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COURSE 962915

Weatherization Guide Chapters 6 & 7

Review Material

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Summary Of This Course

WEATHERIZATION GUIDE CHAPTERS 6 & 7

Approved by the

Wisconsin Department of Safety and Professional Services Safety and Buildings Division

Course Identification Number 962915

Educational Credit Hours: 6 Hours

Course Provider:

USCONTRACTORLICENSE LLC

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Chapters 6 and 7 of the Weatherization Field Guide focus on repair standards and weatherization procedures that improve energy efficiency, durability, and occupant safety.

Chapter 6 emphasizes performing only necessary, cost-effective repairs that support weatherization measures, including proper repair or replacement of windows and doors, air sealing, weather-stripping, and quality assurance documentation.

Chapter 7 addresses manufactured-home weatherization, highlighting duct sealing, return-air improvements, floor, wall, and ceiling insulation, air sealing, combustion safety, and proper installation of replacement furnaces and water heaters. The chapter also covers ventilation, window improvements, and interior storm windows while stressing compliance with manufacturer instructions, applicable codes, combustion testing, gas leak detection, and thorough final inspections to ensure safe, effective, and long-lasting weatherization work.

This Course is approved for the following electrical Registrations/Certifications or Licenses:

Dwelling Contractor Qualifier	6 Hours of Continuing Education	
Manufactured Home Installer	6 Hours of Continuing Education	
Commercial Building Inspector	6 Hours of Continuing Education	

This course is a distance learning or e-learning course, which allows the attendee to complete the course on their time schedule.

Course Outline

This course is a distance learning or e-learning course, which allows the attendee to complete the course on their time schedule.

Chapter 6 - Repair

6.1 Windows and Doors

6.1.1 Window Repair and Replacement

6.1.2 Door Repair and Replacement

Chapter 7: Manufactured Home Weatherization

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7.5.6 Interior Drill and Blow

7.6 Sidewall Insulation

7.6.1 Preparing Siding for Wall Insulation

7.6.2 Sidewall Blowing Technique

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7.7 Air Sealing

7.8 Combustion Appliance and Fuel Distribution Safety

7.9 Heating Unit Replacement

7.10 Water Heater Replacement

- 7.10.1 Gas Water Heater Installations
- 7.10.2 Exterior Access Water Heater Closets

7.12 Window Replacement

7.13 Interior Storm Windows

7.14 Door Replacement

180 questions related to the reference materials are used to test the attendee on their comprehension of the materials. A 70% score will need to be attained in order to pass this course.

Answer Sheet(s)

2 bubble style answer sheets are included. When you are finished with the exam, you may return the answer sheets for grading to:

By Mail: Uscontractorlicense LLC
PO Box 268
Platteville, Wisconsin 53818

By Email: michael@uscontractorlicense.com

By Fax: 608-571-0096

Once we get the answer sheets back, we will graded them, enter your hours into the attendance portal and email or mail you back your certificate of completion(s). You will be responsible for renewing your license with the DSPS at www.license.wi.gov website.

Any questions, please contact us at 608.348.6688

Foreword

The Wisconsin Weatherization Field Guide is a comprehensive guide to installing weatherization measures and verifying the quality of the work. The Field Guide is a tool for crew workers, energy auditors, and inspectors. The program's policies and administrative practices are identified in the Wisconsin Weatherization Program Manual.

The Field Guide started with dedicated weatherization crew workers determined to improve their trade and the services provided to their customers. It evolved from there to documenting those practices to share them with the rest of the weatherization network. The original Wisconsin Weatherization Field Guide was produced through a collaboration of the 2005 Weatherization Technical Advisory Group, Slipstream (*formerly Wisconsin Energy Conservation Corporation (WECC)*), and Saturn Resource Management.

Wisconsin is one of the national leaders in the Weatherization Assistance Program, and this guide represents the ongoing effort to continually improve our practices and procedures to deliver the best product to our customers.

Credits

Information in *Chapter 5 – Sections 5.15.1, 5.15.2, 5.15.3, 5.15.4, and 5.15.5* is used with permission from *the WAP Precautionary Radon Mitigation Field Guide* by Dick Kornbluth, Dick Kornbluth, LLC, Copyright 2018, Section 11 – Sumps; Pages – 18-22.

The original document was developed in 2005 through collaboration between Wisconsin Division of Energy Services, Slipstream (*formerly Wisconsin Energy Conservation Corporation (WECC)*), Saturn Resource Management, the Technical Assistance Group (TAG) and various technical consultants.

Weatherization Works

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slipstream

Chapter 6: Repair

Repairs are defined as items necessary for the effective performance or preservation of installed weatherization materials. Repair measures are required to be reasonable, cost effective, and performed only when needed to install a measure necessary to effectively weatherize a building, along with written and photo documentation in the client's file. Examples include, but are not limited to, repairing minor roof leaks, electrical repairs, and fixing water leaks. Repairs may also include installing protective materials involved with weatherization measures, such as paint used to seal materials installed through weatherization.

Follow all applicable lead- and asbestos-safe work practices when performing repairs.

6.1 Windows and Doors

Windows and doors typically make up a small percentage of a building's thermal boundary. It is rare that enough heat loss occurs through them to justify cost-effective repair or replacement.

Experience from blower door testing has shown windows and doors tend not to harbor large air leaks. Though conductive and convective losses through windows and doors are often quite high on a per-square-foot basis, these losses are not affected much by most simple weatherization improvements.

Replacing missing and broken glass, re-glazing glass, installing sash locks, and installing weather-stripping is usually considered air sealing, not repair work (see *Air Sealing and Indoor Air Quality in Chapter 1 – Section 1.4*).

6.1.1 Window Repair and Replacement

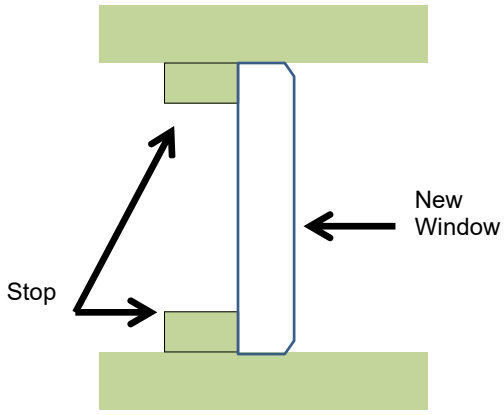
Observe the following standards for window repair and replacement:

1. Seal around a replacement window on the exterior and interior to prevent water intrusion and air infiltration.
2. When replacing or installing new exterior trim or stop, prime all bare wood.
3. When replacing a broken pane of glass, size the replacement pane $^{1}/_{8}$" to $^{3}/_{16}$" smaller than the opening, to allow for movement of the frame.
4. Install tempered safety glass when the location requires it.

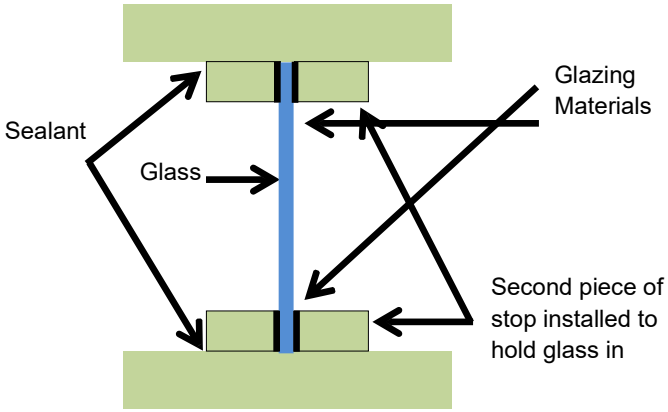
Replacing or Repairing a Basement Window

Determining whether to repair or replace windows located in an unintentionally conditioned basement is based upon customer use. Covering the entire window with plywood or other sheathing should only be considered when it is clear that the customer is agreeable to this option.

Before installing a new basement window, remove rotted framing and replace with pressure-treated lumber. Seal around framing to prevent water intrusion. Standard-size vinyl basement windows are a good choice for replacement when the customer requires an operable window, or cut a custom-sized piece of glass for the opening, allowing natural light to enter. Install a stop inside the framing as needed to place new window or glass against. A second piece of stop is used to hold the glass in place from the inside, creating a fixed-pane window.



Side view of new basement window installation using treated framing stop.



Side view of basement window glass installation using treated framing stop.

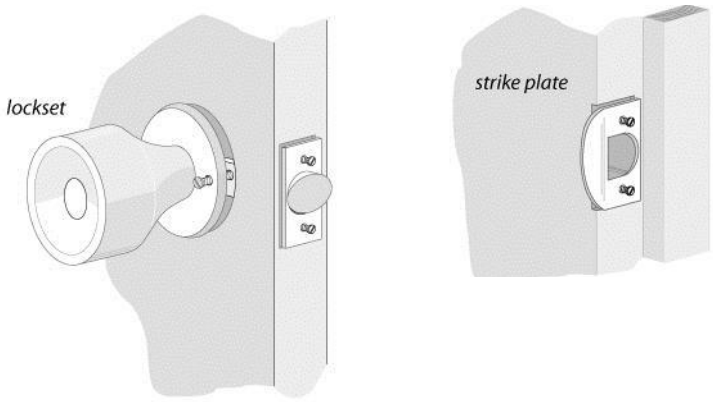
6.1.2 Door Repair and Replacement

Door operation affects building security and durability, so doors are often an important repair priority. Only primary doors may be replaced.

Door Repair

Door repair can also save energy if the existing door fits poorly. To improve the air seal of a door, limit door repair to the following work:

1. Replace missing or inoperable locksets. In some cases, a modernizer kit may be necessary.
2. Replace, install, or reposition the strike plate, as needed.
3. Replace, install, or reposition stops, as needed.
4. Replace deteriorated threshold.
5. Install a door shoe if needed to repair damage.



Minor door repair: Tightening and adjusting locksets, strike plates, and hinges helps doors work better and seal tighter.

Replacing a Primary Door

Follow these instructions when replacing a primary door:

1. Seal around the replacement door on the exterior and interior to prevent water intrusion and air infiltration.
2. If replacing or installing new exterior trim or stop, prime all bare wood.
3. After installation, confirm the door opens and closes smoothly, latches, and locks when shut.

Replacing or Fabricating a Basement Door

In older homes, basement exterior doors are often odd shapes and sizes. Sometimes, no door is present. If a door is present, it is sometimes in disrepair. Often weatherization installers fabricate a replacement door out of lumber — for air-sealing purposes, for security reasons, to preserve weatherization materials, or to maintain the integrity of the existing building materials.

Follow these instructions when fabricating a replacement basement door:

1. Use treated lumber.
2. Take precautions to reinforce the door, to prevent warping and to ensure longevity.
3. Seal around the replacement door framing on the exterior and interior to prevent water intrusion and air infiltration.
4. Insulating the fabricated basement door is optional. If insulated, insulation should be a minimum of R-5.
5. After installation, confirm the door opens and closes smoothly, latches, and locks when shut.

Final Inspection and Quality Assurance Standards

Acceptable installations shall meet the following standards.

General Repairs

1. The repairs are necessary for the effective installation, performance, and/or preservation of weatherization materials installed in the building.
2. The repairs are cost efficient and correct the problem(s) at hand.

Window Replacement

1. Window installation meets program instructions and the window unit is ENERGY STAR® certified.
2. The installed window opens smoothly and operates properly.
3. The installed window is installed square, plumb and true, as structurally allowable.
4. The installed window does not leak.
5. Installation meets all applicable best practices (e.g., flashed effectively, unit is back caulked, etc.)
6. Proper lead-safe work practices are documented in file.
7. The customer file contains photographs of the pre-existing window, and the photographs demonstrate the pre-existing window met the Wisconsin Weatherization Program guidelines for replacement.

Door Repair

1. All necessary door repairs were undertaken.

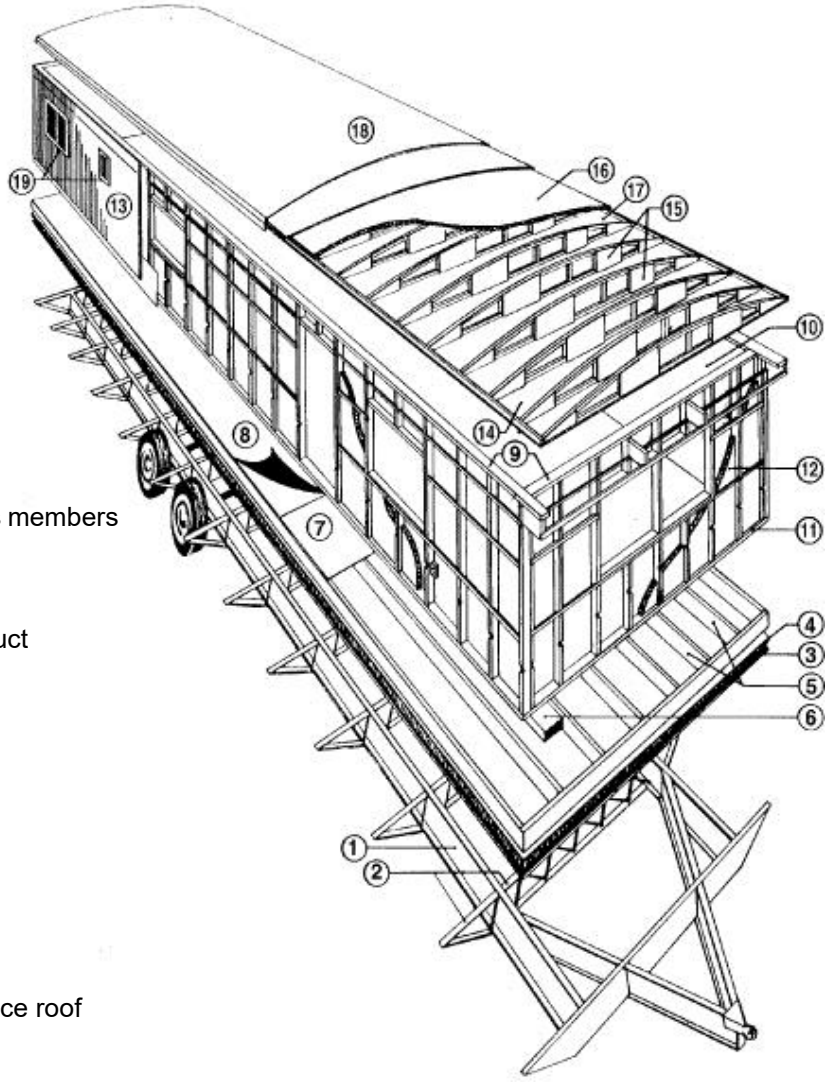
Door Replacement

1. The installed door opens and closes easily, latches tightly, and performs its function.
2. Replacement door meets R-value requirement.
3. Installation meets all applicable best practices (e.g., flashed effectively, back caulked, etc.).
4. Proper lead-safe work practices are documented in file.
5. The installed door does not leak.
6. The installed door is installed square, plumb and true, as structurally allowable.
7. The customer file contains photographs of the pre-existing door, and the photographs demonstrate the pre-existing door met the Wisconsin Weatherization Program guidelines for replacement.

Chapter 7: Manufactured Home Weatherization

7.1 Manufactured Home Weatherization

Manufactured homes, also known as mobile homes, present unique weatherization opportunities and challenges. Often, manufactured home weatherization practices differ from the practices for site-built dwellings. Manufactured homes typically use more energy per square foot than site-built homes, but their standard construction makes them more straightforward to weatherize. Insulation retrofits, air sealing, duct sealing, and replacement heating systems present some of the best energy-saving opportunities in manufactured homes.



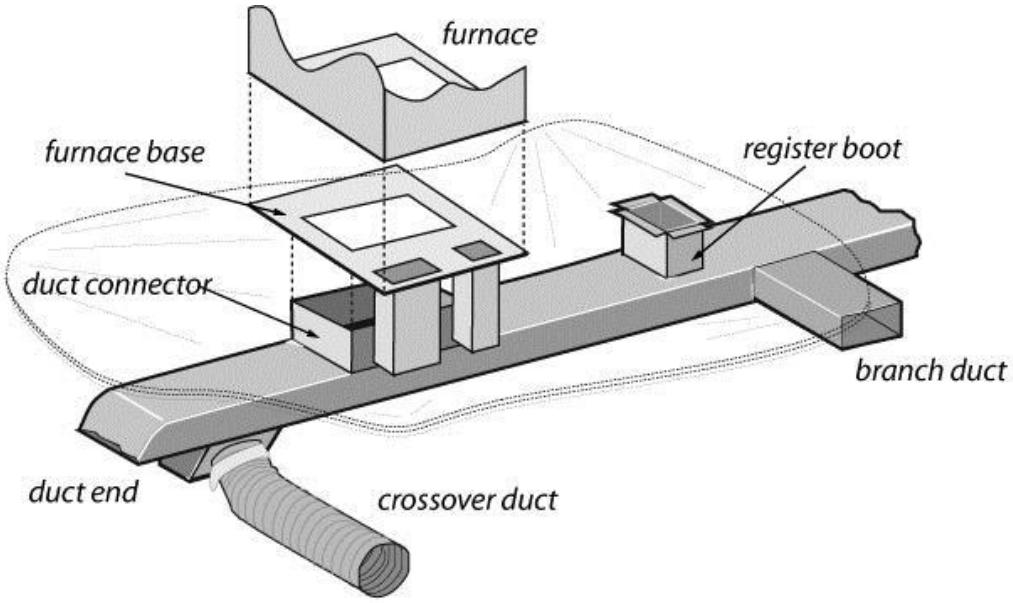
Typical Components of a Manufactured Home:

1 — Steel chassis
2 — Steel outriggers and cross members
3 — Underbelly
4 — Fiberglass insulation
5 — Floor joists
6 — Heating/air conditioning duct
7 — Decking
8 — Floor covering
9 — Top plate
10 — Interior paneling
11 — Bottom plate
12 — Fiberglass insulation
13 — Metal siding
14 — Ceiling board
15 — Bowstring trusses
16 — Fiberglass insulation
17 — Vapor barrier
18 — Galvanized steel one-piece roof
19 — Metal windows

7.2 Supply Distribution System

Manufactured home supply ducts are usually outside the home's pressure boundary and often leak significantly, presenting an opportunity for savings through effective duct sealing. Sealing the ductwork should be completed prior to any repair work to the belly or insulating the belly cavity. Many leakage points in the system can be accessed from underneath the belly or from inside the home, see *Chapter 7 – Section 7.2.3*.

Visually inspect ducts and registers using a digital camera, borescope, or mirror and flashlight to identify large holes, gaps, or disconnected sections. Take photos by placing the camera (with the strap around the wrist) inside of the ductwork.



Manufactured home ducts: Manufactured home ducts leak at their ends and joints–especially at the joints beneath the furnace. The furnace base attaches the furnace to the duct connector. Leaks occur where the duct connector meets the main duct and where it meets the furnace. Branch ducts are rare, but easy to find because their supply registers are not in line with the others. Crossover ducts are found only in double-wide and triple-wide homes.

7.2.1 Pressure Pan Duct Testing

To measure the relative leakiness of the forced-air distribution system, complete the following steps:

1. Set up the manufactured home in winter condition, with all interior doors open and stationary.
2. Set the digital gauge to "PR/PR" and connect a pressure hose from a reference tap to outside. Measure the baseline House with respect to Outside (HwrtO) pressure. Turn on the blower door fan and adjust it to create a 50-pascal pressure difference HwrtO adjusted for baseline.

3. Without changing the blower door speed, disconnect the outdoor pressure hose from the digital gauge. Connect a pressure hose from an input tap to the pressure pan.
4. Go to the supply register located furthest from the furnace on one end of the manufactured home. Place the pressure pan over the register and record the pressure difference in the Diagnostic Workbook.
    a. If the positioning of the register does not allow the pressure pan to form an airtight seal, other materials (duct mask and cardboard, etc.) may be used to create an airtight seal over the entire register. After developing an airtight seal, attach a metal pressure probe to the end of the hose. Puncture a small hole in the sealing material, insert the metal probe into the hole, and record the pressure difference.
5. Repeat Step 4 (4a) at all remaining registers in the home.

7.2.2 Interpreting Duct Leakage Results

When duct leakage exists, it allows air to infiltrate the ductwork; this infiltration causes the pressure difference as measured by the pressure pan between the supply ducts and the main body of the home. The more existing duct leakage, the greater the pressure difference between the ducts and the home's interior.

If ducts on one side of the home exhibit higher (less negative) pressures than ducts on the opposite side, substantial duct leakage exists in the general vicinity of those higher-pressure ducts, rather than at each duct individually. If such a discrepancy is observed at the ducts surrounding the furnace, this may indicate a need for duct sealing on the ductwork and connections near the furnace.

7.2.3 Manufactured Home Duct Sealing

If possible, seal supply ductwork located in the manufactured home belly so the cumulative pressure pan readings of all registers is 3 pascals or less, when the home is at 50 pascals with respect to outside. When duct sealing does not reduce the cumulative reading to 3 pascals or less, discontinue duct sealing and document the results in the Diagnostic Workbook.

The following locations are typically sealed from inside the manufactured home:

1. **Furnace to plenum connection when AC is not present:** Access this area by removing the A-coil access panel when no central air conditioning is present or gain access to this connection from underneath by cutting a hole in the road barrier under the heating system. Seal the road barrier after the duct sealing is completed.

    Since the temperature at this location can be very high, it is recommended to use materials other than butyl tape, such as step-flashing cards, whenever possible. Butyl tape sags and loses its adhesive properties quickly at elevated temperatures.

    For small to medium holes apply butyl tape and/or mesh tape and then apply a thick coat of mastic over both. To seal larger holes, attach sheet metal with fasteners taking care to seal the edges using mesh and mastic. Small holes and seams can be sealed with mesh

and mastic or mastic alone. Mesh is applied over all butyl tape, overlapping onto the ductwork to ensure a lasting seal.

2. **Register risers (collars) to floor and trunk:** Access this area by removing the floor registers or gain access to this connection from underneath by cutting a hole in the road barrier directly under the riser. Seal the road barrier after the duct sealing is completed.

   Secure riser to trunk and/or floor before sealing connections. Large gaps can be covered with step-flashing cards. Be sure to sandwich mastic between the card and ductwork to obtain a permanent seal. Take care when sealing the riser to the top of the floor covering to allow the register enough room to seat correctly. Do not extend the tape beyond the lip of the register. As with all applications, butyl tape should be covered and overlapped with mesh tape and mastic, completely imbedding all exposed butyl tape, however, this may not always be possible at the top of risers.

3. **In-floor trunk lines:** Access this area by removing the floor register. Short pieces of pre-formed J-channel work well to hold collarless trunks tight to the floor before sealing with mastic. Trim channel as needed to ensure it is covered by the register.

4. **Trunk Termination:** The ends of trunk lines are often not sealed. Access this area by cutting into the road barrier directly at the end of the trunk. Seal the trunk termination by using butyl tape and overlapping with mesh tape and mastic. Seal the road barrier after the duct sealing is completed.

   An optional method, when sealing the trunk termination is not possible, is to install a “scoop” or blocking after the last register. Ensure the scoop or blocking will not cause a pressure imbalance or reduce the air distribution at other registers. The scoop is constructed of sheet metal and is sealed to the duct walls, as per normal procedures. Ductwork is normally constructed to provide static pressure, which equalizes flow. When scoops are installed, they reduce the ability to create static pressure and the result is increased flow out of the scooped register. If the scoop is installed in ductwork in a room already getting adequate air flow, comfort and pressurization issues may arise.

   Another option for blocking is to use the friction fit bag method. Push the bag as far back as possible from the last register and if access allows seal the bag in place with mastic.

The following locations are typically sealed from under the manufactured home. The road barrier (belly) may need to be cut open to gain access to the ductwork.

1. **Trunk to crossover duct on double-wide manufactured homes:** Generally constructed of insulated flex duct, the inner sleeve shall be mechanically secured and sealed to the starter collar of the main trunk. This is usually accomplished with strap ties or large diameter hose clamps. Sealing is generally performed with mastic. The outer sleeve is then secured to the trunk or the road barrier but does not need to be sealed.

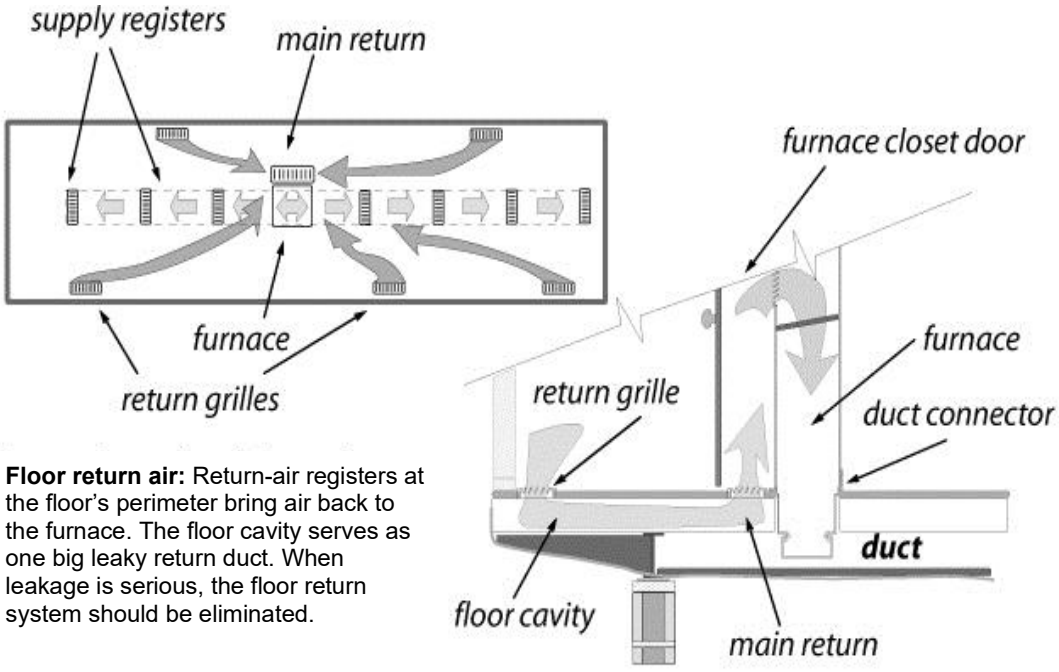
2. **Plenum to trunk connections when central AC is present:** The trunk is opened directly below the furnace. It is recommended this piece be removed and replaced with an oversized piece of sheet metal either mechanically fastened to the inside or outside of the trunk. Placing the piece on the inside of the trunk ensures it will never sag or fall

out. As with all metal-to-metal connections, sandwich them with mastic. Sealing is performed in the same manner as Number 1 above.

3. **Take-offs from main trunk to side registers:** These connections can only be accessed from below the manufactured home. They are particularly leaky in ductboard trunk lines. Seal using the same materials and methods as used for collars and risers.
4. **Ends of trunk runs, abnormal leaks, anomalies, and any seams between sections:** The seams and other unusual leaks can be very difficult to locate. It is recommended the technician physically inspect all ducting whenever possible to find these leaks that may not otherwise be addressed. Seal as appropriate for the wide range of conditions that may be encountered.

7.3 Return-Air Distribution System

Many manufactured homes do not have ducted return systems; instead, the entire cavity or attic space is used as a return duct. Eliminate floor and ceiling cavities used as return-air plenums in favor of having return air flow through the hallway directly into the furnace.



Floor return air: Return-air registers at the floor's perimeter bring air back to the furnace. The floor cavity serves as one big leaky return duct. When leakage is serious, the floor return system should be eliminated.

To eliminate a belly return-air system:

1. Block all floor return registers with a durable and tight air barrier, being careful to find hidden return registers under built-ins, behind furniture, and in kitchen cabinet kick-spaces.
2. In the furnace closet, block all floor duct openings completely. If the existing atmospheric furnace is retained, be careful not to seal its combustion air inlet.

3. Install grilles or a louvered door to provide furnace manufacturer's recommended net free return grille area in the furnace closet door.
4. Measure the temperature rise of the furnace to confirm air flow is within the manufacturer's instructions.

7.3.1 Measuring Temperature Rise

The heating system's temperature rise should be within the range specified on the manufacturer's label. If no manufacturer's information is available, ensure the furnace has sufficient air flow so the temperature rise is between 40° and 80°F.

To test the temperature rise of a manufactured-home heating system:

1. Inspect the plenum/furnace joint before measuring the temperature rise. Repair this joint, if needed, after completing testing.
2. Make sure all interior doors are open and stationary, except the furnace closet door.
3. Close the furnace closet door completely.
4. Turn on the furnace and allow the furnace to reach full steady-state conditions. Measure the supply temperature at the register closest to the furnace, making sure the air flow to this register is not blocked and no significant duct leakage exists between the furnace and the thermometer.
5. Subtract the house air temperature (the return air) from the supply air temperature. The difference is the temperature rise.

If the temperature rise is too high or too low, investigate for restrictions to air flow or remaining duct leakage. The fan speed may be adjusted to bring the temperature rise within the acceptable range.

7.3.2 Measuring Room Pressure Differences

When interior doors are closed while the heating system operates in a manufactured home, the supply air pressurizes the room and creates a pressure imbalance between the room and the main body of the home. This room-to-house pressure difference causes increased air exfiltration through that room's primary pressure boundary. Mitigating or eliminating the room-to-house pressure differences saves energy by reducing air leakage through the room's primary pressure boundary.

To measure individual room pressure differences:

1. Start/operate furnace air handler.
2. Measure the pressure difference across each interior door, one at a time. Place a hose inside the room away from the supply register and connect to the input tap of the digital gauge. Close the door, making sure the hose is not pinched or restricted. Record the room pressure with respect to house on the Diagnostic Workbook. If the room does not have a supply register, do not measure it.

3. Rooms with a measured pressure of greater than 3 pascals are excessively pressurized indicating the necessary path for return air is not present. A connection between the room and house can be achieved by the following:
    a. Undercut the door (usually this is the most cost-effective option),
    b. Install a grille in the door, or
    c. Install a jumper duct under the floor.

After determining the size of the opening needed to lower pressurization, consult with the customer as to the best option for their situation. A simple method to determine the size of the opening needed to lower the pressurization in a room is to open the door slowly while measuring the pressure difference across the door until the pressure difference is 3 pascals or less. Measure the square inches of the opening created. This is the minimum net free area of room-to-house opening required to reduce the pressure difference to 3 pascals or less.

Example: *The door is opened by 2 inches, and the door is 80-inches tall. The net free opening to be added would be 160-square inches. Divide this area by the width of the door to determine how many inches need to be cut off the bottom of the door. An example would be 160/32 or 5 inches. This is probably not going to be an acceptable solution (from a privacy standpoint). A door grille with 160 square inches of net-free area may be a better solution.*

7.4 Floor/Belly Insulation

Manufactured home existing floor cavities are usually insulated with wide fiberglass blankets attached to the bottom of the floor joists (typically 2 x 6 joists). Therefore, the entire cavity is uninsulated. In floors with transverse floor joists (following the width of the home), the duct is attached to the bottom of the floor joists, resulting in a dropped belly. This enlarged floor cavity can require an excessive amount of insulation, unless technicians can pin the belly material up to the floor joists to reduce the belly's volume. Average insulation densities for loose fill insulation installed in manufactured home bellies will be 1.25 to 1.75 pounds of blown fiberglass per cubic foot. **Do not dense-pack or over-fill this area.**

7.4.1 Preparations for Belly Insulation

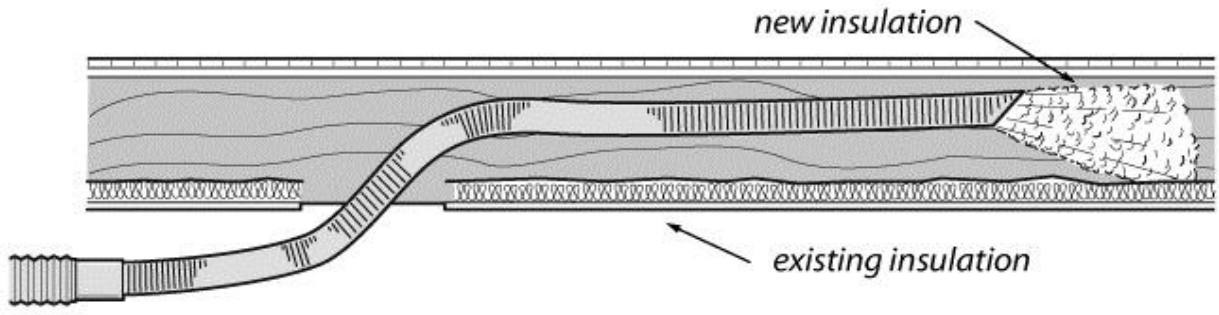
Manufactured homes normally have a "road barrier" of fiberboard or tough fabric that protects the floor from rodents and road dirt during transport. Damage to this barrier is common and results in air leakage. Before installing belly insulation, follow these preparatory steps:

1. Confirm no water or sewer leaks are present. Confirm with customer if previous leaks or frozen pipes have occurred and document the locations. If leaks are discovered, contact the energy auditor or project supervisor for guidance on how to proceed.

2. Complete duct sealing (see *Return-Air Distribution System in Chapter 7 – Section 7.3*) and non-guideline air sealing around floor penetrations (see *Air Sealing in Chapter 7 – Section 7.7*) before installing floor insulation.
3. A vapor barrier may be used to provide a working surface for installers and ground moisture control. Remove the vapor barrier when site conditions may cause surface water under the manufactured home to pool on top of this barrier if leaving in place.
4. Secure water pipes up, as close to the floor joists as possible, so insulation will fill in beneath them. This ensures plumbing pipes are located on the interior (warm) side of the thermal boundary, to prevent frozen pipes. If this is not possible, insulate the pipes separately or insulate the belly underneath the pipes, leaving the space above the pipes uninsulated to allow ambient heat from the home to warm the pipes and prevent freezing.
5. With flexible dropped bellies, try to fasten the belly material to the floor joists in order to eliminate excess volume of the belly.
6. Repair holes in the belly, except those that provide convenient access for blowing insulation. Fasten belly patches with adhesive, clinch staples, or screws and lath strips, to provide durable patches. For large holes in road barriers, preferred patching materials include insulated sheathing board, fiberboard, and nylon reinforced mesh specifically manufactured for manufactured homes.

7.4.2 Insulating the Belly from Underneath

Blowing insulation into the belly with a large diameter fill tube from underneath is an effective and preferred installation method. The conditions and space restrictions underneath the manufactured home determine whether this option should be considered. A ground moisture barrier makes installing the insulation more comfortable for the installer. Insulation can be blown through existing holes in the road barrier before patching them. Installers should note where insulation has been installed and where it has not been installed. Some of the floor areas usually may only be accessible from underneath if they are to be filled at all.



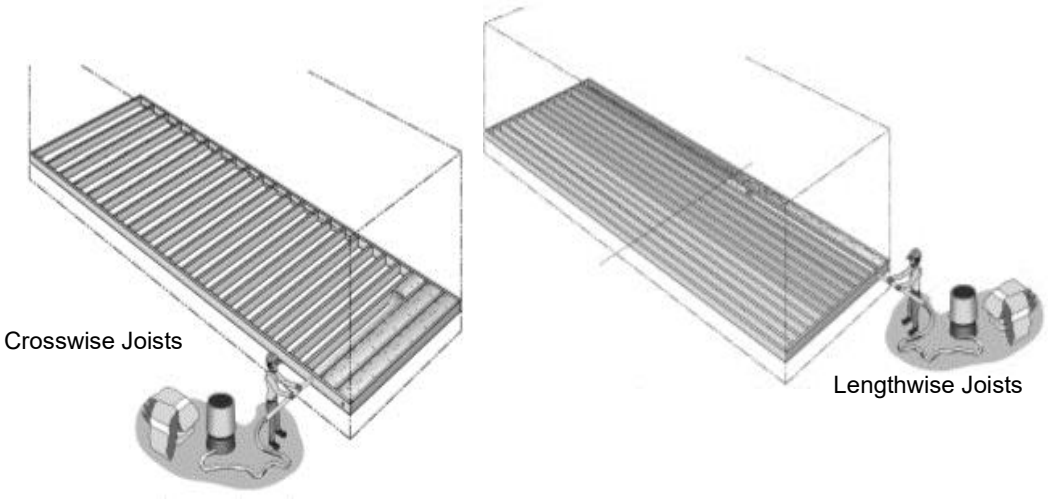
Blowing bellies: A flexible fill tube, which is significantly stiffer than the blower hose, blows fiberglass insulation through a hole in the belly from underneath the home.

Fill tube inserted into belly hole.

Blowing insulation from under the home: A large diameter fill tube fills cavities rapidly from underneath.

7.4.3 Rim Blow through Rim Joists

Blowing insulation through the rim joist is another installation method. However, rim joists may not be drilled if they are determined to be a structural component of the foundation support system or if floor joists are 24 inches or greater on center. Drilling can be dangerous without a good drill and a sharp bit. To avoid weakening the door threshold, do not drill beneath doors. Do not drill directly through trim covering rim joist. Use wooden plugs to seal holes drilled in the rim joist. When possible, substitute the wing blow (see *Wing Blow in Chapter 7 – Section 7.4.4*) to avoid structural problems.



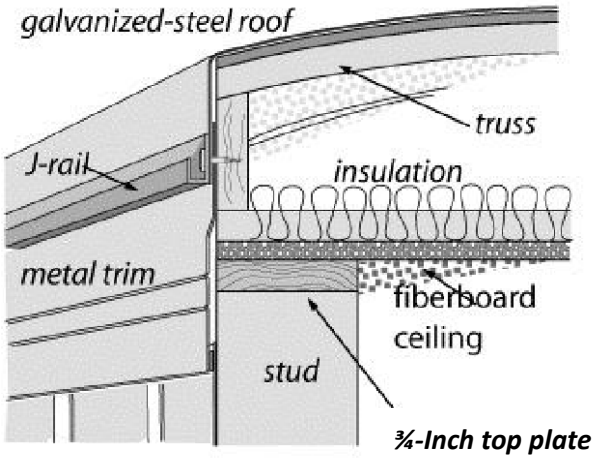
Insulating through the rim joist: Manufactured homes have either lengthwise or crosswise joists.

7.4.4 Wing Blow

Blowing insulation through the belly at the wing is a variation of the rim joist blowing technique. This method has some of the advantages of blowing from underneath and blowing through the rim joist. Specific areas, notably the floor cavity between the hole and the installer, need to be insulated using a shorter flexible fill tube. If bellies cannot be insulated through the rim joist and must be insulated from the wing or underneath, the use of a large diameter fill tube is preferred.

7.5 Attic/Ceiling Insulation

Fiberglass batts or blankets are usually present in the narrow roof cavity, but there is typically room for additional insulation. The space available typically varies from 1 or 2 inches along the building's edge, up to 10+ inches in the center for homes with bowstring trusses. Lightweight sloped-roof trusses provide up to 3 inches at the edge and up to 2 feet at the center. Crews may use a variety of methods to insulate manufactured home roof cavities, depending on the characteristics of the roof cavity, personal methodology preferences, and conditions on-site. Install insulation at uniform coverage and density between 1.25 and 1.75 pounds per cubic foot. Typically, it is more difficult to insulate the edges of the attic, so ensure insulation covers these areas.



Bowstring roof details: Hundreds of thousands of older manufactured homes were constructed with these general construction details.

7.5.1 Preparing for Ceiling Insulation

Inspect the ceiling and roof to determine if conditions allow for adding insulation. It is important to perform repairs, as needed, to reinforce the ceiling.

Before installing ceiling insulation, follow these preparatory steps:

1. Hold insulation 3 inches back from recessed light fixtures, fan and heater housings, and chimneys not insulation contact (IC) rated. IC rated light and fan fixtures may have insulation surrounding them. Chimneys with zero-clearance thimbles can also contact insulation.
2. Complete air sealing around chimney bypasses above the heating system and water heater if present.
3. Inspect for ceiling openings in closets and cabinets and confirm insulation will not spill down through the ceiling into these areas.
4. Seal bypasses. If accessibility restrictions prevent air sealing, document the reason(s) in the customer file.

5. Mark the fill tube at 1-foot increments. If the edge is 7 feet from the hole, insert the fill tube to the 7-foot mark; if the fill tube does not go in far enough, try again.

7.5.2 Blowing the Roof Cavity from the Roof Blowing from a Square Hole

With customer approval cutting a 10-inch square hole directly over a truss gives access to two joist cavities and enough room to maneuver a 2-inch diameter fill tube. This large fill tube allows for a fast fill rate. The hole is stuffed with fiberglass batt to make it stand high. Patch the hole with a 14-inch square piece of stiff galvanized steel sheeting, sealed with roof cement and screwed to the roof with sheet-metal screws. Cover the patch with an 18-inch square piece of peel and seal butyl-aluminum roofing.

7.5.3 Blowing the Roof Cavity through Round Holes

Some technicians prefer drilling smaller holes to cutting the large square holes. This method requires using a smaller diameter fill tube to fill the roof cavity. The holes are filled with plastic plugs and sealed with silicone caulking. The plugs are covered with 6-inch-square patches of peel and seal. With this method, the holes are easier to patch. However, this system requires more holes in the roof.

7.5.4 Blowing a Pitched Roof

Pitched roofs are common in double-wide manufactured homes. More volume exists under these roofs than in a metal-roofed single-wide manufactured home. The density will be lower (≤ 0.6lb/ft^3) than when blowing the narrower, more airtight cavities and the cavity does not need to be completely filled to the peak. These roof cavities are often accessible through roof vents or the gable end.

In double-wide manufactured homes, adequate clearance may exist to insulate the ceiling cavity as an open blow. Access to the ceiling cavity can be gained through the gable end by removing the siding panels. Planking is usually necessary to distribute the weight of the installer and to make moving among the webbed trusses easier.

7.5.5 Blowing the Roof Cavity from the Edge

Metal roofs on manufactured homes are usually fastened only at the edge, where the roof joins the wall. When there is clear access along one long side of the home, this method can result in a fast and effective fill with minimum disturbance to the roof.

This procedure requires scaffolding in order to be performed safely and efficiently.

Carefully reseal the roof edge after insulating the cavity. The best way to refasten the roof edge is to

Roof-edge blowing: Use a rigid fill tube to blow insulation through the roof edge. This avoids making holes in the roof, though this process requires much care in refastening and resealing the roof edge.

seal it to the framing with new putty tape and staple it with an air-powered stapler, the way it was originally fastened. Also, seal the J-rail with putty tape, and re-screw it with larger sheet-metal screws.

7.5.6 Interior Drill and Blow

Drilling holes and blowing insulation into the roof cavity through a fill tube from the interior is a good procedure for inclement weather or when the exterior condition of the roof will not support other methods. The larger the hole, the easier it is to maneuver the tube out to the edge of the roof cavity. Use a plastic plug that matches the hole size. Use care not to damage the hole because the edge of the plug will not hide very much damage around the hole. If all of the holes are drilled in a straight-line, trim board may be installed to hide the drill holes.

Installing insulation through the ceiling: The technician pushes the fill tube into the cavity and out near the edge of the roof. The holes are drilled in a straight line for aesthetics.

7.6 Sidewall Insulation

The sidewalls of many manufactured homes are not completely filled with insulation. This reduces the R-value of the existing insulation because of convection currents and air leakage.

Before installing sidewall insulation, follow these steps:

1. Ensure the customer is aware of any pre-existing damage to the walls as well as the potential damage that can occur from insulating the walls.
2. With customer approval, remove pictures and wall hangings from the interior walls. Re-hang pictures and wall hangings after insulating the walls.
3. Add nails or screws to interior paneling and trim as necessary to reinforce interior walls.
4. Inspect the electrical system to determine if the wiring and circuit breakers or fuse box is adequate. Check the area around wall switches and outlets to determine if there is evidence of past electrical problems.

Checking walls: Measure the cavity and the existing insulation level. Make sure wall outlets work before and after insulation installation.

Do not insulate the walls if the wiring is in poor condition. If the wiring is poor in a specific area, contact the energy auditor or site supervisor for guidance on how to proceed. Document the conditions in the customer file.

If aluminum wiring is present, take the following precautions:

1. Mark cavities with outlet, switch, or light fixture on the outside siding. These cavities should be carefully tubed rather than stuffed with a batt, or, if excessive movement of the wires will still occur, then the cavity should not be insulated.
2. Test each outlet, switch, or light fixture to confirm that it is operating properly before insulating. Re-test afterward.

7.6.1 Preparing Siding for Wall Insulation

Metal siding on manufactured homes is typically installed vertically. Most metal-sided manufactured homes have horizontal rows of screws, which attach siding to horizontal 1 x 2 belt rails. Remove the bottom two rows when using the wall stuffing technique. To use the sidewall blowing technique, remove only the bottom row of screws. The metal siding joins piece-to-piece, with the first piece sliding inside a crimped channel in the second piece. It is better for this joint to remain together. Fastening a short sheet metal screw through the two sheets keeps them together during the insulation process.

Loosening siding for wall insulation: Remove screws at the bottom of the metal siding. Before installing insulation, fasten the siding sheets together at the bottom with a short sheet-metal screw.

Occasionally, manufactured-home siding is horizontal instead of vertical. To insulate these cavities, simply remove the bottom row of siding. Reinstall the siding when the insulation work is complete.

7.6.2 Sidewall Blowing Technique

Blowing insulation into manufactured-home sidewalls is similar to insulating sidewalls of site-built homes, although the fiberglass insulation is installed at a lower density. Take care not to create bulging walls during installation.

Insulate to the maximum structurally allowable. Insulate walls with complete coverage and uniform density throughout the accessible wall cavity. Insulating above windows is not required.

Bowing walls: Using a fill tube works well for most mobile home wall cavities.

7.6.3 Sidewall Stuffing Technique

The best materials for this method are batts completely encased in breathable polyethylene film. Unfaced batts also work, when installed with a plastic sheet. The smooth plastic sheet allows the batt to slide up the wall against the interior paneling, without snagging or bunching. Some homes do not lend themselves to this technique because of obstructions in the walls.

7.7 Air Sealing

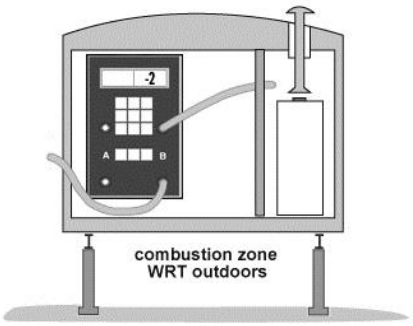
See *Air Sealing in Chapter 1 – Section 1.4* for additional information.

7.8 Combustion Appliance and Fuel Distribution Safety

See *Combustion Appliance and Fuel Distribution Safety* in *Chapter 5 – Section 5.8* for additional information.

When the water-heater cabinet has an exterior door, best practice for completing depressurization testing is to insert testing probes via interior pathways. Run the hose through the exterior only when an interior pathway is not available.

When conducting gas leak detection, include gas piping under the manufactured home when accessible. Consider sampling ambient air for the percentage of LEL upon entry under the manufactured home.



Water heater greatest depressurization achievable (GDA) test: Measure depressurization in the water heater closet from indoors if possible.

7.9 Heating Unit Replacement

Replacement furnaces shall be approved for use in manufactured homes. Follow current policy for the minimum Annual Fuel Utilization Efficiency (AFUE) rating. Replacement units should fit the footprint of the furnace closet and shall not stick out into the hallway.

Follow these steps when installing a new manufactured-home furnace:

1. Install properly sized units according to ACCA Manual J or an equivalent sizing formula by calculating the heating loads based on the post-retrofit dwelling characteristics. Include a copy of the sizing calculation in the customer file.
2. Properly remove and dispose of existing unit.
3. Install a new furnace base, unless the existing base matches the new furnace.
4. Support the main duct underneath the furnace with additional strapping, if necessary, to hold it firmly in place.
5. Attach the furnace base firmly to the duct connector. Seal all seams between the base, the duct connector, and main duct with mastic and fabric tape.
6. Carefully seal the base plate to the floor, in order to prevent air leakage through the belly and floor.
7. Provide a complete air seal and weather seal around the new chimney and combustion air pipe where it penetrates the roof, ceiling, wall, and/or floor.
8. Provide a complete water-tight weather seal at the roof penetration. Reinforce the area underneath the roofing with plywood or other strong material if necessary, to create a strong patch and to prevent a low spot in the roof at the penetration. It is best for any

roof patch to be slightly elevated from the surrounding roof, to prevent water collection at the patch.

9. Conduct a combustion test and confirm the test results meet manufacturer's instructions.
10. Install a condensate pump, if necessary, to convey the furnace's condensate to an approved sanitary drain per code. See *Condensate Removal in Chapter 3 – Section 3.8.2*.
11. Use existing distribution system and gas supply line.
12. Provide an owner's manual with heating system replacements.

See *Heating System Measures in Chapter 3* for more information.

Condensate pumps: These small pumps install in the furnace cabinet.

7.10 Water Heater Replacement

Replacement water heaters shall be approved for use in manufactured homes. See *Water Heater Replacement in Chapter 4 – Section 4.1* for additional information.

7.10.1 Gas Water Heater Installations

The following standards are specific to gas water heater replacements:

1. Measure and adjust gas pressure to follow manufacturer's instructions.
2. Follow manufacturer's venting instructions along with the International Fuel Gas Code to establish a proper venting system.
3. Seal the combustion air sleeve where it meets the water heater tank, using an approved sealant, to reduce the likelihood of backdrafting.
4. Confirm the combustion air sleeve is properly sealed and drawing air from outside of the water heater CAZ.
5. Follow manufacturer's instructions to establish a proper combustion air system.
6. Verify there are no gas leaks in any of the supply piping.
7. Confirm the presence of a proper sediment trap on the gas line.
8. Test for carbon monoxide.
9. Remove and properly dispose of existing water heater.

7.10.2 Exterior Access Water Heater Closets

Follow these steps when addressing exterior access water heater closet:

1. Insulate water heater closet at the exterior closet door and associated wall area. Cover air vents if they are present and route combustion air (for gas units) from underneath the belly or through skirting.
2. Seal the common wall between the living area and water heater.
3. Ensure water heater is properly drafting after completing the work.
4. Insulate all water pipes to prevent freeze-up problems.

7.11 Repair

See *Repair in Chapter 6* for more information.

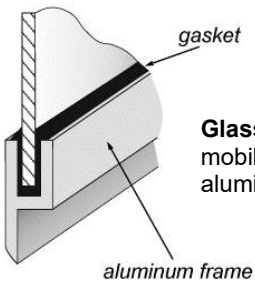
7.12 Window Replacement

See *Repair in Chapter 6 – Section 6.1.1* for more information.

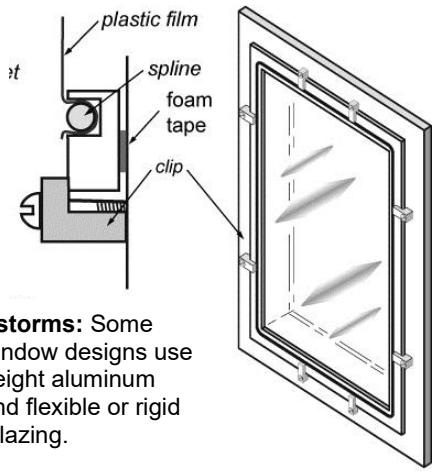
7.13 Interior Storm Windows

Interior storm windows double the R-value of a single-pane window and reduce air leakage, especially in the case of leaky jalousie prime windows. Install interior storm windows on primary single-pane windows that currently have no storm window when selected by the Manufactured Home Energy Audit for replacement as a measure or listed as a repair. The following types of storm windows can be installed:

- Install stationary, removable interior storms with awning- and jalousie-style windows.
- Install sliding interior storm windows to match exterior sliding prime windows. Make sure the movable sash of the storm window is on the same side as the primary window for horizontal sliders.



Glass interior storms: Traditional mobile home storm windows have aluminum frames glazed with glass.



Plastic storms: Some storm window designs use a lightweight aluminum frame and flexible or rigid plastic glazing.

7.14 Door Replacement

Install minimum R-5 or standard manufactured home replacement doors when listed on MHEA as a repair. Manufactured home doors come in two basic types: metal manufactured home doors and more typical wood-frame residential doors (as in stick-built homes). Manufactured home doors swing toward the outdoors and are usually not standard heights. House-type doors usually swing toward the interior of the home. If the existing door is a conventional door, See *Repair in Chapter 6 – Section 6.1.2*.

To replace a metal manufactured home door, follow these steps:

1. Measure the existing door and frame *before removing them* to ensure the replacement door is sized appropriately.
2. Exercise care and caution if removing the existing door trim, to enable trim to be re-attached after the new door is installed.
3. Remove and properly dispose of the old door — do not leave it on-site.
4. Install the new door frame plumb and level, using shims as necessary. Detaching the door from the doorframe first may make it easier to work with the doorframe.
5. Seal the space between the rough framing and the door frame. If spray foam is used for air sealing, use minimal expansion foam, since excessive foam expansion can force the door out of level or plumb.
6. Caulk around the door and frame as necessary to prevent water intrusion.
7. Confirm the new door opens, closes, latches, and locks properly.
8. Reattach the door trim.
9. If necessary, install a J-type channel above the door to direct rainwater away from the entry.

Final Inspection and Quality Assurance Standards

Acceptable installations shall meet the following standards.

General Instructions

1. All work follows the regulations of all authorities having jurisdiction.
2. All materials are installed to manufacturer instructions.
3. All debris is removed from the job site and properly disposed, recycled, or delivered to a licensed hazardous waste facility.
4. All applicable building permits were attained.
5. When applicable, all materials must be approved for use in manufactured homes.

Heating Systems (See *Chapter 3* for general standards)

1. Heating system is approved for manufactured homes.
2. Thermostat is located on an interior wall.

Distribution Systems

1. Manufactured home return air system is centralized through living space.
2. Sheet metal with fasteners or a friction fit bag appropriately sealed was used to block supply ends extending beyond the last register.
3. Sheet metal with fasteners was used to block large holes in the distribution system.
4. Sealing material is not failing.
5. Total measured pressure of supply registers in a manufactured home is < 3 pascals when HwrtO = 50 pascals, unless sealing activity and documentation shows it is not cost effective to continue.
6. Room pressures are < 3 pascals when the air handler is operating.

General Repairs

1. The repairs are necessary for the effective installation, performance, and/or preservation of the weatherization materials installed in the building.
2. The repairs are cost efficient and still correct the problem(s) at hand.

Glass Replacement

1. Glass is the correct type for the installation (e.g., tempered glass is required in doors and sidelights, within 6 feet of tubs, and for all windows less than 18 inches off of the ground or floor level; obscure glass may be required in bathrooms).

Window Replacement

1. Window installation meets program instructions and is ENERGY STAR® certified.
2. The new window opens smoothly and operates properly.
3. The new window is installed squarely, as structurally allowable.
4. The new window does not leak.
5. Installation meets all applicable best practices (e.g., drain planes, back caulked, etc.).
6. Proper lead-safe work practices are documented in file.
7. The customer file contains photographs of the pre-existing window, demonstrating unit met Wisconsin Weatherization Program protocols for replacement.

Door Replacement

1. The new door opens and closes easily, latches tightly, and performs its function.
2. Replacement door meets R-value requirement.
3. Installation meets all applicable best practices (e.g., drain planes, back caulked, etc.).
4. Proper lead-safe work practices are documented in file.
5. The replacement door does not leak.
6. The replacement door is installed squarely, as structurally allowable.
7. The customer file contains photographs of the pre-existing door, demonstrating unit met Wisconsin Weatherization Program protocols for replacement.

A-1: Glossary

ACH: air changes per hour, an estimate of building ventilation or air leakage rates.

ACH_{50}: air changes per hour at 50 pascals, a measurement of a building's air leakage rate, as determined with a blower door.

ACH_{nat}: air changes per hour (natural), an estimate of building ventilation or air leakage rates under normal operating conditions.

Add-A-Hole Method: A zone pressure diagnostic test to measure/estimate serial leakage, involving adding a hole of known size to one side of the series leakage path and measuring the pressure differential before and after adding the hole.

AFUE: Annual Fuel Utilization Efficiency, the seasonal efficiency of a space heating system. It is expressed as the percentage of useful energy delivered to a building, as impacted by long-term weather conditions, compared to the amount of energy consumed.

AGA: American Gas Association, an organization that provides standards for gas appliances and fuel systems.

Appliance: Any device (refrigerator, freezer, etc.) powered by electricity designed for household use. May be replaced as an ECM as approved by the Division.

ASHRAE: American Society of Heating, Refrigeration, and Air Conditioning Engineers, an organization that provides standards for a wide variety of space conditioning and ventilation work.

Base load measures: Energy conservation measures that reduce any energy use of the dwelling unit that is not driven by weather. Base load ECMs may include water heater replacement, LED lamp replacement, or refrigerator and freezer replacement.

Basement: The substructure of a building, with the exterior walls forming the building foundation. Most of the basement is usually below ground. Wall heights vary but are usually higher than 70 inches. In Wisconsin, the basement is often the combustion appliance zone. If the basement is unintentionally heated by ducts or pipes, the work done on the basement is sealing and insulating the box sill and sealing any large opening in the exterior walls. If the basement is intentionally heated, the walls may be insulated on the exterior, based on how much is above grade exposure and the results of modeling the building with the NEAT audit. See *Chapter 2 – Section 2.5 Floor and Foundation Insulation* for more information on treatments.

Blower door: a system used to measure air leakage through a building shell, using a calibrated fan coupled with a pressure gauge.

BTU: British Thermal Unit, an SI unit of heat energy.

BTU/hr: BTUs per hour, a measurement of an HVAC system's capacity to consume fuel or deliver space conditioning energy.

CAZ: Combustion appliance zone.

CFL: Compact fluorescent lamp.