed for recommended use and application, temperature tolerances, shut down procedures and storage.
- Two-part closed-cell polyurethane foam must be rated as Class 1 Fire Retardant. The card/certificate from the box must be left with the insulation foam because it identifies the foam as fire retardant.
- Must be installed 2" thick.
- If attic is used only for the service of utilities, foam will be separated from the attic space using a suitable ignition barrier covering or coating according to manufacturer's specifications
- If attic is used for storage or occupancy, spray foam will be separated from the attic space using a thermal barrier material (e.g., 1/2" gypsum wallboard) as specified by applicable building code and manufacturer specifications
- If code requirements are unclear, consult local code officials for clarification
- Insulation must be neat in appearance and of a consistent depth.
- When cost effective according to the NEAT Audit, the two-part closed-cell polyurethane foam may be installed at the Energy Auditor's discretion.
- If installed in a confined space, there should be a negative pressure in the area. Follow NIOSH Standards regarding the definition of a confined space.
- Recommend tenants, especially children, vacate the premises while being installed and for one hour (or as long as the manufacturer recommends) after completion or until all VOC gases are gone.
- Weatherization workers must wear a NIOSH certified respirator as well as eye and skin protection as specified in the product SDS.
- Clean up any overspray or excess of the two-part foam.
- Do not use it in areas with knob and tube wiring.
- Do not cover electrical boxes.

5014.04 Sloped Attics/Flat Roof

- Dense pack ceiling slants by tightly stuffing with fiberglass or some other stuffing material at either the top or the bottom of each run.
- Holes drilled from the interior shall be filled with non-shrinking compound and returned to a paint-ready surface
 - Setup a dust control enclosure for all interior access locations that limits insulation and construction dust exposure to the occupant and occupant belongings
 - Install airtight, rigid, blocking material at all cavity openings that aligns with the pressure boundary and will not fail under dense pack pressures
- Each cavity must be insulated with dense-packed cellulose insulation (3.5 lbs./cubic foot) by tube-filling the cavity. Blown fiberglass material may also be installed to a minimum density of 2.2 pounds per cubic foot.
- If the sloped areas have existing fiberglass insulation or loose-filled cellulose, the top and the bottom of each cavity must be sealed, if possible, instead of re-insulating.
- If both top and bottom cannot be sealed, one or the other must be sealed to prevent convective looping in the cavity. See [Section 4010](#) for more information on air sealing.
- Small ceiling areas such as over bay windows or flat roof areas are to be insulated with dense packed insulation.
 - This can be done by drilling or removing the fascia board and tube-filling each cavity.
 - Ventilation is not needed when dense packing flat roofs.
- A signed and dated Insulation Installation Requirements certificate attached to the back of the kneewall door must include:
 - Insulation type
 - Installed thickness and settled thickness
 - Coverage area
 - R-value
 - Number of bags installed in accordance with manufacturer specifications

Manufactured Homes

SWS 4.0103.9; 4.0103.13

- Create access to attic by removing existing gable vents or installing new gable vents on each gable of the home that are large enough for access to install insulation correctly
- All holes in the ceiling should be sealed.
- Blown fiberglass with a flame spread and smoke development index of 25/450 or less when tested in accordance with ASTM E84 or UL 723 is to be used for the insulation.
- Average insulation densities for loose-fill fiberglass insulation installed in manufactured home ceiling cavities shall be 1.25 to 1.75 pounds per cubic foot.
- Cellulose must not be used because weight and moisture absorption.
- Ventilation fans may be covered with insulation if all holes and penetrations are sealed with a nonflammable sealant.
- Recessed lighting fixtures and fan/light combinations that are Type-IC rated by UL may be covered with insulation.
- Fiberglass insulation shall not be installed within 3 inches of metal flues, chimneys, heaters, fans, and lights that are not Type-IC rated.
- Combustion appliance vent blocking is required when insulation is installed, except where combustion air is pulled through a combustion air pipe that surrounds the combustion appliance vent pipe (concentric pipe system). Follow manufacturer's recommendation for clearances between vent and combustible insulation.
- Ceiling insulation must be installed in such a manner that ensures complete coverage over heated areas.
- Attic insulation will not be installed if the furnace draws fresh air from the attic.
- During the energy audit of manufactured homes, if the energy auditor cannot physically gain access to the sidewalls and attics to determine the existing R-values, the energy auditor should use the information from the manufactured home nameplate to make the determination. If unable to physically verify existing R-values and unable to obtain information from the manufactured home nameplate, use

the chart provided below to estimate insulation R-values. Iowa is in Zone 3. See [Section 5020 Manufactured Homes](#)

- Manufactured home ceilings shall not be dense packed or over-filled so as to create ceiling structural problems.
- Whenever possible, ceiling insulation is to be done from the outside by lifting the roof from the edge and using the tube method. Insulation may also be installed from the ends.
- Exterior insulating may also be completed using the tube-fill method through holes opened in the roof, making all areas of the ceiling accessible by the tube-fill method. This is not the preferred method for insulation manufactured home attics.
- If an exterior installation method or side-opening method is used, all roof penetrations and areas of potential leakage must be sealed with elastomeric sealant (when compatible with roof materials), or with other equivalent sealant, as necessary. Areas that are to be patched must be cleaned to the metal roof surface.
- Blown fiberglass insulation is not to be installed from the interior of the home.
- Some manufactured homes might have a gabled roof constructed over the original one. In this roof-over attic space, the following will be followed:
 - Attic space created by the roof-over will be accessed in accordance with the single-family attic access.
 - If the roof-over does not allow physical access to the roof-over attic, access to the original attic will be gained through roof venting.
 - If existing insulation height in the attic is less than the height of the heel plate (original attic), access will be made through the original roof and the original attic cavities will be filled before blowing insulation over the original roof.
 - At a minimum, the access holes to the original attic cavities will be sealed to prevent air leakage.
 - If existing insulation height is equal to or greater than the height of the heel plate (original attic), the insulation will be installed in the end cavities before blowing on top of the original roof.
 - Access to the end cavities will be gained and insulation will be installed.
 - Insulation will not be installed on top of the original roof until the end cavities are insulated and air sealed in the original attic.
 - If insulation is installed on top of the original roof, it will be installed in accordance with the single-family loose-fill blown insulation installation standard.
- A signed and dated Insulation Installation Requirements certificate must include:
 - Insulation type
 - Installed thickness and settled thickness
 - Coverage area
 - R-value
 - Number of bags installed in accordance with manufacturer specifications

5014.05 Damming – Heat Sources

- Insulation dams and enclosures will be installed as required.
- Damming material must also be around all heat sources in the attic, such as flue pipes, chimneys, mechanical ventilation (unless Type-IC rated), and recessed lights (unless Type-IC rated) whether insulation is being installed or not.
- All damming materials must be installed at least 3" from the heat source.
- Do not insulate over an existing fan with a light or heat source that is not Type-IC rated; damming materials must be installed around the heat source.
- A rigid dam having a height at least 4" greater than the insulation to be installed will be constructed to ensure a 3" clearance between combustion flue vent and dam.
- Damming material must be metal that is at least .007" thick, or a nonflammable material meeting local codes.
- Damming material is to be permanently attached to the ceiling joist with staples, nails, or screws.
- If local codes allow, brick or masonry chimneys that have liners must be sealed, but need not have damming installed around them.
- If an unlined chimney or B-vent goes through the roof and is not in use, damming material is to be installed in case the chimney is later used by the client.
- Chimneys, which do not go through the roof, must be sealed at the top with metal and caulk.

5015 Attic Venting

SWS 4.0103.2c

- Although the preferred strategy for attic moisture is prevention through attic by-pass sealing, attic ventilation may be used as a last resort for removing moisture. Relatively dry outdoor air can be used to ventilate attics to remove moisture that accumulates from roof leaks, air leakage from the interior, and vapor diffusion.
- All attic ventilation will have screens with non-corroding wire mesh with openings of 1/16" to 1/4" to prevent pest entry (e.g., birds, bats, bees).
- Existing vents that are not screened will be covered with non-corroding wire mesh with openings of 1/16" to 1/4".

Gable Vents

- New gable vents must be installed with a frame appropriate for the type of siding on the house. Vents must be installed according to manufacturers' recommendations and be neat in appearance.
- Gable vents on wood sided houses must be installed with a brick molding frame.
- The brick molding frame must be installed so the siding butts up to the edge of the frame (the frame does not go over the siding).
- The joint between the siding and frame shall be caulked with a paintable caulk and be neat in appearance.
- Vents are to be fastened to the frame with screws.
- Any siding damaged during vent installation is to be repaired or replaced.
- If there is no attic access in the home, a large enough gable vent must be installed with hinges to allow for entrance into the attic.
- If there is no sheathing, a 2x4 frame must be built on the attic side of the siding to attach the vent frame.

Roof Vents

- Roof vents are to be made of galvanized steel or plastic.
- Based on the minimum venting of one (1) square foot of free airflow for every 600 square feet of attic floor space, determine if additional vents are needed. Natural ventilation may be considered as part of the free airflow.
- Roof vent holes are to be cut to close tolerance to ensure the maximum free airflow and water tight fit. Rafters are not to be cut. Roof vents are not to be installed over rafters.
- Roof vents are to be installed as high as possible on the roof (bottom edge in line with the 4th course of shingles).
- The top edge of the vent must be inserted under the shingles. The sides of the vent should be inserted under the shingles if possible.
- Roof vents are to be sealed with tar under the vent and nailed with neoprene washer aluminum nails.
- Tar should not be visible on installed roof vents or the roofing around them.
- Vents are to be evenly spaced and be neat in appearance.
- Placement of vents is to be in accordance with the drawings on the work order.
- Discarded materials are not to be dropped into the attic area.
- The color of the roof vent is to match or compliment the color of the shingles.

Soffit Vents

- Soffit vents are to be installed square with the house, evenly spaced and a uniform distance from the house.
- Vents are to be screwed to the soffits (staples and nails are not acceptable for installing soffit vents) with the louver opening facing the house.
- The hole cut for the vent is to be cut with close tolerance to assure maximum free airflow.

- If soffit venting or eave venting is present, soffit vent chutes will be at least 6" above the final insulation level and mechanically fastened to block wind entry into insulation or to prevent insulation from blowing back into the attic.
- If soffit venting or eave venting is present, chutes will be installed to maintain clearance between the roof deck and baffle in accordance with manufacturer specifications.
- Installation will allow for the highest possible R-value above the top plate of the exterior wall.

5020 SIDEWALL INSULATION

STANDARD

Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value through dense pack insulation when determined cost effective by the NEAT Audit. Use of cellulose insulation is required unless structural issues are identified. Dense pack insulation is to be installed using a machine with an airlock system and capacity to blow a minimum of 3.5 psi. In order to achieve the required dense pack, cellulose insulation must be blown at 3.5 pounds per cubic foot density (approximately one (1) pound per square foot in a 2x4 wall).

SWS SWS4.0201 4.0102

FIELD GUIDE

Energy Auditor/Inspector

- Note all types of siding material. Wherever possible, determine the presence and condition of the previous layer of siding or sub-siding.
- Exterior walls are not to be insulated if they have wood or composition board lap siding with no sheathing.
- When siding is at or below-grade, fiberglass insulation must be installed in the wall cavities. Only the below-grade cavities are to be insulated with fiberglass.
- Note whether siding material contains asbestos or lead paint. If so, determine whether the siding can be safely removed or drilled using Weatherization Safe Work Practices (See the *Iowa Weatherization General Appendix*).
- If a house has walls which are open (either no plaster/drywall inside or siding outside) the Energy Auditor should consider deferring all work on the house as beyond the scope of the program.
- Depending on the application method of installing wall insulation, the Energy Auditor will decide if the siding should be drilled or removed.
- Sidewalls with active knob & tube wiring will not be insulated.
- Vinyl, steel and aluminum siding which is not under warranty shall be removed.
- Vinyl, steel or aluminum siding, which is under warranty, may be removed with client written permission.
- Vinyl, steel, aluminum, etc. siding may only be drilled at the discretion of the client and Energy Auditor.
- If siding cannot be removed it may be drilled with written client permission.
 - When using 1" holes, there shall be at least three (3) holes per eight-foot (8') cavity.
 - The upper hole should be drilled at the pressure point in order to ensure good compaction of the insulation in that area.
 - Plugs must be wood or plastic, unless the house is stucco (see below).
 - All plugs used shall be painted to match the siding prior to their installation.
 - All plugs must be sealed in place.
- Vertical or Masonite siding may be drilled using either the one-inch method or with a hole large enough to allow the tube-filled dense-pack method.
- Stucco siding penetrated from the exterior side of the wall shall be retextured and painted to match the existing stucco on the house.
- All insulation installed through the interior side of the wall requires prior written approval by the client.
- Interior will be masked and dust controlled during drilling when accessing from the interior. Shrouds and containment devices are required.
- Blown fiberglass insulation is not to be installed from the interior of the home.
- Note any area with exterior moisture damage, including missing or rotted siding or siding with excessive deteriorated paint, or other problems.
- Note the condition of any exposed structural components for structural integrity.
- All structural and moisture problems must be corrected prior to insulating the walls.

- Document the location of chase ways containing utility runs or ductwork in the sidewalls, interior soffits, wall height changes, pocket doors, drop ceilings, open closets or cabinets, or other construction details.
- Wall cavities open to return air supplies are to be sealed so the cavity may be insulated.
 - The upper story returns are to be blocked off.
 - The return air supply is to be routed through the home, and an adequate air supply and a balanced system are required.
 - Return registers in exterior wall cavities on the first floor must be sealed directly above the register.
- Determine if the walls are balloon framed. The top of the cavities must be stuffed or sealed if the walls are to be dense-packed.
- If the walls will not be insulated by the program, the top of the cavities must be sealed.
- This includes walls with knob & tube wiring.
- See [Section 4010](#) for more information on air sealing procedures.
- Check for the presence of any existing insulation.
 - Do not drill through siding to check for existing insulation.
 - Look for evidence, such as insulation plugs, of previously installed insulation.
 - Check several test locations.
 - If existing insulation is vermiculite, see [Section 2153](#) for procedures.
 - If there is existing insulation, determine if re-insulating the entire wall or insulating the pressure points would be effective.
 - This is determined by type of existing insulation, the volume of the home and the initial blower door reading.
- Note the depth of the stud cavities in order to determine the quantity of insulation needed.
- Calculate the amount of cellulose insulation needed. The calculation should be based on 3.50 lbs./ft³. Wall cavity depth x .29 = pounds of insulation needed per square ft. of wall space.
- Wall insulation will be inspected using a combination of infrared camera and blower door.
- Certificates for wall insulation, crawl space insulation, any sealed (non-accessible) attic and band joist insulation must be attached within one foot of the electrical panel in the basement.

Manufactured Homes

- The exterior siding and the interior wall materials must be inspected prior to the installation of insulation.
- Weak or damaged wall materials must be repaired or reinforced prior to installing insulation within program spending limits.
- If a manufactured home has aluminum wiring, sidewalls shall not be insulated.
- During the energy audit of manufactured homes, if the energy auditor cannot physically gain access to the sidewalls and attics to determine the existing R-values, the energy auditor should use the information from the manufactured home nameplate to make the determination. If unable to physically verify existing R-values and unable to obtain information from the manufactured home nameplate, use the chart provided below to estimate insulation R-values. Iowa is in Zone 3.

Figure 1-10 HUD Insulation Standards —1976 vs. 1994 — A Comparison

		1976 Thermal Standards			1994 Thermal Standards		
		Zone 1	Zone 2	Zone 3	Zone 1	Zone 2	Zone 3
Single-Wide	Ceiling	R-11	R-11	R-19	R-14	R-19	R-19
	Wall	R-7	R-7	R-13	R-11	R-13	R-19
	Windows	Single aluminum	Double aluminum	Double aluminum	Double aluminum	Double aluminum	Double wood or vinyl
	Floor	R-7	R-11	R-14	R-11	R-19	R-19
Double-Wide	Ceiling	R-11	R-11	R-19	R-14	R-22	R-22
	Wall	R-7	R-11	R-11	R-11	R-13	R-19
	Windows	Single aluminum	Double aluminum	Double aluminum	Double aluminum	Double aluminum	Double wood or vinyl
	Floor	R-7	R-11	R-19	R-14	R-19	R-22

HUD strengthened its insulation standards as of October 1994. This table gives typical R-values and window types used to meet the 1976 and 1994 HUD Code's thermal standards. Note that the climate zone map changed when the 1994 thermal standards took effect.

Figure 1-10 provided by Glen Salas of SMS.

WX Worker

- Rigid fill tubes will be made of a material that will not hold an electric charge, such as Schedule 40 PVC Electrical Conduit, or be grounded. For an additional level of protection, the metal coupler on the hose will be connected to a grounding wire. Grounding wire will be connected to the grounding rod.
- All sidewall insulation shall be installed through the exterior side of the wall, if possible.
- The preferred method of wall insulation is tube-fill, dense-pack method.
- The dense-pack insulation method includes the following steps:
 1. Follow lead safe work practices.
 2. Lift or temporarily remove the siding to gain access for drilling.
 3. Drill 2-to-3-inch diameter holes to access the stud cavity.
 4. To prevent settling, cellulose insulation must be blown at 3.5 pounds per cubic foot density. This would be approximately one (1) pound per square foot in a 2x4 wall. Blowing cellulose insulation this densely typically requires using a fill tube.
 5. Mark the fill tube in one-foot intervals to help the person blowing insulation to verify the correct penetration of the tube into the wall.
 6. Starting with several full height, unobstructed wall cavities allow the crew to measure the insulation density. Start with an empty hopper. Fill the hopper with a bag you've weighed. An 8-foot cavity (2x4 on 16-inch centers) should consume a minimum of 10 pounds of cellulose.
 7. Plug holes and return siding to original condition. If siding is damaged or destroyed during the process, it must be replaced with new siding which matches existing.
- If siding must be drilled using 1" holes, there shall be at least three (3) holes per eight-foot (8') cavity.
 - The upper hole should be drilled at the pressure point in order to ensure good compaction of the insulation in that area.
 - Plugs must be wood or plastic, unless the house is stucco (see below).
 - All plugs used shall be painted to match the siding prior to their installation.
 - All plugs must be sealed in place.

- Vertical or Masonite siding may be drilled using either the one-inch method or with a hole large enough to allow the tube-filled dense-pack method.
- Depending on the application method of installing wall insulation, the Energy Auditor will decide if the siding should be drilled or removed.
- Vinyl, steel, aluminum, etc. siding may only be drilled at the discretion of the client and Energy Auditor.
- Stucco siding penetrated from the exterior side of the wall shall be retextured and painted to match the existing stucco on the house.
- Interior Drilling
 - Holes drilled from the interior shall be filled with non-shrinking compound and returned to a paint-ready surface.
 - Interior will be masked and dust controlled during drilling when accessing from the interior.
 - Shrouds and containment devices are required.
 - Blown fiberglass insulation is not to be installed from the interior of the home.
 - Create access holes through the interior wall surface in a straight horizontal line sufficient to access the cavity with fill tube without damaging the wall surface
- When insulating two-story homes with balloon framing, insulation must be dense-packed in second story floors to reduce air leakage.
- All cellulose installed in walls must be installed to constitute a dense-packed application. If re-insulating walls, all pressure points must be dense-packed.
- If repairing drywall due to damage caused by the weatherization crew or contractor, the drywall shall receive three (3) coats of joint compound, textured, and painted to return it to its original appearance.
- If installing drywall in order to ready it for wall insulation, one (1) coat of joint compound is to be applied, rough edges sanded, and made ready for a second coat.
- Certificates for wall insulation, crawl space insulation, any sealed (non-accessible) attic and band joist insulation must be attached within one foot of the electrical panel in the basement.
- All work is to be neat in appearance.

Slate Siding

Refer to the *Iowa Weatherization General Appendix* for guidelines regarding slate siding.

Manufactured Homes

SWS 4.0202.3; 4.0202.4

- The exterior siding and the interior wall materials must be inspected prior to the installation of insulation. Weak or damaged wall materials must be repaired or reinforced prior to installing insulation within program spending limits.
- Additions to manufactured homes will be treated as site built described above.
- Wall areas that are readily accessible should be loosened from the bottom and insulated with 1½" of vinyl faced fiberglass batts using a Plexiglas or equivalent to push batts up into the wall cavity. If a manufactured home has aluminum wiring, sidewalls shall not be insulated.
- Use the MHEA Audit to determine whether additional insulation should be added.
 - Documentation concerning why the walls were not insulated should be in the client file, if MHEA called for additional insulation.
 - Prior to and after insulating walls electrical outlets should be checked to make sure they are in working condition.
 - Items hanging on the walls should be removed prior to insulating the walls to avoid breakage.
- Installing insulation above windows and doors is usually not feasible or cost-effective and is not required in manufactured homes.
- Certificates for wall insulation, crawl space insulation, any sealed (non-accessible) attic and band joist insulation must be attached within one foot of the electrical panel.

Blown Fiberglass

- If skirting overlaps siding, skirting will be removed and replaced in good working order.
- Fasteners will be removed from the bottom of the siding, working upward until the siding can be pulled away from the framing approximately 6" without damaging the siding.
- Temporary fasteners will be installed near the bottom of the siding panels at the seams.

- If sub-sheathing is present under the siding, access through the sub-sheathing will be required.
- Installer pre-work assessment will be conducted to determine:
 - Moisture damage
 - Presence of infestation or pests
 - Location and integrity of wiring
 - Holes to the interior and exterior
 - Loose paneling or siding
 - Location of belt rails
 - Location of wall obstructions (switches, outlets)
 - Existing insulation
 - Wall hangings for removal during work
- Problems will be corrected before work begins.
- Using fill tube, 100% of each cavity will be filled to a consistent density:
 - Loose fiberglass material will be installed and will be specifically approved for air flow resistance to a minimum density in accordance with manufacturer specifications.
 - The number of bags installed will be confirmed and will match the number to achieve 1.5-1.6 pounds per cubic foot.
 - Insulation will be verified to prevent visible air movement using chemical smoke at 50 Pascal of pressure difference.
 - Blown fiberglass will not be blown from inside the home.

5021 Cantilever Floor Insulation

- Verify that installation area is free of:
 - active water leaks, fuel leaks (i.e., gas, oil, propane), and pest intrusions
 - energized knob and tube wiring
 - uncovered electrical junctions
 - improperly terminated devices (ventilation fans, dryers, plumbing stacks, condensate lines, combustion appliance flues/chimneys, etc.)
 - unshielded high-temperature devices (non-IC rated recessed lights, chimneys, flues, vents, etc.) unless they are zero clearance devices
 - insulation escape openings
- Any cantilever floor, such as under bay windows or rooms over unconditioned areas (except tuck-under garages), must have a ½" treated plywood sheathing to fully cover the bottom of the floor. (See Figure 2)
- The cantilever floor shall be insulated using the dense-pack method, a minimum density of 3.5 pounds per cubic foot.
- The drilled sheathing is to be plugged and painted.
- All plugs must be sealed in place.

FIGURE 2



5030 FOUNDATION

STANDARD

To form a consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value.

SWS 20202.1,2,3 3.0104.1 3.0104.2 3.0104.3 3.0104.4 3.0105.1 4.0401.1

Energy Auditor/Inspector

Note the condition of the foundation walls. Document the location of building penetrations and damaged areas, if needed. If the foundation wall is damaged, determine if corrective action is allowable or possible within the scope of the program.

5031 Crawlspace/Slab

Measure the crawlspace area including height of foundation walls for the NEAT Audit.

- Verify that all exterior bulk moisture is directed away from the foundation with appropriate drainage techniques and exterior foundation drainage details are functioning properly (e.g. rain screens, weep holes) See [Section 7020](#) General H&S repairs for grading and guttering
- Determine whether the crawlspace is unconditioned or unintentionally conditioned.
 - Treat a post foundation as an unconditioned area and insulate the floor over the crawlspace using the dense pack method.
 - Try to align the thermal boundary with the air boundary.
 - If the crawlspace is connected to a basement, decide if isolating it from the basement is appropriate.
 - Determine whether to insulate the walls or ceiling of the crawlspace. Do not call for both.
 - Consider the possibility of water lines freezing and ductwork being put in an unconditioned space.
 - If the floor is to be insulated, the NEAT Audit will determine the R-Value to install.
 - If the foundation walls are to be insulated, the approved methods are listed in [Section 5031.03](#).
- Document any plumbing pipes, chase ways, or other by-pass air leakage sites which need to be sealed.
- If these by-passes lead to the attic, they must be sealed in the attic if possible. Otherwise, they must be sealed in the crawlspace.
- If the by-passes lead to an exterior wall, they must be sealed in the crawlspace.
- Plumbing leaks will be repaired before crawl space upgrade in accordance with the most recently adopted IRC.
- Look for exhaust vents that terminate in the crawlspace area. These vents are to be extended to outside the foundation and terminated.

WX Worker

- Penetrations will be sealed with a durable material with a minimum expected service life of 10 years.
- If penetrations are greater than ¼", a pest proof material (caulking, steel wool, etc.) will be used to fill the opening before sealing.

5031.01 Vapor Barrier

Energy Auditor/Inspector

- Note any existing debris in the crawlspace.
- Debris that may cause injury or puncture ground covers (e.g., nails, glass, sheet metal screws) must be removed from the crawlspace and disposed of properly.
- Note whether a vapor barrier is present and inspect for complete coverage and effectiveness.
- If a vapor barrier is not present and the crawlspace is accessible, a 6-mil, ground vapor retarder of 0.1 perm or less barrier must be installed.
- If clear vapor retarder used, the agency must be prepared to explain to the client why there is moisture visible under the vapor retarder.
- Vapor barriers are not to be installed in crawlspaces where there is a danger of pooling water due to high water table or poor drainage.
- Calculate the amount of material necessary to cover all exposed soil.
- When seams exist, they will be overlapped a minimum of 12" and must be sealed to prevent moisture and vapors from wicking through.

- Extend ground vapor retarder up to 6" below sill plate and secure, unless two-part foam or rigid foam board is to be used for insulation.
- The ground vapor retarder will not interfere with the established drainage pattern (e.g., to sump pits, French drains, etc.)
- The client will be informed of the importance of and cautioned not to damage the vapor barrier in the crawlspace. Clients will also be instructed to not store hazardous and flammable materials in the crawlspace.

Manufactured Homes

- If conditions of the ground and skirting mandates, a moisture barrier that covers the ground will be installed with allowances for structural supports and accessibility.
- Homeowner will be advised that all plastic is biodegradable and will have a life span much shorter than the home.

WX Worker

- Debris that may cause injury or puncture ground covers (e.g., nails, glass, sheet metal screws) must be removed from the crawlspace and disposed of properly.
- Ground vapor retarder must be 6-mil thick polyethylene. When seams exist, they will be overlapped a minimum of 12" and sealed using caulk, mastic, or house-wrap tape. The sealant must be compatible with the vapor barrier. See [Section 4010](#)
- A vapor barrier, covering 100% of the exposed crawl space floor, will be installed and sealed to the wall's air and moisture barrier. Ground vapor barrier will be fastened to ground to prevent movement in accordance with ASTM E1643 and manufacturer's recommendations.
- The ground vapor retarder should extend up to the 6" below sill plate and secured, unless two-part foam or rigid foam board is to be used for insulation.
- For wall to floor connection, the wall moisture barrier will be installed under the ground vapor retarder.
- Care must be taken not to tear the polyethylene.
- A minimum expected service life of 10 years will be ensured.

5031.02 Crawl Space Venting

Energy Auditor/Inspector

- Unintentionally conditioned crawlspaces should be treated as a mini-basement. They should be heated during winter and cooled during the summer.
- A return HVAC system duct or grille is not allowed.
- A floor grille, acting as a transfer grille, can be installed. It should be noted that installation of a transfer grille between crawlspace and the house may be in conflict with some codes unless crawlspace surfaces are also fire rated.
- Accidental active depressurization of the conditioned crawl space via a return duct or return duct leakage that creates recirculation into the house should be avoided. This should not be confused with continuous, active depressurization of the crawlspace via an exhaust fan vented to the exterior that is a proven soil gas control strategy.
- During periods of high outdoor relative humidity, when the crawlspace is cooler than the outside air, ventilation may cause condensation in a crawlspace. For this reason, all existing vents must be closeable or a cover made for them. Thermal vents are not allowed.
- Vents are not to be added to the foundation.
- With client permission, all existing crawl space vents in areas inside the thermal boundary should be permanently sealed shut. If sealing shut, use a durable, rigid, and pest resistant material
- If drainage problems exist which may create standing water or moisture production, mechanical foundation ventilation or a sump pump may be necessary. (See [Section 2090](#))

WX Worker

- If required by the work order, existing vents in the crawlspace area are to be sealed.
 - If sealing shut from outside, treated plywood should be used.
 - Inside, foam board may be used.

5031.03 Crawlspace Wall Insulation

SWS 4.0301.2,3

- There are four approved methods of crawlspace wall insulation.
- The Energy Auditor will determine when to insulate crawl space walls and which method to use.
- In all cases a vapor retarder must be installed.
- Certificates for wall insulation, crawl space insulation, any sealed (non-accessible) attic and band joist insulation must be attached within one foot of the electrical panel in the basement.

Method 1 – R-19 Fiberglass

- Insulation is to be R-19 or greater fiberglass batts.
- Insulation may be installed either horizontally or vertically along the crawlspace walls. The edges of the insulation must be sealed and it must be attached to eliminate sagging and separation between batts.
- If vapor retarder is installed up the walls to the top of the sill box, unfaced fiberglass will be used.
- Insulation is to extend from the sill plate down to the floor.
- The box area must be insulated to R-19 if required by NEAT
- The top of the batts shall be held in place with lath, 1x2"s, or staples.
- **Fiberglass insulation is not to be installed on walls of crawlspaces where there is a danger of pooling water due to high water table or poor drainage.**

Method 2 – Rigid Foam

- Minimum R-19 foil faced rigid foam may be used to insulate crawlspace walls if local codes permit.
- Foam board must be foil faced.
- All joints must be sealed and entire interior exposed foundation covered.
- Insulation is to extend from the sill plate to the floor.
- The box area must be insulated to R-19 if required by NEAT
- Insulation must be attached to the walls.
- Vapor barrier must cover the floor of the crawlspace.

Method 3 – Two-Part Closed-Cell Polyurethane Foam

- Only use if local codes permit.
- Manufacturer's guidelines must be followed for recommended use and application, temperature tolerances, shut down procedures and storage.
- Two-part closed-cell polyurethane foam must be rated as Class 1 Fire Retardant. The card/certificate from the box must be left with the insulation foam because it identifies the foam as fire retardant.
- Apply [SPF](#) to prescribed R-value in a continuous layer over entire surface of wall from bottom to top plate using a pass thickness maximum in accordance with manufacturer specifications.
- Two-part closed-cell polyurethane foam must be covered with ignition barrier material when local codes require. If required, the additional costs must be entered into the NEAT Audit.
- Vapor retarder must be put on the ground in crawlspaces when insulating the foundation walls.
- Insulation shall not be installed in areas prone to high moisture, flooding, or homes in low-lying areas.
- Must be installed to meet R-19 requirements.
- Insulation must be neat in appearance and of a consistent depth.
- When cost effective according to the NEAT Audit, the two-part closed-cell polyurethane foam may be installed at the Energy Auditor's discretion.
- The box area must be insulated to R-19 if required by NEAT.
- If installed in a confined space, there should be a negative pressure in the area. Follow NIOSH Standard as what is defined as a confined space.
- Recommend tenants, especially children, vacate the premises while being installed and for one hour (or as long as manufacturer recommends) after completion or until all VOC gases are gone.
- WX Workers must wear a NIOSH certified respirator as well as eye and skin protection as specified in the product SDS.
- Clean up any overspray or excess of the two-part foam.

5031.04 Floor over Crawlspace Insulation

Energy Auditor/Inspector

- The agency Energy Auditor will decide when and how to insulate floor area over the crawlspace and the NEAT Audit will determine the R-value. If floor over the crawlspace is to be insulated and there are no water lines, then all heat ducts in the crawlspace shall also be insulated (see [Section 5040](#)).
- If the floor is insulated, the crawlspace must be isolated from any conditioned or unintentionally conditioned areas.

WX Worker

- The two acceptable methods for insulating floors are described below.
- Certificates for wall insulation, crawl space insulation, any sealed (non-accessible) attic and band joist insulation must be attached within one foot of the electrical panel in the basement.

Method 1 - Fiberglass Batt

- The floor must be the air barrier when fiberglass is used.
- Wood lath and galvanized nails may be used to hold the insulation in place with a maximum spacing of 18" on center. Twine used to hold the insulation in place must be made of polypropylene, nylon or polyester with a breaking strength of at least 150lbs. and 12" maximum spacing between anchor points.
- Wire used to hold the insulation must be zinc-coated, stainless, or similar corrosive resistant material with a minimum diameter of .035". Wire must be spaced no more than 18" apart. Supports and anchors must be zinc coated, stainless steel, or similar corrosion resistant material. Staples for wood lath are to have a 1/4" crown. Staples for wire and twine are to have a 3/8" crown and nails are to be galvanized and penetrate the joist at least 5/8.
- Wire hangers may also be used if spaced no more than 18" on center and have a minimum thickness of .090 inches. The hanger ends must penetrate the joist at least 1/2".
- The insulation must not be compressed more than 10%.
- Do not insulate water pipes from the heated side. Insulation should be installed between the pipe and the cold side of the crawlspace.
- Any covered water valves shall have a tag with "WATER VALVE" written on it and hung below the valve and insulation.
- Install flags that can be seen below the floor joists at any utility junctions that will be covered by insulation

Method 2 – Dense-Pack Cellulose (preferred method)

Any cavities with water lines must be insulated using Method 1.

- Dense-packed equals 3.5 pounds of insulation per cubic feet. To figure the number of pounds of insulation needed per square foot of joist thickness, multiply 0.29 times the cavity thickness.
- Reinforced poly may also be installed on the floor joist. The poly must be installed with staples placed in such a manner to support the weight of the dense-pack insulation. The poly is then slit and cellulose is dense-packed into the cavities. The slits must be sealed when done insulating OR
- Floors over unheated spaces such as crawlspaces which do not have water lines may have rigid insulation board applied to the ceiling joist.
 - The insulation board must cover the entire floor assembly. Seams and penetrations must be sealed.
 - The insulation board is then drilled and cellulose is dense-packed into the cavities. The holes must then be plugged.
- Homes without foundations that have exposed floors are to be insulated using the dense pack method.

Manufactured Homes Floor Insulation Requirements

Energy Auditor/Inspector

- During the energy audit of manufactured homes, if the energy auditor cannot physically gain access to the sidewalls and attics to determine the existing R-values, the energy auditor should use the information from the manufactured home nameplate to make the determination. If unable to physically verify existing R-values and unable to obtain information from the manufactured home nameplate, use the chart provided in [Section 5020](#) to estimate insulation R-values. Iowa is in Zone 3.
- Inspect the floors from the interior to determine if there are any holes or penetrations to be repaired before insulating.
- Belly cavities must be inspected to determine the location of the plumbing, any existing plumbing leaks, and the R-value of existing insulation. Leaks should be fixed prior to weatherization.

- Duct leaks should also be sealed before installing insulation.
- Belly rodent barriers must be inspected for general condition, structural strength, and major air leakage, prior to installing insulation. Necessary belly rodent barrier repairs must be made if additional insulation will be added or if holes in the belly allow significant air movement between the belly cavity and the outside atmosphere.
- Fiberglass insulation is to be used to insulate the manufactured home underbelly.
- Cellulose is not to be used.
- Average fiberglass insulation densities for loose-fill insulation installed in manufactured home bellies shall be 1.5 to 1.6 pounds per cubic foot.
- Due to some manufactured homes having extended warranties, if the manufactured home is less than 15 years old it will be at the Energy Auditor's discretion whether or not to insulate the underbelly.
- If water pipes are located at the bottom of the belly rodent barrier and it is not possible to get at least two inches of insulation between the pipes and the rodent barrier, then the following must be attempted, if cost effective and feasible:
 - The pipes must be insulated with additional insulation, either inside the belly or on the exterior of the rodent barrier, or
 - The pipes shall be moved closer to the floor above or the insulation above the pipes should be removed.
- Belly insulation must be installed in such a manner that ensures complete coverage under heated areas.
- Bellies shall not be dense packed or over filled so as to create undue stress on the belly rodent barrier. All belly insulation is to be determined by the MHEA Audit.
- Holes that have been made in belly rodent barriers for the installation of insulation must be patched and sealed.
- Rim joists may not be drilled if they are determined to be a structural component of the foundation support system.
- Fiberglass batt insulation may be used if conditions warrant such as under ductwork, small areas requiring insulation, etc.

WX Worker

Underbelly Insulation Methods

- Select insulation that: has a flame spread and smoke development index of 25/450 or less when tested in accordance with ASTM E84 or UL 723; are of minimal water absorbency; are noncorrosive
- A signed and dated Insulation Installation Requirements certificate inside the water heater cabinet must include:
 - Insulation type
 - Installed thickness and settled thickness
 - Coverage area
 - R-value
 - Number of bags installed in accordance with manufacturer specifications

METHOD 1 - Belly-Board Penetration

- When insulation has to be installed from underneath the belly, the installation of a 6-mil vapor barrier on the ground by the first person to go underneath is preferred, in order to reduce health risks to the weatherization workers from animal feces.
- When insulating from underneath, the use of insulation hose or a large diameter fill tube is preferred. Holes shall be spaced and sized to accommodate the directional nozzle or fill tube.
- The maximum insulation travel beyond fill tube or nozzle shall be no more than two (2) feet.
- Flexible fill tube shall not be more than two (2) feet shorter than the length of the cavity being filled.
- The preferred methods of securing belly patches are through the use of adhesives, clinch staples, screws and lath strips whenever possible to provide a lasting patch.
- Preferred patching materials for large holes in belly rodent barriers include insulated sheathing board, fiberboard, and nylon reinforced belly bottom material specifically manufactured for manufactured homes.
- Ductwork shall be inspected for insulation that might have accidentally entered during insulation work.

METHOD 2 – Rim Joist Penetration

- Rim joists may not be drilled if they are determined to be a structural component of the foundation support system.
- Rim joist penetration is preferred when the joist size and condition allow for safe and proper installation.
- The trim on the bottom of the exterior wall shall be removed to expose the rim joist.
- Rim joist access shall not be used if it will weaken or damage the manufactured home.
- Care must be taken to avoid damage to plumbing and electrical lines attached or adjacent to the rim joist.
- Rigid or flexible fill tube shall not be more than 2' shorter than the length of the cavity being filled.
- Upon completion of insulation work, rim joists that have been drilled shall be plugged with a wood plug. The plug shall be sealed in the hole with an adhesive compound.
- Ductwork shall be inspected for insulation that might have accidentally entered during insulation work.

5032 Sill Box Insulation

Energy Auditor/Inspector

- Measure the sill box area and document any existing insulation for the NEAT Audit. Insulation will only be installed in the sill box when required by the NEAT Audit.
- Agencies are encouraged to use Method 2, Two-Part Closed-Cell Polyurethane Foam.
- If the foundation box allows infiltration, seal the box area with caulk or non-expanding foam sealant.

WX Worker

- There are four approved methods of sill box wall insulation. The Energy Auditor will determine which is to be used.
- A signed and dated Insulation Installation Requirements certificate within 1 foot of the electrical panel must include:
 - Insulation type
 - Installed thickness and settled thickness
 - Coverage area
 - R-value
 - Number of bags installed in accordance with manufacturer specifications

Method 1 – R-19 Fiberglass

- Box areas must be insulated to R-19, when called for by NEAT.
- Kraft faced Fiberglass:
 - Fiberglass must have Kraft barrier installed toward the winter-heated side
 - Fiberglass must be in contact with wood
 - Kraft paper must be sealed around all edges
- Fiberglass with rigid foam
 - Fiberglass must be unfaced R-13
 - Fiberglass must be in contact with wood on five sides
 - Fiberglass must be covered with 1" rigid foam
 - Rigid foam must be neatly sealed around all edges

Method 2 – Two-Part Closed-Cell Polyurethane Foam SWS 4.0401.1

- When cost effective according to the NEAT Audit, the two-part closed-cell polyurethane foam may be installed at the Energy Auditor's discretion.
- Only use if local codes permit.
- Select SPF that is between 0.5 and 2.0 lb/ft³ in density and has a flame spread/smoke development index of 25/450 or less when tested in accordance with ASTM E84 or UL 723
- Manufacturer's guidelines must be followed for recommended use and application, temperature tolerances, shut down procedures and storage.
- Two-part closed-cell polyurethane foam must be rated as Class 1 Fire Retardant. The card/certificate from the box must be left with the insulation foam because it identifies the foam as fire retardant.
- Two-part closed-cell polyurethane foam must be covered with ignition barrier material when local codes require. If required, the additional costs must be entered into the NEAT Audit.
- Must be installed to R-19.

- Apply two-part foam to prescribed R-value in a continuous layer from subfloor surface, over band/rim joist and sill/wall plate, and in contact with foundation or ceiling below using a pass thickness maximum as indicated by manufacturer specifications
- Insulation must be neat in appearance and of a consistent depth.
- If installed in a confined space, there should be a negative pressure in the area. Follow NIOSH Standards to define a confined space.
- Recommend tenants, especially children, vacate the premises while being installed and for one hour (or as long as the manufacturer recommends) after completion or until all VOC gases are gone.
- Weatherization workers must wear a NIOSH certified respirator as well as eye and skin protection as specified in the product SDS.
- Clean up any overspray or excess of the two-part foam.

Method 3 – Rigid Foam 4.0401.3b language

- Equivalent to R-19 foil-faced foam may be used to insulate box areas, when called for by NEAT and local codes permit.
- Select rigid insulation that: is a class II vapor retarder and is between 0.5 and 2.0 lb/ft³ in density and has a flame spread/smoke development index equal to or less than 25/450 when tested in accordance with ASTM E84 or UL 723
Must be installed in contact with wood

5033 Basement

Energy Auditor/Inspector

- Determine whether the basement functions as a conditioned, unintentionally conditioned, or unconditioned area. A tuck-under garage is to be considered unconditioned space.
- If the basement area is unconditioned, note the condition of any existing floor insulation. If there is no insulation, enter the area in the NEAT Audit and the audit will determine the amount of R-value needed.
- Measure the basement floor and wall area for the NEAT Audit.
- Inspect for signs of basement floor moisture and determine if necessary corrective actions can be completed within program spending limits.
- Note the presence of water lines and the potential for freezing because of the addition of floor insulation.
- Note the presence and location of any direct penetrations. Note any plumbing pipes, chase ways, or other by-pass air leakage sites. If these by-passes lead to the attic, they must be sealed in the attic if possible. Otherwise they must be sealed in the basement. If the by-passes lead to an exterior wall, they need to be sealed in the basement. Document areas that are to be sealed.
- Note the number, size, and condition of windows and exterior doors. Note any broken or missing parts or missing glass that would allow air infiltration.

5034 Attached or Tuck-Under Garage

Energy Auditor/Inspector

- An attached or tuck-under garage is to be considered unconditioned space and should be insulated with fiberglass, dense-pack cellulose, or two-part foam (two-part closed-cell polyurethane foam must be rated as Class 1 Fire Retardant and covered where local codes require).
- If the house to garage leakage is less than 200 CFMs and it is already insulated, additional air-sealing is still required.
- Smoke pencil with a blower door or infrared camera should be used to determine the source of air leakage. Air sealing must be completed.
- If adding insulation to unfinished ceilings or common walls in attached or tuck-under garages 5/8" fire-rated sheetrock must be installed.
- Duct work in ceilings must be sealed before insulating.
- Ducts supplying or returns heat to the garage need to be sealed off.
- The sheetrock may be installed first and the ceiling and wall dense-packed or two-part foam may be installed prior to installing the sheetrock.
- Fiberglass batts must be used in the ceiling cavities with water lines.
- Cellulose or two-part foam must be used in cavities with no water lines.
- See [Section 4010](#) for information about infiltration sealing in garages.

WX Worker

- If required by work order, ceilings or common walls in tuck-under garages will be finished with 5/8" fire-rated sheetrock.
- If required by work order, fiberglass, dense-pack cellulose, or two-part foam insulation will be installed. If dense-pack cellulose is required, the 5/8" sheetrock will be installed first, drilled for insulation, and plugged when complete.
- A signed and dated Insulation Installation Requirements certificate within 1 foot of the electrical panel must include:
 - Insulation type
 - Installed thickness and settled thickness
 - Coverage area
 - R-value
 - Number of bags installed in accordance with manufacturer specifications

5040 Duct Insulation

STANDARD

To lower thermal conductance of duct system and minimize condensation on the duct system.

SWS 5.0107

Energy Auditor/Inspector

- Note any ductwork in an unconditioned area. Also note any ductwork that might be put into an unconditioned area as a result of other work being completed. This ductwork must be insulated to a minimum of R-8.
- Note any flex duct. All flex ducts must be insulated to R-8 regardless of location.

Manufactured Homes

- If ducts are not within thermal, pressure, and vapor boundary, continuous air barrier, insulation, and vapor retarder will be installed either on the ducts or at the belly liner.

WX Worker

- Ducts must be insulated whenever supply or return ductwork run through unconditioned areas (this also applies to separate air conditioning systems).
- Select insulation with a flame spread and smoke development index of 25/50 when tested in accordance with ASTM E84 or UL 723
- Select insulation that includes an exterior vapor retarder layer
- Remove damaged or wet duct insulation from premises
- Verify ductwork is sealed before insulating
- Insulate all ducts outside the thermal boundary to a minimum of R-8
- Insulate all ducts exposed to the exterior to a minimum of R-12
- Secure blanket insulation in full contact with the duct surface using mechanical fasteners (e.g., stick pins, metal wire)
- Secure reflective insulation to duct in compliance with manufacturer specifications including required air spaces
- Seal all seams and connections of the duct insulation using UL 181 approved tape so that no gaps exist in the vapor retarder
- Post a dated receipt signed by the installer that minimally includes: Installed insulation type, coverage area, installed thickness, and installed R-value
- If reflective exterior insulation is used the documentation must include the number and width of included air spaces

SECTION 6000 ELECTRIC EFFICIENCY MEASURES

6010 Electric Baseload Measures

STANDARD

Clients' electric usage will be reduced by installing more energy efficient appliances. Energy used for lighting will also be reduced while maintaining adequate and safe lighting levels.

- Electric baseload usage accounts for over 40 percent of a household's energy use. This includes lights, refrigerators and freezers, and other electrical appliances.
- The Iowa Weatherization Program can address lighting by replacing standard incandescent bulbs with energy efficient bulbs. The program also replaces older, inefficient refrigerators and freezers with higher efficient units.

6011 Refrigeration & Freezer Removal/Replacement

SWS 7.0101.1

FIELD GUIDE

Energy Auditor/Inspector

- Discuss with client the approximate age of the existing refrigerator.
- Tell the client the usage of their refrigerator will be metered.
- Do not promise the client a new refrigerator. The replacement will be done according to the digital line logger.
- Refrigerator and freezer replacement model(s) must be rated as ENERGY STAR®. The Energy Star® rating is not required for freezer replacement models unless charged to a utility contract.
- All replacement refrigerators must meet the UL-250 standard.
- For situations where a straight one for one replacement is made, the replacement refrigerator must not be larger than the size of the old refrigerator.
- For situations where two (2) or more refrigerators will be replaced by one (1) new one or where a refrigerator and freezer will be replaced by one (1) refrigerator, the new refrigerator may be larger than the ones being replaced if needed in order to meet capacity needs.
- Side-by-side refrigerators may be installed as replacements if determined to be cost effective by the BART program. See the *Iowa Weatherization General Appendix* for further information.
- The program will not pay extra for any additional features such as ice makers or extended warranties. If an appliance, installed by the agency, fails within the first five years, it may be replaced once.
- The client is responsible for completing the hook up of any ice maker included with a new appliance.
- The color must be white or off-white, unless there is no difference in price for one of a different color. NOTE: Other colors are allowed if client pays the additional cost.
- The number of appliances that may be installed is limited to what is allowed by the BART replacement protocol. For example, if a house contains 2 refrigerators and 1 freezer and the replacement protocol allows for the replacement of all three appliances, then all three may be replaced.
- If a home has multiple refrigerators, they should be metered.
 - If a refrigerator cannot be metered, the estimated usage for that make and model may be found in the look-up table in the NEAT Audit.
 - If a refrigerator is not metered, the reason should be recorded in WAMS.
- All freezers must be metered. If a freezer is not metered, it is not eligible for replacement.
- Costs for replacements are limited to what is allowed by the replacement protocol and other limitations described above.
- Appliance replacement in rental units is allowed only when the renter owns the old appliance.
- All refrigeration appliances located in intentionally or unintentionally conditioned areas must be metered.
- Appliances in unconditioned areas may be metered and replaced if:
 - The new unit will be installed in an intentionally or unintentionally conditioned area, or
 - A 2-for-1 replacement will occur with the new unit being installed in an intentionally or unintentionally conditioned area.

- If a refrigerator cannot be metered because it cannot be moved, the estimated usage for that make and model may be found in the look-up in the NEAT/MHEA Audit.
- Removal and proper disposal of all replaced appliances is required. The appliances must be disposed of according to the environmental standards in the Clean Air Act (1990), Section 608, as amended by Final Rule, 40 CFR 82, May 14, 1993.
- Appliance repair is not allowed.
- The replacement policies and guidance cannot cover all possible situations. In some cases, common sense must be used to determine whether an appliance replacement is appropriate. For example, if a household has a second refrigerator that is seldom used or is used to store very little, it would not make sense to replace it with a new appliance. Instead, efforts should be made to encourage the client to allow the straight removal of the appliance.
- Install a digital power meter to the refrigerator. Caution: If the refrigerator is running when ready to install the power meter, allow the refrigerator to sit for a minimum of five (5) minutes before plugging into the Digital line logger. This will allow compressor pressure to be relieved.
- The time the logger is plugged in should be recorded.
- The appliance(s) must be metered for a minimum of 120 minutes (2 hours).
- Record the kWh usage and the number of minutes from the Digital Line Logger on the Client Home Energy Audit and on the client agreement form. This information is needed because it will be entered later in the WAMS material database.
- Use the TI-89 calculator to determine the annual energy consumption by each appliance.
- The Annual Energy Consumption Conversion Table (Conversion Table) may also be used to convert short-term metering results to an annual energy consumption amount.
 - The short-term metering results are based on the duration of the metering and the meter reading. The annual consumption is shown on the Conversion Table, rounded to the nearest 100 kWh.
 - The table lists short-term kWh readings down the left side and minutes that the appliance was metered on the top.

Example: If a refrigerator is metered for 120 minutes (2 hours) and the Digital Line Logger showed it used .43 kWh, the annual usage from the conversion table would show the annual usage of the refrigerator at 1900 kWh.

Once the annual energy consumption of the existing appliance(s) has been determined using the TI-89 or the Conversion Table, the Energy Auditor can determine if it is cost effective to replace the existing appliance(s). This is done by comparing the annual energy consumption of the existing appliance(s) with the replacement ratings of the “new” appliances.

The replacement ratings of “new” appliances are found on the Replacement Ratings Report, which is produced by the BART program (see BART Manual in the *Iowa Weatherization General Appendix*). The Energy Auditor reviews the replacement ratings for the appliances listed on the Ratings Report to see which appliances have a rating less than the annual energy consumption of the existing appliances. Any appliance or combination of appliances may be installed as long as the replacement rating of an appliance or total replacement rating of any combination of appliances is less than the total energy consumption of the existing unit or combination of existing units.

Example:

Bart Rating Table

ID	Rating	Brand	Style	Size
R1	1160	Whirlpool	TF	14
R2	1140	Amana	TF	16
R3	1300	Frigidaire	BF	18
R4	1250	Kenmore	TF	16

The client has two appliances. The two units were metered for 2 hours, and showed consumption of 0.252 and 0.180. We extrapolate these values to annual consumption rates using the TI-89 or the Conversion Table and find the rates of 1,104 kWh and 788 kWh, respectively. The total annual energy consumption of these two units is 1,892 (1,104 + 788).

In this example, the replacement refrigerators cannot be exchanged for either of the existing units since the replacement ratings of the replacement refrigerators exceed the annual energy consumption of each of the existing units (1,104 and 788). However, a replacement refrigerator can be installed if both of the existing units are removed because the replacement rating of any of the refrigerators listed is less than the total annual energy consumption of the existing units (1,892).

- When determining which new appliances can be installed, ensure the new appliance will fit into the space available and hinged on the correct side.
- Once it is determined whether the replacement appliance or a combination of appliances is cost-effective, discuss the possibility with the client.
- It may be possible to propose the replacement of multiple appliances for one new appliance. Greater energy savings are realized if multiple appliances can be replaced with one (1) appliance.
- If the client agrees to a replacement of an appliance or a combination of appliances, complete the Client Agreement Form and have the client sign the form.
- The Client Agreement Form lists the existing appliances that will be replaced and the new appliances that will be installed.
- The form is printed on three-part NCR paper so one (1) copy can be given to the client, one (1) copy kept by the agency, and one (1) given to the appliance vendor.

WX Worker

- Removal and proper disposal of all replaced appliances is required. The appliances must be disposed of according to the environmental standards in the Clean Air Act (1990), Section 608, as amended by Final Rule, 40 CFR 82, May 14, 1993.
- Appliance will be installed in accordance with manufacturer specifications and local codes.
- Any penetrations to the exterior of the home created by the installation of the appliance will be sealed.
- Appliance shall be ENERGY STAR® rated. Energy-related appliance controls will be demonstrated to the occupant.
- Specific information on the proper maintenance of the equipment will be provided to the occupant.
- Warranty information, operation manuals, and installer contact information will be provided to the occupant. Appliance will carry a minimum one-year warranty that will provide a replacement appliance if repeated issues relating to health, safety, or performance occur.
- Appliance will fit in the available space without blocking access to light switches, cabinets, etc.

6012 Energy Efficient Lighting

SWS 7.0103.1

FIELD GUIDE

Energy Auditor/Inspector

Incandescent light bulbs will be replaced with light-emitting diode (LED) bulbs. A maximum of 20 LED bulbs may be installed in each house.

1. LED bulbs must be omni-directional.
2. LED bulbs must be soft- or warm-white to provide the hue similar to incandescent bulbs (unless client requests brighter light).
3. All LED bulbs installed must be ENERGY STAR® (version 2.0) rated.
4. LED bulbs installed in a dimmable socket must be designed to work with traditional dimmer switches.
5. LED bulbs installed in an enclosed housing must be approved for recessed or enclosed spaces.

LED bulbs will be installed with client permission in each house.

LED bulbs can have a lower wattage than incandescent bulbs and still provide the same light output. Table 1 shows the bulb wattage that should be selected when replacing incandescent bulbs with LED bulbs.

TABLE 1

Incandescent	Approximate LED
100 w	15 w
75 w	11 w
60 w	8 w
40 w	6 w

WX Worker

Install bulbs where instructed in work order. Do not leave the bulbs with the client to install.

6020 Air Conditioning

STANDARD

Air conditioning, while not a measure considered by the Iowa Weatherization Program, must be identified for client records. Information needed for WAMS and NEAT includes: existing air-conditioning type (window/central) and Btu or tons (12,000 Btu = 1 ton) of each air conditioner for use in NEAT and WAMS.

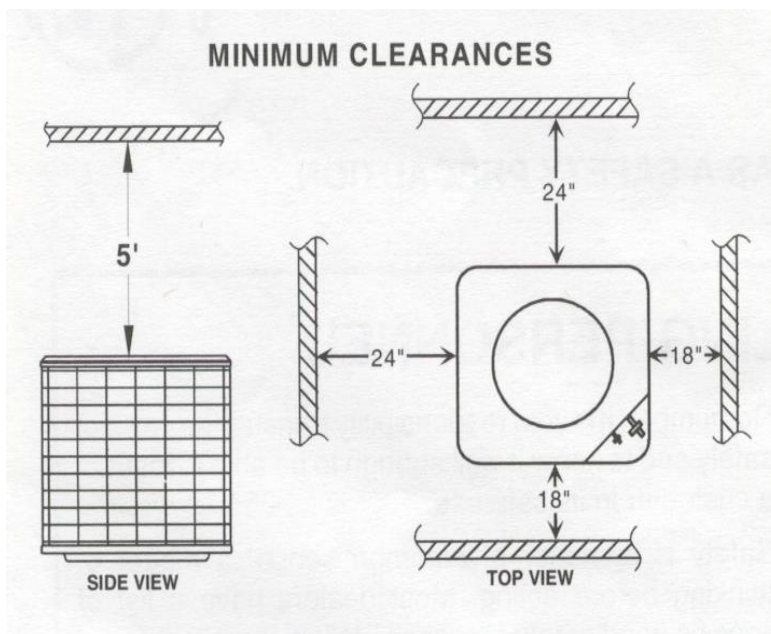
FIELD GUIDE

Energy Auditor/Inspector

Visually inspect the outside unit to ensure clearances meet manufacturer's instructions. See Figure 1 for clearance from the sides and top of the unit to walls and other objects. The unit cannot be completely enclosed. One side must be unrestricted. Make sure the cooling fins are not obstructed with leaves or dirt. Explain to the client why this is important, restricting airflow could lead to poor operation and/or severe equipment damage.

FIGURE 1

Outside condensing unit



Visually inspect the inside unit to determine if there is proper condensate drainage. If drainage problems exist, which may cause damage to the furnace, repairs or replacement may be made using program funds within heating system repair limits.

Visually inspect A-coil for dirty or obstructed fins. Clean if needed. If an A-coil is leaking and will result in damage to the furnace, it may be replaced within program expenditure limits, if not repairable.

SECTION 7000 REPAIRS

7010 Incidental Repairs

STANDARD

Incidental repairs are defined as repairs necessary for the effective performance or preservation of weatherization materials. All repair measures must be installed to meet requirements listed below.

SWS 3.1201; 3.1203; 3.1203

FIELD GUIDE

Energy Auditor/Inspector

For single-family dwellings, manufactured homes and multi-unit dwellings that have 4 or fewer units, the amount that can be spent on incidental repair is limited to what is allowed cost. The cost of these repairs must be input in the NEAT/MHEA Audit and included in the audit's SIR calculation. The repairs may be done if the cumulative SIR (with the repair costs included in the SIR calculation) is 1.3 or greater. For multi-unit dwellings that have 5 or more units, estimated repairs must be included in the prior approval request that is reviewed by the DCAA.

All repair measures must be tied to an energy conservation measure (ECM) and the ECM must be identified in the NEAT/MHEA Audit Itemized Costs comments section. Window/door repair/replacement must be reported as an ECM (if allowed by NEAT/MHEA).

Like material and/or compatible materials will be used for repairs.

WX Worker

Windows

Channels

- Install window channels following the manufacturer's instructions.
- Channels must be installed when replacing both upper and lower sashes.
- Channels and springs must operate properly. The lower sash must stay in the open position when raised and down when closed. The client should be able to open and close sash easily.
- Vinyl channels shall not have the weatherstrip cut away from the parting stop or any other part of the channel.
- Channels shall have an angle cut on the bottom to match the slope of the window sill.
- Channels are to fit tight to the sill and within 1/8" of the top.
- All installed channels shall be caulked in place with a paintable type caulk or a colored caulk matched to the window.

Repair

- Window repair materials shall be of the type and size already existing on the window.
- The finished window shall operate smoothly, form a tight seal, and be neat in appearance.
- All unfinished wood shall be planed or sanded smooth and be painted, stained, or varnished to a smooth finish and match the existing finish as closely as possible.
- Only finishing or casing nails are to be used on the interior and galvanized casing nails on the exterior.
- The check rails (or meeting rails) of the upper and lower sashes are to be flush.

Sill

- If replacing the window sill, it must be either a factory-made sill or be made from treated lumber.
- Sill is to be beveled flush with the interior wall.
- Sill shall be the same distance from the house as the rest of the windows.
- Sill shall be installed at the same angle as other windows on the home.
- Only galvanized casement or finish nails are to be used.
- All seams shall be caulked after installation.
- Sills shall be painted to match the rest of the windows on the home.

- Primed coil stock may be used to wrap split sills. When wrapping sills, top, ends and all edges shall be covered.

Stop

- Window stops shall be installed in such a way as to ensure a tight seal between the jamb, sash, and stop.
- Wood installed shall be similar in size and shape to existing stop in the house.
- Installed window stop is to be planed or sanded smooth.
- New stop is to be painted or varnished to blend with current trim.
- Corners of installed materials are to be mitered or coped.
- If matching window stop is not available, then all stop on the window is to be replaced.
- All work to the window shall be neat in appearance.

Doors

Grade Entrance

- Openings wider than three feet or longer than eight feet shall have two doors installed instead of one large door.
- Grade entrance doors are to be made of shiplap, car siding or 1" x 4" tongue and groove lumber. Doors more than 6 square feet must be framed on the bottom side of the door using a 1" x 4" or 1" x 6" across the entire width of the top and bottom, then the two sides, then the center, forming what looks like two square frames, after which a 1" x 4" or 1" x 6" is placed in each of the two square frames on diagonal from the hinge location to the center of the opposite edge.
- All framing lumber is to be installed with glue and screws. The vertical joints of the car siding are not to be glued.
- Grade doors are to receive three new "T" hinges (minimum of 5") and a handle.
- Where possible, some form of a drip cap should be installed at the top of the door to help shed water.

Lower Grade

- Lower grade entrance doors are to be made of shiplap, car siding or 1" x 4" tongue and groove lumber or ¾ inch treated plywood. Doors more than 6 square feet must be framed on the bottom side of the door using a 1" x 4" or 1" x 6" across the entire width of the top and bottom, then the two sides, then the center, forming what looks like two square frames, after which a 1" x 4" or 1" x 6" is placed in each of the two square frames on diagonal from the hinge location to the center of the opposite edge. Any door over 6' in height needs at least 3 hinges equally spaced.
- A flush surface must be touching the weatherstrip.
- All framing lumber is to be installed with glue and screws. The vertical joints of the car siding are not to be glued.
- Steel or solid core slab doors may also be used.
- A lower grade entrance door must have a latching device. Keyed locksets are preferred but barrel bolts or hook & eye are acceptable. If there is an entrance to the basement from the lived-in portion of the house, a keyed lockset must be used.
- All doors are to operate smoothly, be painted or stained to a smooth water-resistant finish, and be neat in appearance. Pressure-treated wood is to be left unpainted.

Interior Door

- Hollow core doors may be used only on the interior of the home to close off unheated portions of the house such as walk-up attics.
- Whenever possible, 1¾" thick doors should be used.
- All installed doors shall receive a smooth finish, be painted or varnished to match existing doors, and be neat in appearance.

Jamb Replacement/Repair

- For jamb repair, remove damaged or deteriorated portion of the jamb and replace with matching materials, butting uniformly to near members.
- All loose sub-members and casing is to be secured and all wood installed is to be finish grade or factory-made jamb material.

- Common stock materials such as #2 or #3 1" x 6" and 2" x 6"s are not an acceptable jamb material except for treated lumber for grade door.
- All installed lumber is to be planed or sanded smooth and painted or varnished to a smooth finish to match existing.
- All work is to be neat and form a tight seal.
- WX worker is to tighten or re-set hinges. Work is to be done in accordance with accepted carpentry standards. New installations require hinges to be mortised.
- Casing used is to match the existing casing on the house. If matching casing is not available, then all of the casing on the door is to be replaced. Wood is to be installed flush with the wall to ensure a tight fit.
- Any damaged interior wall is to be repaired with like materials.
- WX Worker is to tighten or re-set the strike plate to hold the door flush with the doorstop.
- Strike plate is to be mortised into the jamb.
- All doorsills being replaced must be made from treated lumber or a factory manufactured sill.
- All doorsills installed must be flush with the floor of the house.

Repair

- When required, existing doors will be adjusted to properly fit the jamb and allow for ease of operation.
- All repair work must be within accepted carpentry standards.
- Doors may be repaired if possible and if less expensive than replacing the door.
- All replacement materials are to be of the type and size already existing on the door.
- Doors are not to be covered with plywood and all repairs must be permanent in nature.
- All exposed wood (after cutting) is to be planed or sanded smooth and painted or varnished.
- The finished door should make a tight seal and operate smoothly.

Stop

- Wood used for stop is to be manufactured for that purpose.
- If a section of the stop is missing or must be replaced and the stop cannot be matched to the existing stop, replace all stop on that jamb.
- Joints are to be mitered or coped to form a tight corner joint.
- Wood installed is to be sanded smooth and painted or varnished to a smooth finish and approximately match the existing wood.

Drywall (may also be infiltration in some cases – Energy Auditor decision)

- Only ½" drywall shall be used when installing on entire wall or ceiling (if ceiling joist is on 16" center). If ceiling joist is on 24" center, 5/8" drywall will be used.
- Five-eighths inch fire-rated drywall must be used over or between a garage and the house.
- Drywall installed on ceilings must be installed perpendicular to the ceiling joist.
- Whenever possible, drywall installed on walls should also be installed perpendicular to the studs.
- Drywall is to be installed using 1¼" drywall screws.
- Screws shall be placed no more than 12" apart on each stud or ceiling joist. Screws shall be countersunk into the drywall without breaking through the paper.
- Metal corner bead is to be installed to all outside corners. Inside corners must be taped with perforated paper tape or if 1/4" or less, caulk is acceptable. If fiberglass tape is used for other seams, be sure to use the proper joint compound to ensure against cracking.
- All gaps wider than ¼" must be filled with a non-shrinking compound manufactured for that purpose prior to taping.
- If installing drywall in order to ready it for insulation, one (1) coat of joint compound is to be applied and made ready for a second coat.
- If existing drywall must be sealed, one coat of joint compound is to be neat in appearance and made ready for a second coat.
- Drywall repairs shall be made with the same thickness material as existing.
- The hole should be squared and a properly sized patch nailed or screwed in place.
- The drywall patch shall receive tape and joint compound and be applied to make a neat patch.
- If repairing drywall due to damage caused by the weatherization crew or contractor, the drywall shall receive three (3) coats of joint compound, textured and painted to return it to its original appearance.
- All work is to be neat in appearance.

Foundation Repair

- When caulking masonry joints, use siliconized type caulking compounds. Caulk is to form an air and watertight seal and all work is to be neat in appearance.
- Spray foam may not be used on exterior surfaces unless painted to protect against deterioration.
- If the foundation has loose or missing bricks or holes in the foundation, the area is to have bricks properly re-set with mortar.
- If the foundation cracks involve a large area, the area should be back plastered. Back plaster is to be even, neat, and match the existing back plaster.
- A pre-mixed fiber bond material should be used or the following formula, or equivalent, may be used:
 - 1 part masonry cement
 - ½ part Portland cement
 - 2 parts masonry sand

Plaster (may also be infiltration in some cases – Energy Auditor decision)

- Plaster repairs shall include covering the exposed lath with a plaster mix to the same thickness as the original wall.
- Plaster mix or a non-shrinking drywall mix must be used.
- Standard drywall compound is not acceptable for plaster repairs.
- Large areas of missing plaster may be covered with a drywall patch, provided the edges can be finished flush with the existing plaster surface.
- Gaps between the drywall patch and the drywall shall be taped.

7020 General Health & Safety Repairs

STANDARD

General Health and Safety Repairs are defined as "Repairs necessary (1) for installation of weatherization materials; (2) to maintain the integrity of weatherization materials; (3) to eliminate health and safety problems in the home (i.e., moisture problems)." General Health and Safety Repairs is limited to plumbing repairs, sump pumps, ENERGY STAR® dehumidifiers, electrical repairs, gutters and downspouts, banking and grading, mold/mildew cleanup, minor asbestos abatement, and pest control. The cost limit for General Health and Safety Repairs category is described in the Iowa Weatherization General Appendix. There are no waivers allowed.

SWS 20105; 2.0402; 2.0404; 20602

FIELD GUIDE

Energy Auditor/Inspector

Plumbing Repair

- Leaking water pipes and sewer lines may cause moisture problems within the house.
- Minor repairs may be made to water pipes and sewer lines within spending limits, but cleanup of any unsanitary conditions due to plumbing leaks is the sole responsibility of the client.

Sump Pumps

- Sump pumps may be installed to control water in lower levels of the home.
- Sump pumps must be installed to meet manufacturer's instructions and all local codes.
- Interior grading will be sloped to sump pump, if possible.
- Sealed covers must be installed on sump pumps pits as described below.
 - All new sump pumps (not replacement pumps) must be installed in a pit designed for that purpose and must be covered with an airtight cover unless installed in a dirt floor.
 - Existing sump pumps in pits designed for that purpose must be covered with an airtight cover manufactured for that purpose, unless installed in a dirt floor.
 - Existing sump pumps in small pits (five-gallon buckets for example) do not need a sealed cover.
 - Sump pits with a sealed cover must have a vent pipe extending to outside the thermal boundary.
- SHPO review is required for new sump pit installation where one did not previously exist.

Dehumidifiers

Dehumidifiers may be installed, with client permission, to help control humidity in basements during summer months in homes with existing mold or moisture problems.

- Explain to the client that the dehumidifier might result in an increase in electric usage.
- All moisture source control methods must have been exhausted before installing a dehumidifier.
- Manufacturer specifications will be followed for size and use.
- Dehumidifiers must be ENERGY STAR® rated and installed to drain properly.
 - If a drain does not exist, a dehumidifier may be installed by utilizing a dedicated condensation pump to an existing drain or sewer line.
 - In this case, the dehumidifier must be put up on blocks to allow for proper drainage.
 - If the basement area is divided in separate rooms, drying will be provided to all basement areas.
- Educate the client on proper usage of the dehumidifier including settings and summer/winter use.
- Occupant will be educated on how and when to change filter and clean condensate drain of the dehumidifier in accordance with manufacturer specifications.

Site Drainage

- Poor site drainage is often the reason for wet foundations, basements, crawlspaces, and slabs.
- The ground around the foundation of the house should be sloped away from the house so water runs away from the house and not toward it.
- Ideally, the ground adjacent to the foundation should have a minimum 5% slope away from the house (six inches of fall in the first 10 feet).
- Check for the following site drainage situations:
 - Does the site direct rain and snow melt toward the foundation rather than away from it?
 - Are there depressions in the ground close to the house where water can collect?
 - Are sidewalks or paved driveways sloped so they direct water toward the foundation rather than away from it?
 - Does the house have an effective gutter/downspout system that collects and drains rain water away from the foundations?

Gutters and Downspouts

- Gutters and downspouts can be an important part of solving a site drainage problem.
- Agencies should note if the house has an existing effective gutter/downspout system.
- If the gutter system is in good condition, but is clogged with debris, they may be cleaned by the program if client is physically unable to do the job and all other options (such as family or chore services) have been exhausted.
- The cleaning can only be done at the time of weatherization services and cannot be repeated as needed. See [Section 2073.03](#) for more information on Gutters and Downspouts.

Electrical Repair

- Correcting electrical wiring problems is generally not an allowable weatherization measure. Inspect for bare wires and knob and tube wiring. Inspect service boxes to ensure they have secure covers.
- See [Section 2130](#) and [Section 5014](#) for information on knob & tube wiring.
- Determine the type and amp rating of the main service box. This information should be available on the main service box.
- Determine existing wire type and the location and condition of each type present.
- Note the size of the existing fuses/breakers and determine if they are properly sized for their circuits.
- If the Energy Auditor determines that a hazardous situation (beyond the scope of the program) exists, work must be deferred until the problem is corrected. If using program funds for minor electrical repair (within the General Health and Safety Repair limit), a licensed electrical contractor must be used to perform electrical work needed to correct a problem.

Asbestos

- Clients will be provided with the Asbestos in Homes handout anytime materials with presumed asbestos are present in the house.
- The handout can be found on the Weatherization Program Members Only page of <http://www.weatherization.iowa.gov/>.

- Minor asbestos removal, such as asbestos tape on furnace ductwork and on boiler pipes, is allowable under the General Health and Safety Repair limits described in the *Iowa Weatherization General Appendix* and must be performed by a licensed asbestos abatement contractor.
- Minor asbestos removal is the minimum amount necessary in order to perform weatherization work.

Pest Control

- Pest removal/extermination is only allowed in cases when weatherization would be deferred otherwise. If pests cannot be reasonably removed, or where removal poses a safety concern for workers, work should be deferred on the house.
- If necessary, pest and termite treatment will be completed before crawl space upgrade