

Site Built Housing and Mobile Home Weatherization Specifications For the State of Oregon Weatherization Assistance Program



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Oregon Building Codes apply to all homes. Building codes include specifications on components and allowable installation methodologies.

SECTION 0: GENERAL INSTALLER REQUIREMENTS

- 00.01 Weatherization measures shall be installed in accordance to the specifications cited in this document, United States Department of Housing and Urban Development (HUD) code, and all applicable Oregon state codes and federal regulations, which may include the most recent versions of the Uniform Building Code (UBC) and the National Electric Code (NEC) and Uniform Mechanical Code (UMC).
- 00.02 Where state and local codes or specification regulations are in conflict, the most stringent requirement shall apply. When state and local codes are less restrictive, Oregon Housing & Community Services (OHCS) may approve their use in lieu of these specifications. Such approval shall be requested and approved in writing by OHCS before the measure is installed.
- 00.03 If a specific application is not addressed in the specifications, codes or regulations; the agency shall consult OHCS to determine appropriate action consistent with the codes, regulations and these specifications.
- 00.04 If a specific application or measure contained in these specifications is in conflict with the adopted heat loss computerized audit used in the low-income weatherization program by OHCS, the Site Built and Mobile Home Weatherization Specification shall take precedence over the computerized audit. Such deviation from the computerized audit shall be noted in the file.
- 00.05 Upon completion of weatherization work, a signed and dated insulation certificate indicating square footage insulated, R-value installed, type of insulation and bag count shall be posted at the job site. In addition, the coverage chart and ASTM standards off of the Insulation bag must be posted on the jobsite. A copy of the insulation certificate must be included in the job file. Best practice would be for the inspector to take a legible photo of the posted certificate and include it in the job file.
- 00.06 All materials installed shall meet Federal Material Specification and Standards listed in Appendix KK. Installers are responsible for knowing whether their products comply with this specification and are therefore eligible for installation under the program.
- 00.07 The installer shall warrant weatherization materials and labor against failure due to manufacturing and installation defects for a period of a least one year. It shall be the installer's responsibility to file a claim for replacement of any installed warranted material that carries a manufacturer's warranty in excess of one year (i.e. insulated glass units, 5 years).
- 00.08 When the installer evidences structural damage by obvious water stains, dry rot, termites, etc. it shall be immediately called to agency's attention.
- 00.09 The installer shall indicate to the client in writing any materials or components being replaced which are assumed to become the property of the installer (i.e., salvage).
- 00.10 Installers shall procure all permits, materials, and labor necessary to install weatherization measures in the residence unless noted elsewhere in this specification book.
- 00.11 Each job site shall be left clean (free of debris and surplus) at the completion of each job. Any damage resulting from the installation of measures shall be repaired at installer's expense.
- 00.12 A copy of the most recent revision of these specifications shall be given to each installer/crew by the agency for which they are providing services. A receipt for this document shall be kept in each installer's file.
- 00.13 The installer shall obtain from the Oregon Construction Contractors Board (CCB) a Lead-Based Paint Renovation (LBPR) contractor's license, when working on homes that may contain lead based paint or were built before 1978. See the Oregon CCB's website for more information <http://www.oregon.gov/CCB/lead-based-paint.shtml>. If the installer is exempt from the requirements to have a CCB license then the installer's business must file with the Oregon Department of Human Services as a lead certified firm. <http://www.oregon.gov/DHS/ph/lead/docs/RRPFirmApplication.pdf>

SECTION 1: ATTIC

- 1.01 General: material shall be installed according to the provisions of the current Oregon Building Code or other applicable codes and shall meet the requirements of agency weatherization program. Any exceptions shall be approved in writing in advance by the agency. Upon completion of weatherization work, a signed and dated insulation certificate indicating square footage insulated, R-value installed, type of insulation and bag count shall be posted at the job site. In addition, the coverage chart and ASTM standards off of the Insulation bag must be posted on the jobsite. A copy of the insulation certificate must be included in the job file. Best practice would be for the inspector to take a legible photo of the posted certificate and include it in the job file.
- 1.02 Sealing attic bypasses: sealing methods may vary and shall include but not be limited to the following locations: top plates of interior wall partitions, housing of exhaust fans and recessed lights; soil vent stacks and plumbing vents; duct work that penetrates the ceiling; electrical light boxes, clothes chutes, dumb waiters, and pocket doors.
- 1.03 Increase the attic insulation to a minimum of R-38 or the maximum allowable depth available. Depending on the weight of the material to be installed, allowances shall be made for compression of the existing material to ensure a final minimum value of R-38.
- 1.04 The installer is responsible for determining that the ceiling system is structurally adequate to support the additional insulation and load before installation. The installer shall be responsible for repair of ceiling damage during the installation of the ceiling insulation and associated work.
- 1.05 Heat producing fixtures: solid flame-resistant enclosures shall be securely attached around all heat producing fixtures such as Type B vents, doorbell transformers, and other miscellaneous line-voltage electrical devices.



Doorbell Transformer

Exhaust fans (without light fixtures) and exhaust fans with IC-rated fixtures are not considered heat producing fixtures and do not require shielding.

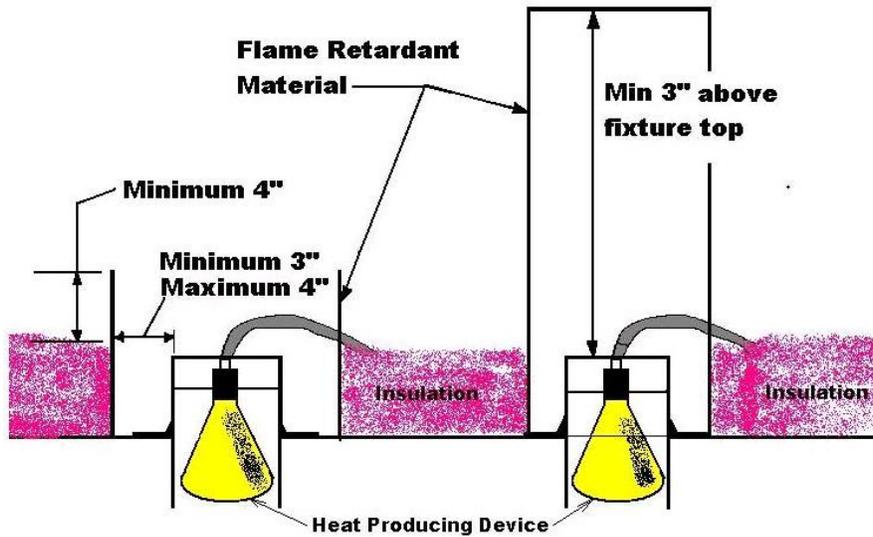
1. Shielding shall keep insulation at least 3 inches but not more than 4 inches from the sides of the fixtures.
2. Shielding shall extend at least 4 inches above the final level of insulation.
3. Shielding material shall be non-combustible and securely attached to the building.



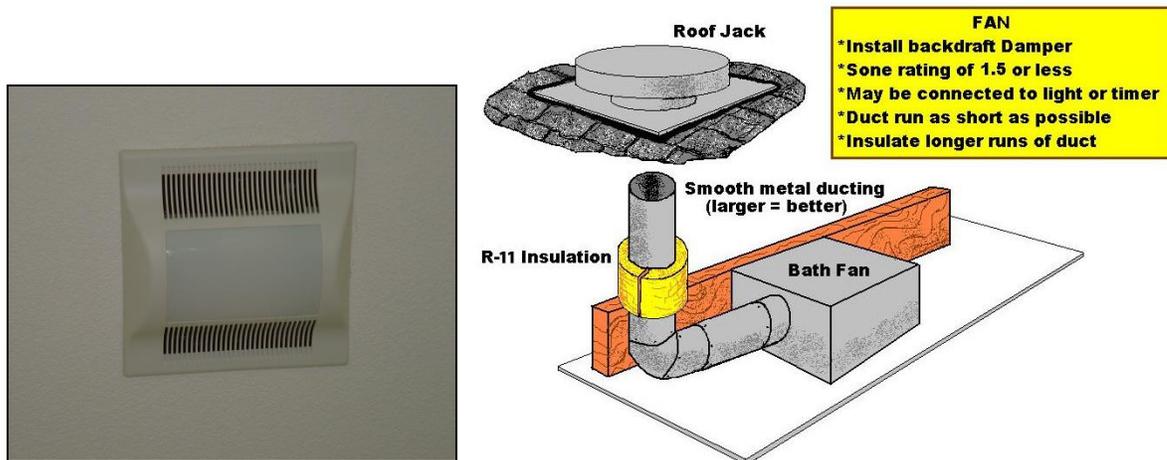
Shielded B Vent in Attic

1.06 Non-IC rated recessed light fixtures: An airtight enclosure taller than surrounding attic insulation will be placed over non-IC rated recessed light fixtures. The enclosure must be kept at least 3" away from the top and sides of any fixture. The top of the rigid barrier enclosure must be air sealed with non-insulating rigid material (e.g. gypsum or equivalent perm rating and R-value). The top enclosure material will be an R-value of 0.5 or less and must be left free of insulation. It is at the agencies discretion to choose to enclose recessed light fixtures or to shield them in a conventional manner.

Heat Producing Fixtures in Attics



Exhaust Fans



- 1.07 Bathroom and other exhaust fans, except kitchen exhaust fans, may vent through the attic space with a direct connection to the outside. The recommended method for ducting exhaust fans is to run the duct directly through a roof jack using rigid metal ducting. Use of existing roof vents is acceptable as long as attic ventilation requirements are maintained. If a convenient roof vent does not exist, one shall be added.
1. The run shall be as short as possible. Exhaust fans shall be equipped with an operating back-draft damper.
 2. Duct shall be smooth, rigid duct vent, mechanically fastened and at least the same diameter as the fan connection. Ducts should not have traps or reversing horizontal runs. It shall be substantially airtight to the outside (i.e. use of roof jack or other positive connector).
 3. Bathroom exhaust fans (that do not contain lights or heat lamps) are not heat producing fixtures and do not require shielding.
 4. Replacement fans shall have a Sone rating of 1.5 or less.
 5. It is acceptable for an exhaust fan to be connected to a light or timer.
 6. If an exhaust duct run must be installed in an excess of 8', then it is recommended to insulate the entire run of duct with unfaced R-11 fiberglass batts that are secured with twine to prevent condensation in the duct.
- 1.08 Kitchen range exhaust fans shall be connected with a manufactured duct of not less than 26 gauge galvanized sheet metal, substantially airtight to the outside (i.e. use of roof jack or other positive connector) and extended vertically, directly into a code-approved metal vent cap. This duct shall have no horizontal or 90 degree bends and shall be installed to meet all local building codes. The fan or duct system shall be equipped with an operating back draft damper.
- 1.09 Manufactured chimneys (i.e. "metalbestos") shall be shielded like any heat-producing fixture. All insulation shall be kept a minimum of 3 inches from metal flues. If fiberglass, rock wool or other non combustible loose fill insulation is installed in the attic space, no clearance is required around the masonry chimneys (**does not include cellulose insulation**). Non-combustible insulation is insulation material which conforms to the standard test method ASTM E136.82.

KNOB AND TUBE WIRING



- 1.10 Knob and tube electrical wiring is often found in the walls and attics of older homes. The possibility that insulation may trap heat produced by overloaded knob and tube wiring circuits requires insulation shall be kept 3 inches away from any live knob and tube wiring. Depending on agency policy, Oregon Building Code allows insulation to be installed over, around or in contact with knob and tube wiring if the following conditions are satisfied. (Oregon Building Codes Division, Temporary Rule effective January 1, 1993; Amends Part VI of the 1990 Edition of the Oregon One and Two Family Dwelling Specialty Code). See Appendix AA for sample electrical inspection report.
- 1.11 An unfaced fiberglass batt of highest R-value possible shall be placed under the knob and tube wiring. If knob and tube wiring exists in an attic space and is known to be dead (verified and documented by a licensed electrician) then the wiring may be covered by insulation.
- 1.12 A licensed journeyman electrician or a certified electrical inspector shall inspect all visible knob and tube wiring. This includes repairs, alterations or extensions to the electrical system.
 1. All defects found during the inspection shall be repaired prior to the installation of insulation.
 2. All knob and tube circuits shall have over-current protection in compliance with the 60°C column of Table 310-16 of National Fire Protection Agency (NFPA) 70-1 990. Over-current protection shall be 15 amp circuit breakers or Type S fuses. The Type S fuse adapters shall not accept a fuse of an ampacity greater than that permitted in this chapter.
- 1.13 Fiberglass and cellulose insulation are acceptable for use in contact with approved knob and tube wiring. Foamed-in place insulation shall not be used with knob and tube wiring.
- 1.14 Non-soldered exposed splices or connections shall be protected by installing solid flame resistant enclosure, securely attached with at least 3 inch clearance from insulation.
- 1.15 When existing knob and tube wiring will not be upgraded as required it shall not be covered. Two options are:
 1. Insulate below with nothing above. Maintain a minimum 3 inch air space to the sides of the knob and tube wiring.
 2. Insulate below and tent or lid with a shield 3 inches above. Shield the knob and tube wiring and blow loose fill insulation in the remaining areas of the attic, or install insulation in the attic area (not over the knob and tube wiring). The shielding material shall have a flame spread of 25 or less when tested in accordance with ASTM E-84-80 and be electrically nonconductive.

Vapor Retarder

- 1.16 If vapor retarder is installed with ceiling insulation, the retarder shall be placed between the insulation material and the conditioned living space. Vapor retarder shall not be installed over the top of existing insulation.
1. Slashing of vapor retarder on new insulation is prohibited. Install unfaced insulation or remove the facing if necessary.
 2. If existing insulation has an attached retarder that is reversed, this retarder shall be slashed before new insulation is installed.

Loose Fill Insulation

- 1.17 Loose fill insulation shall be level and smooth with uniform R-value throughout and not sloped at the eaves. The only exception is in attics with very low pitches, where the roofline and venting prevents adding the full-required depth of insulation.
- 1.18 Attic air sealing shall be performed when installing additional insulation in attics and rakes with existing insulation.



Sealing of a chimney chase way



Knee wall blocks needed before insulating

- 1.19 Insulation levels shall be maintained to the full amount over heated areas wherever space permits. Dams or sloping insulation over unheated areas such as garages and covered patio/porches are options.
- 1.20 Dams may consist of batt insulation with an R-value to that specified for the ceiling and at least 14 ½ inches wide. If batt insulation is used, the batts shall be placed flat around the perimeter of the ceiling. Dams shall be securely attached to the framing.



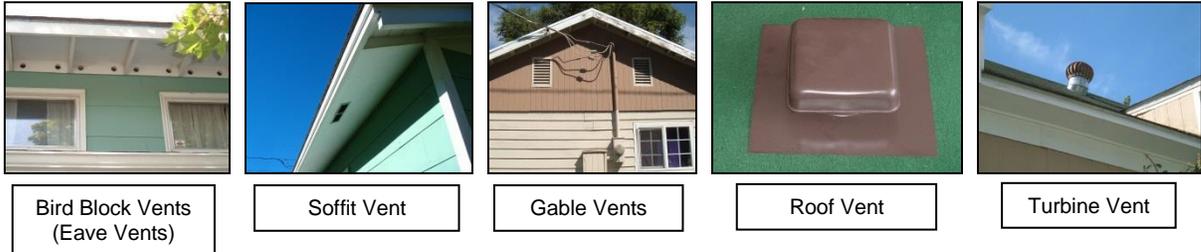
Cardboard baffling of soffit vents

Batt or Blanket Insulation

- 1.21 The blanket or batt insulation must completely cover the top plate of the exterior wall.
- 1.22 The blanket or batt shall fit tightly together with no gaps except those required for clearance around heat-producing fixtures. Batts of full width: 15-inch wide batts for 16-inch on center joists and 23 inch wide batts for 24 inch on center joists) shall be used. The blanket or batt shall be installed without overlapping or unduly compressing the insulation.
- 1.23 Insulation shall retain the full R-value after the installation of batt or blanket insulation. The insulation shall be level and smooth throughout the attic space except over ducts.
- 1.24 If no insulation exists, two layers of batts may be used. The first layer of batts may have a vapor retarder facing towards the conditioned living space. The second layer of batts shall be unfaced and shall run perpendicular with the first layer. If an attic contains knob-and-tube wiring, the two layers of batts can be installed parallel with each other but with the seams and joints staggered to not have any seams or joints from the bottom layer exposed to the vented attic area. (Section 1.11)

Attic Ventilation

- 1.25 Installation of additional attic venting is allowed, but not required. The preferred methods for controlling moisture is to repair any roof leak immediately, control humidity levels in conditioned space, properly vent out exhaust fans, and air seal the thermal boundary between the attic and conditioned space. Agencies are not restricted from installing additional venting. If ceiling is air sealed and the zone pressure is close to 50 Pa. eliminate the 1:150 and 1:300 attic venting requirements and instead require air sealing the thermal boundary between the attic and the conditioned space verified by visual inspection and pressure diagnostic testing. These changes will not restrict individual agencies from following their current practices if they choose.



- 1.26 All vents shall be installed according to the manufacturer's recommendations.
1. Vents shall be installed to cover the entire opening,
 2. Vents shall be leak proof, and screened with corrosion resistant 1/8-inch mesh to prevent insects from coming through.
 3. Vents shall be securely attached and sealed if necessary with Flex-O-Seal™ sealant or equivalent.
 4. Roof tar is unacceptable when using plastic roof vents.
- 1.27 Vents shall not be restricted with roof rafter/joists or enclosed soffit vents, etc.
- 1.28 Roof vents are not an acceptable alternative for lower attic ventilation.
- 1.29 Only the net free area of the openings for rotating air turbines may be considered for calculating ventilation.
- 1.30 Vents should be installed in an equally spaced manner. Cross ventilation is preferred.
- 1.31 Other configurations of vent placement and mechanical attic ventilation that provide equivalent performance require agency approval.

Attic Access

- 1.32 Attic access openings shall be protected from having loose fill insulation fall through the opening.

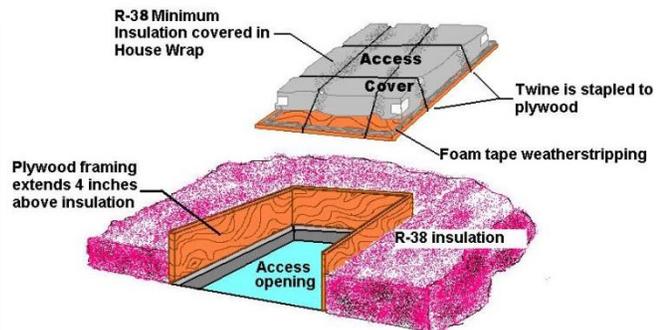


Fiberglass dam used for protection

1. 14 ½ inch or wider insulation batt with an R-value equal to that specified for the attic may be placed tightly around the perimeter of the access opening.
2. The opening may be framed with ½ inch plywood or similar material, permanently attached, extending at least 4 inches above the final level of the insulation.
3. Insulation attached to the access shall be covered with house wrap and securely twined.



Attic access with insulation, Tyvek™ and twining



- 1.33 Horizontal and vertical openings into the attic shall be insulated to the same level required for the wall or ceiling: R-38 for horizontal openings and R-21 for vertical openings. Insulation shall be permanently attached and shall cover the access entirely.
1. The insulation shall be completely covered with an air barrier (i.e. house wrap, Tyvek™ or equivalent).
 2. Access doors, which incorporate retractable ladders or similar devices, shall be insulated. This shall be accomplished by installing an insulated cover over the opening in the attic.
 3. Attic access doors shall be made substantially airtight by installing framing, caulking around framing and weather-stripping. The weather-stripping for horizontal openings shall be closed cell foam tape and shall be securely attached. Install latch, if needed, to ensure tight closure.

Water Pipes

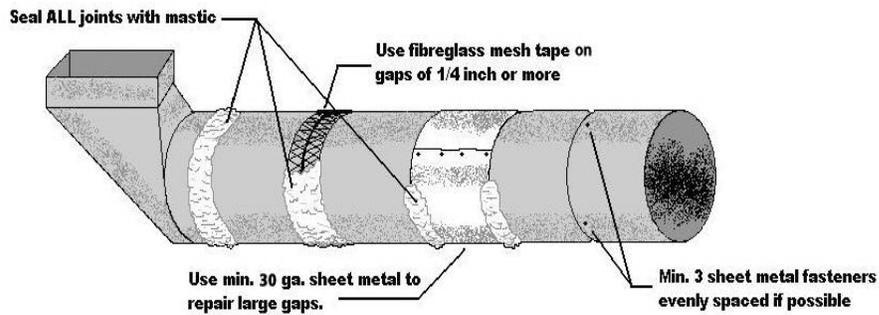
- 1.34 All exposed water pipes after insulation is installed in attic spaces shall be insulated to R-3 with pre-split tubular foam or a minimum R-11 unfaced fiberglass batt. The pipe insulation shall be installed in accordance with Specification 3.12-3.16.
- 1.35 All exposed water pipes in the attic shall be covered with a minimum of 3 inches of insulation or separately wrapped to meet water pipe specifications.

See photos in Underfloor Section 3.

Heating Ventilation and Air Conditioning Ducts (HVAC)

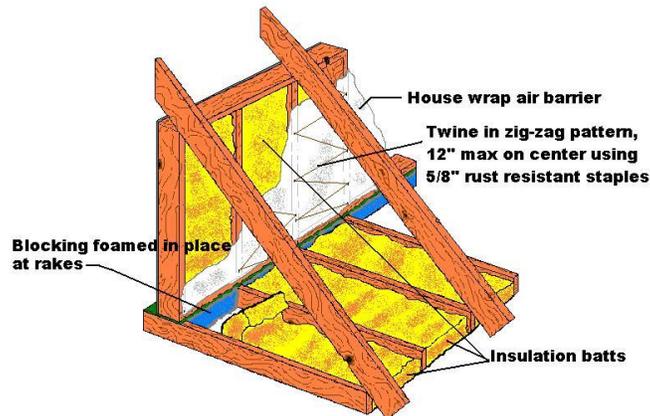
- 1.36 HVAC ducts located in the rake or attic areas shall be sealed and insulated to R-19 (see Section 5.12). The insulation under and around the duct shall be equivalent to the ceiling insulation required with a minimum of R-19 on top of the duct. Seal ducts prior to installing attic or rake insulation. If the attic is being insulated with loose fill insulation that could fall off the duct, which is common with ducts larger than 8 inches in diameter, separate duct insulation shall be installed. If clearance is limited the highest attainable R-value shall be installed.

Ducts



Knee Wall Attic

Knee Wall



- 1.37 Air leaks in knee wall attics shall be thoroughly sealed to reduce air and moisture leakage. (See Section 6 for air sealing information and Section 2.11-2.14 for kneewall insulating requirements.)



Knee wall block, rigid board insulation secured with foam

- 1.38 Knee walls adjoining attic spaces shall be insulated to a minimum of R-21. Insulation shall be installed in accordance with the specifications for unfinished walls. See Section 2.



Batt Insulation

Tyvek™

Insulation, Tyvek™, Twining

- 1.39 Insulating knee walls using blown in fiberglass (BIF) shall meet the following requirements:
1. All penetrations shall be sealed prior to installing insulation.
 2. The entire wall surface shall be covered with a suitable air barrier; i.e. Tyvek™ or equivalent product.
 3. Support the air barrier with twine attached at every point it crosses a stud. Attaching twine shall not exceed 12 inches on center.
 4. Twine shall be installed in a zigzag pattern not to exceed 12 inches.
 5. 5/8-inch staples of at least 18 gauge corrosion resistant materials shall be used to attach twine.

6. The air barrier shall be cut in an “X” pattern in each cavity.
7. Install approved loose fill fiberglass insulation.
8. It is highly recommended to seal all patches with an adhesive in addition to the previously stated specifications.

1.40 Insulating rake area with floors:

1. Attic spaces with floors shall be insulated to the recommended level or highest practical R-value. Access holes not less than 1 inch in diameter shall be drilled in each joist cavity.
2. If the rake area to be insulated has flooring which is not to be removed, cellulose insulation shall be installed in the rake area using the high density technique described in Appendix I. It will be an agency decision whether high density insulation can be installed. Knee wall blocks shall be installed in accordance with Appendix D.
3. If the rake area will be used for storage, wooden plugs of appropriate size shall be installed in the holes after the insulation process is complete. If additional insulation is to be installed on top of the floor then no plugs are needed.

1.41 Attic spaces open to the rake and/or slope area in knee wall (story and a half) homes may be ventilated two ways.

Sloped ceilings between ventilated attics shall be insulated where practical. Airflow may be maintained over the sloped ceiling insulation by tubes, baffles or by using rigid insulation; or the sloped ceiling area may be insulated to the full cavity depth where local codes allow, provided containment materials used at the lower and upper cavity openings allow for rapid vapor diffusion.

1.42 All soffit, eave, or freeze vent openings shall be left free of any blockage by insulation or other materials and such vents shall remain effective following weatherization.



Soffit/Eave Vents

1.43 In attics with non-insulated porch areas that contain soffit ventilation, soffit vents do not have to be baffled providing that, they are at least three inches away from the edge of the insulation.

Skylight Chases

- 1.44 Skylight chases shall be treated like an unfinished wall in a kneewall attic. Insulation shall be R-21 (R-13 if space is limited), be covered with house wrap, and supported with twine. Particular attention should be paid to sealing air leaks and insulating corners at the top chord of the truss.

Exterior Roof Insulation

- 1.45 Exterior roof insulation shall be a minimum of R-20 or the highest R-value approaching R-20 that is practical while maintaining the requirements of this specification.
- 1.46 Insulation shall be in rigid board form (e.g. rigid polystyrene or polyisocyanurate insulation). A fire-rated barrier equivalent to ½ inch or greater plywood sheathing, edge supported (no exposed joints between sheathing) shall be installed between the insulation and the inside space. Two inch tongue and groove decking or ½ inch taped gypsum board equals or surpasses this requirement.
- 1.47 If no vapor retarder exists, one with a perm rating of 1 or less shall be installed between the insulation and the heated space. However, if insulation is already present in the roof system, then a vapor retarder shall not be installed.
- 1.48 The installer shall contact the agency at least 48 hours in advance to request an in-progress inspection during the installation.
- 1.49 Other methods of installing exterior roof insulation shall be approved by the agency in writing prior to beginning the work.

Section 2: Blown in Wall Cavity Insulation



- 2.01 General: material shall be installed according to the provisions of current Oregon Building Code or other applicable codes and shall meet the requirements of the agency weatherization program. Any exceptions shall be approved in writing in advance by the agency. Upon completion of weatherization work, a signed and dated insulation certificate indicating square footage insulated, R-value installed, type of insulation and bag count shall be posted at the job site. In addition, the coverage chart and ASTM standards off of the Insulation bag must be posted on the jobsite. A copy of the insulation certificate must be included in the job file. Best practice would be for the inspector to take a legible photo of the posted certificate and include it in the job file.
- 2.02 Walls shall be insulated to the highest R-value practical (this shall include above windows) with a minimum of R-13 in 4-inch cavities with R-21 in 6-inch cavities preferable. If insulation exists, additional insulation can be added if cost effective. Any existing voids should be filled.
- 2.03 Insulation shall not be installed in wall cavities which:
1. Serve as air ducts for heating, cooling or ventilation and electrical service boxes.
 2. Contain electric space heaters unless fire stops are present or installed which isolate the heater from all contact by the insulation material. Verification of this shall be accomplished by removal of the heater prior to the installation.
 3. Contain active knob and tube wiring unless corrective action is taken per section 1.10-1.15 of these specifications.
- 2.04 The installer shall perform a thorough visual inspection of the walls and other areas that will be insulated from the interior and exterior to ensure integrity before blowing insulation. If problems are discovered so that insulation cannot be installed, notify the agency before commencing work. The installer is responsible for any damage that occurs as the result of blowing walls.

Blown in Cavity Insulation

- 2.05 Siding and shingles shall be removed and reinstalled in a professional manner. Broken siding or shingles occurring during the insulation process shall be replaced, painted, or primed at the installer's expense.



Open or Unfinished Wall Insulation

- 2.06 Open or unfinished walls to be insulated shall be located between unconditioned and conditioned living spaces to qualify for insulation.
- 2.07 If insulation is being installed, a vapor retarder shall be present or installed towards the conditioned side of the wall. All batt insulation shall be installed in substantial contact with the conditioned wall. Batt insulation shall be faced after stapling.
- 2.08 Insulation exposed to living areas or routine pathways of human contact shall have a cover that has an American Society of Testing and Materials (ASTM) flame-spread rating of 25 or less, i.e. house wrap, FSK, or ½ inch sheetrock.
- 2.09 Insulation shall be fixed to the pony wall. It shall be attached with a suitable adhesive. Adhesive shall be installed in continuous horizontal beads. Air spaces between the insulation and wall shall be minimized.
- 2.10 Insulation shall be cut to fit snugly in each cavity. Insulation shall be cut or slit to fit around wiring or plumbing and electrical boxes in wall cavities. It shall not be compressed behind or around protrusions.

Knee/ Pony Walls

- 2.11 When insulation is added to the knee wall where none exists, all penetrations through the wall shall be sealed with caulk or foam prior to installing the insulation. This would include the gap between the rough opening and the access opening of the knee wall or the pony wall. If the knee wall has existing insulation, then as much air sealing as possible should take place on the interior of the wall.
1. When a pony wall is being insulated, then all penetrations shall be sealed before insulation is installed. Sealing of penetrations shall also include the floor joists at the top of the pony wall. The floor joist cavity area shall be sealed by installing the same size wood framing, (polyisocyanurate, or extruded polystyrene) as the floor joist, and nailed/caulked in place. The pony wall insulation would be installed from the sub-floor to the bottom plate. Knee/pony walls shall be insulated to a minimum of an R-21.

2. The knee/pony wall insulation shall fit tightly against the top of the wall, and the vapor retarder shall be installed against the conditioned side of the wall. The insulation shall completely fill the cavity and be in substantial contact with the conditioned wall.
3. An air barrier i.e. house wrap shall be present on the unheated side of the knee wall/pony wall. The air barrier shall completely cover the insulation. (The air barrier is required to prevent wind washing.)
4. When woodstove, water heater or furnace flue pipe penetrates the pony wall, sealing the flue pipe to the wall shall be performed in accordance with local building codes.
5. When blowing knee wall cavity with loose fill insulation ("BIF"):
Insulating knee walls using the "BIF" (Spec. 1.41)
 - A. The entire wall surface shall be covered with a suitable air barrier; i.e. house wrap.
 - B. Support the air barrier with twine attached at every point it crosses a stud. Attaching twine shall not exceed 12 inches on center. Twine shall be installed in a zigzag pattern not to exceed 12 inches.
 - C. 5/8-inch staples of at least 18-gauge corrosion resistant material shall be used to attach twine.
 - D. The air barrier shall be cut in an "X" pattern in each cavity.
 - E. All penetrations in air barrier shall be sealed with an approved air barrier seam tape.

2.12 Knee/pony wall accesses shall be insulated to R-21 or greater.

1. Insulation shall be permanently attached to the access, and shall properly cover the access.
2. Air barrier (i.e. house wrap) shall cover insulation on access door completely.
3. All four sides of the knee/pony wall door shall be properly weatherstripped. Closed cell foam tape is acceptable for door accesses. The knee wall/pony wall access doors shall stay in the closed position with minimum air movement.

2.13 When the knee wall attic spaces are vented separately, insulation shall be stuffed in the slope cavity. Knee wall insulation shall terminate at the top of the kneewall.

2.14 Support twine shall have anchor points in a zigzag pattern spaced no greater than 18 inches on center. The twine shall be anchored at every point at which it crosses a stud. This specification shall apply to existing insulation, as well as new insulation.



2.15 Dense pack insulation: see Appendices G-K for techniques in blowing high-density wall insulation. High-density wall insulation is defined as installing cellulose insulation at 3.5 pounds per cubic foot or fiberglass* at 2.5 pounds per cubic foot. Other methods for verifying high-density insulation:

1. When there is 80 inches of water column (W.C.) measurement at the port of the insulation blower using a magnahelic gauge.



2. When you cannot retube the cavity using a 1¼ inch ID 1/8 inch wall tube #220 (“hard tube” or summer tube).
3. The agency may perform an infrared thermographic scan of the building at the time of the final inspection. If there are void sections of more than three percent (3%) of the net wall area, then the installer will be required to return and fill the voids.

2.16 Alternative two hole method: two holes per stud space shall be provided for cavities exceeding 48 inches in height. The lower hole shall be no higher than 48 inches from the bottom of the wall. The upper hole shall be no more than 18 inches from the top of the wall. For cavities less than 48 inches high, a single hole may be used located not more than 18 inches from the top of the cavity.

2.17 The agency shall determine access to the wall cavities and other areas. The installer may gain access to other areas in a different manner if approved by the agency; drilling directly through the existing interior gypsum board, lath and plaster, stucco and other material finishes which are similar in texture. This procedure shall have prior approval from the homeowner before work commences.

2.18 * Fiberglass used for dense packing walls must limit maximum air permeance to 3.5 cfm/ft² (as measured using ASTM C522).

Areas for Dense Pack Insulation

- 2.19 To assure positive quality control, the installer may be required to notify the agency a minimum of 48 hours in advance when dense pack insulation is being installed so that an in-progress inspection may be conducted Appendix F.
- 2.20 Special attention shall be given to thermal bypass areas to ensure a tight thermal envelope. These spaces include but are not limited to corners, kitchen and bathroom soffits, pocket doors, intersection of partition walls, walls where plumbing is present, and inside corners of firewalls.
- 2.21 Exterior wall plugs shall be made of material that will not shrink or expand beyond the design of the siding, resulting in damage to the siding or finish (i.e. wood or Styrofoam™). Plugs shall not be of the vented type (i.e. button vents).



1. If the installer accesses the wall cavity by removing the siding or shingles, the installer shall install an appropriate size plug and re-install the siding or shingles.
2. If the drill and fill method is used by the installer, the plugs shall be recessed into place so the outer surface of the plug is below the surface of the siding. The plug shall be covered with an outdoor spackling. The spackling shall have at least one-coat primer paint after being installed.

Thermal Bypass Air Leakage Areas

- 2.22 Insulation may be installed in wall cavities, which have R-7 or less of existing insulation and in cavities less than 3-½, inch thick, depending upon the agency recommendations.
- 2.23 Walls, cantilevered floors and overhangs (eyebrows), wall/ceiling junctures (small attics), wall/floor junctures (porches and garages), rim joists (between first and second and/or other floors), garages under living spaces and offset floors and ceilings shall be insulated utilizing the high density method. Access procedure is described in Appendix F.



Chimney chase way

- 2.24 Cantilevered floors, commonly referred to as “bumpouts” that have open cavities can be insulated with an appropriate size Kraft-faced fiberglass batt and covered with exterior grade plywood or primer painted plywood. It shall be sealed and caulked.

Section 3: Underfloor

- 3.01 General: material shall be installed according to the provisions of current Oregon Building Code or other applicable codes and shall meet the requirements of the agency weatherization program. Any exceptions shall be approved in writing in advance by the agency. Upon completion of weatherization work, a signed and dated insulation certificate indicating square footage insulated, R-value installed, type of insulation and bag count shall be posted at the job site. In addition, the coverage chart and ASTM standards off of the Insulation bag must be posted on the jobsite. A copy of the insulation certificate must be included in the job file. Best practice would be for the inspector to take a legible photo of the posted certificate and include it in the job file.
- 3.02 Insulate underfloor areas to a minimum of R-25 over unheated crawl spaces, unused cellars, and unconditioned basements. With some floors, it may be less expensive to install a thicker batt to fill the cavity rather than devising a support system for thinner batts.
- 3.03 The agency may require that a dry rot inspection be performed before floor insulation is installed. If dry rot is discovered, the installer should stop work and report it immediately to the agency. The agency may decide to drop the measure or pay for repairs. Repairs shall be made prior to installing insulation.

If any wet areas of the sub-floor or wood-supporting members are found, the agency shall be notified immediately and the source of the moisture shall be eliminated. Wet areas shall be dried before floor insulation is installed.

- 3.04 All insulation shall be in substantial contact with the sub-floor to eliminate the possibility of creating a fire chase way and to prevent convective heat loss.”



- 3.05 Insulation shall be cut to fit each joist space. All ends shall fit tight without overlapping. Insulation shall fit tight against structural members, rim joists, foundation walls, and pipes with no gaps.
- 3.06 When fiberglass batts are used in the underfloor, the facing material shall be in substantial contact with the sub-floor and the insulation shall remain attached to the faced material. The facing on batt insulation installed in cavities shall be stapled to the underfloor using 18-gauge 5/8-inch long nickel, solid bronze, or aluminum staples. Faced batts shall be adequately attached to support the insulation prior to twining. Unfaced insulation can be installed where vapor retarder exists in the floor system itself. Vapor retarders shall have a perm rating of 1.0 or less and shall be located between the insulation material and the conditioned living space. Unfaced batts may be allowed at the agencies discretion.
- 3.07 All exposed, uninsulated heating and air conditioning HVAC ducts located in crawl spaces, cellars, and unheated basements shall be sealed and insulated as per Section 5.

- 3.08 Using the blown-in fiberglass method (BIF) method (Spec. 1.39)
1. All penetrations shall be sealed prior to installing insulation.
 2. The entire floor surface shall be covered with a suitable air barrier; i.e. Tyvek™ or equivalent product.
 3. Support the air barrier with twine attached at every point it crosses a stud. Attaching twine shall not exceed 12 inches on center.
 4. Twine shall be installed in a zigzag pattern not to exceed 12 inches.
 5. 5/8-inch staples of at least 18 gauge corrosion resistant materials shall be used to attach twine.
 6. The air barrier shall be cut in an “X” pattern in each cavity.
 7. Install approved loose fill fiberglass insulation.
 8. All penetrations in air barrier shall be sealed with an approved air barrier seam tape after insulating is complete.

Air Sealing

- 3.09 All combustion flues, to attic, wall, or crawl space shall be sealed using appropriate non-combustible materiel.
- 3.10 Sealing of all other penetrations through the floor shall be included in all floor insulation work. Particular attention is necessary under bathtubs, shower stalls, heating registers, and where plumbing or wiring penetrates the floor. Caulking or spray foam meeting the material requirements in Section 6 of sealing are acceptable if they provide a permanent airtight seal. Stuffing with insulation is prohibited.



Plumbing penetration sealed



Sealing knee wall blocks



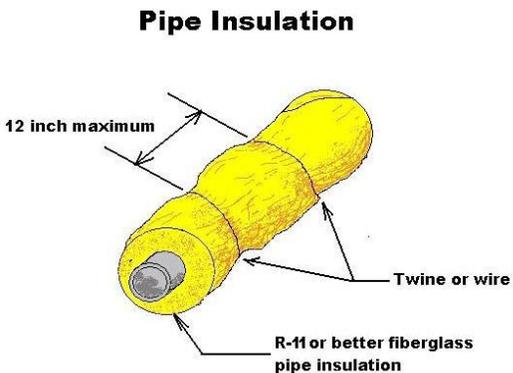
Sealing mobile home floor penetration



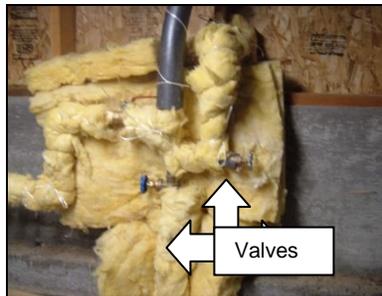
Sealing clothes washer penetration

Water Pipes

- 3.11 Water pipes shall be insulated with R-3 pre-split foam or R-11 vinyl covered insulation in a human contact area, R-11 unfaced fiberglass batts are acceptable in a non-human contact area. If required by agency, drain traps shall also be insulated using R-11 unfaced batts.
- 3.12 Before installation, the installer shall ensure pipes are in satisfactory condition to receive insulation, are free from water leaks, and are properly secured to support the weight of the pipes and insulation. If problems are found, such as leaks or improperly supported pipes, the agency shall be notified before insulating that section of pipe.
- 3.13 Pre-formed pipe insulation material shall be cut and folded or otherwise molded to completely cover all elbows or curved pipe without compressing the insulation or allowing gaps to occur in the insulation. Wrap joints that do not fit tightly, such as T-joints and elbows, with batt insulation. Installer shall use the correct inside diameter size insulation for the pipe being insulated (e.g. it is not permissible to use 1 inch preformed pipe wrap on ½ inch pipe). The lengthwise slit shall be positioned on horizontal pipe so that the slit is on the bottom side of the pipe. Twine, galvanized wire, or non-slipping plastic ties shall be used to secure the insulation. The ties shall be spaced starting at 1 inch from each end of the material and thereafter approximately every 12 inches.



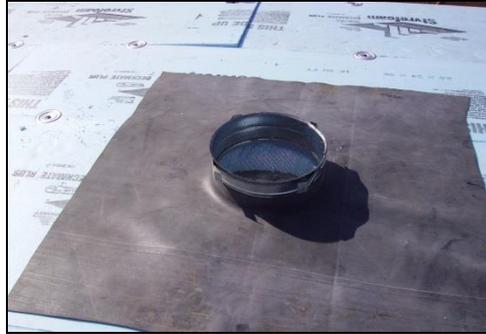
- 3.14 Water pipes insulated with unfaced fiberglass insulation shall be firmly secured to the water pipes without unduly compressing the insulation. A minimum of R-7 (or about 2 ½ inches in depth) shall be maintained after the pipe insulation is complete. The insulation shall be secured in place by polypropylene nylon twine, galvanized wire, or non-slipping plastic ties. The securing method shall be spaced at 2 inches from each end of the material and thereafter approximately 12 inches. Use fiberglass insulation when water piping runs next to a beam or joist.



- 3.15 The location of all valves covered by insulation shall have tags hanging below the final insulation for easy location.

Exhaust Duct

- 3.16 Appliance exhaust vents (e.g. exhaust fans, kitchen range exhaust etc.) shall terminate outside the residence using manufactured duct and be equipped with a back-draft damper. Any new ducts installed under the program shall be made of rigid metal with smooth interior surfaces. Ducting shall be supported in a level position, every 3 feet. Bends or reversing horizontal runs in ducts shall be eliminated. Kitchen range exhaust fan ducting shall meet the material standards in Section 1.08.



Mobile home fan vent

3.17 Dryer Vents

1. All dryers must be vented to the daylight and terminated with an operable dryer vent hood.
2. Mobile home dryer vents must be extended through the skirting to daylight.
3. Dryer vent ductwork must be smooth surfaced, adequately supported and vented to daylight utilizing the shortest run possible. Use of elbows should be limited to the least possible number to ensure unobstructed venting.
4. All joints must be secured using UL – 181 tape (metal tape).
5. Flexible vent pipe may be used between the dryer and the hard pipe connection if it does not exceed three feet in length.
6. Dryer vent pipe must not be installed with sheet metal screws or other intrusive fasteners that will collect lint.
7. Whenever possible, the dryer vent must be installed with a downward slope to the outside to allow for condensation drainage.



Clothes dryer venting

Crawl Space Ventilation

- 3.18 Underfloor areas shall be ventilated by openings in the exterior foundation walls. Openings shall be located as close to corners as practical and shall provide cross ventilation. The required area of such openings shall be equally distributed along the length of at least two opposite sides.
1. Such openings shall have a net-free area (NFA) of not less than 1 square foot for each 300 square feet of floor area, provided there is no standing water or excess moisture.
 2. If there is standing water or the agency feels there is excess moisture, then the NFA, or vent openings shall be 1 square foot for each 150 square feet of crawl space area.
 3. When moisture is not an issue the venting can be 1 square foot for each 1,500 square feet of NFA as long as ground surface is treated with an approved ground cover material and the required openings are placed so as to provide cross ventilation of the space.

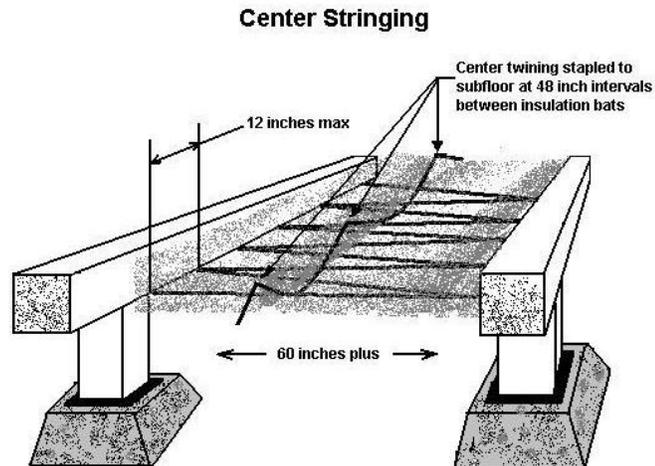


- 3.19 All vents, new or existing, shall be screened with $\frac{1}{4}$ inch corrosion resistant wire mesh attached from the inside and secured on all four sides. Code requires wood in contact with cement or ground to be pressure treated.

Insulation Support Systems

3.20 The support mechanism shall be attached at every point where it crosses a joist or beam. The maximum spacing for the support mechanism with 24 inches on center or greater floor joist spacing shall not exceed 12 inches on center. Shorter spans shall not exceed 18 inches on center. Support for floor insulation shall be provided according to one of the following methods (this applies to new and existing insulation):

1. Twine - polypropylene or polyester twine shall have a breaking strength of at least 150 pounds. The twine shall be installed in a zigzag, joist-to-joist pattern across each joist space. A 16-inch on center floor joist system may be zigzagged across two floor joists, but shall be stapled at every point it crosses a joist. Any joist system larger than 16 inches on center shall be stapled and zigzagged at every joist.
2. Center stringing: shall be used on floors where post and beam construction is 60 inches or greater on center. This is accomplished by twining the floor insulation in a zigzag pattern, securing twine to each floor joist, not to exceed 12 inches. On a seam (that is where two batts join), no more than 48 inches apart, support primary twine by crossing over it and attaching to sub-floor. Center twine shall run parallel to seams in batts.



3. Wood lath - shall be a minimum 5/16 inch by 1 inch, Number 1 grade. Individual lath shall be long enough to span the required distance. Splicing of individual lath is not acceptable.
4. Agency approval shall be issued prior to using other support systems.
5. "Lightning rods" are prohibited.



Twining under manufactured and site built floors

3.21 Fasteners for lath or twine may be either hot-dipped galvanized nails or corrosion resistant staples (i.e., Nickel, solid bronze, or aluminum). All fasteners shall penetrate the supporting structural member at least 5/8-inch. Staples shall be at least 18 gauge. Hand staplers or hammer tackers are not capable of providing adequate penetration of staples and are prohibited from use in this application.

- 3.22 Support systems for floor insulation shall not compress the insulation material more than 10% or otherwise alter the insulation value of the material except where necessary around the perimeter. Insulation shall be permanently supported so as not to block or restrict crawl space ventilation. Support system shall keep insulation in substantial contact with the floor.
- 3.23 In no case shall the support of floor insulation be farther than 3 inches from the end of the batt. Added loose pieces shall not be left unsupported. Special attention shall be given to plumbing.

Ground Cover

- 3.24 If a new ground cover is required per agency work order, it shall be minimum 6-mil black polyethylene or its equivalent in perm-rating, strength and resistance to soil chemical degradation.
- 3.25 All joints shall be overlapped a minimum of 12 inches. The ground cover shall cover all earth but shall not contact any wood members.



- 3.26 All exposed soil shall be completely covered with no rips or tears in the cover. New cover may be placed over the old ground cover.
- 3.27 All debris, where practical, shall be removed from the crawl space before the new ground cover is installed.

Access Door- Outside

- 3.28 Access to the crawlspace shall have a cover that can be securely attached. Wood in contact with cement or ground shall be pressure treated.
- 3.29 Access doors to an adjacent conditioned space shall be insulated to at least the R-value of the insulation being installed on that pony wall. Pony wall access doors shall be made substantially airtight with appropriate materials if they open to a conditioned space. This shall include caulking, framing (finish and rough), weather-stripping (closed cell) and the access door itself shall be repaired or a new one made if needed.

Access Door- Inside

- 3.30 Inside floor accesses shall be insulated to a minimum R-25. The insulation shall be completely covered with an air barrier (house wrap, Tyvek™ or equivalent) and securely twined. The access shall be made substantially airtight by installing framing, caulking around the framing, and weather-stripping. The weather-stripping shall be closed cell foam tape and shall be permanently attached to hold it in place for the life of the measure.

Basements

3.31 Areas under a home containing a basement shall be evaluated as conditioned or unconditioned space. A basement shall be weatherized to be included as part of the conditioned space and thermal boundary if:

1. the heating system is designed to heat the basement, or
2. there are intentional heat registers for forced air systems or zonal heat present in the basement and operational, or
3. the residents of the home are using the space, or
4. they are intentionally heating the space

If none of the conditions above exist then the space must be weatherized to separate it from the conditioned space and thermal envelope.

Conditions favoring underfloor insulation	Conditions favoring perimeter insulation
Zonal pressure shows floor more airtight than the foundation walls.	Zonal pressure shows foundation walls more airtight than the floor.
Damp underfloor with little or no improvement available through weatherization.	Ground cover and/or adequate perimeter drainage existing.
No heating system, ducts and plumbing located in the underfloor.	Heating system, ducts or plumbing located in the underfloor.
Exterior entrance and stairway only.	Interior stairway connecting the house and the basement.
Dirt floor or deteriorating concrete floor.	Concrete floor in reasonable condition.
Rubble or brick foundation walls.	Basement partially occupied or it contains the laundry room.



Rim joist insulation (foam board)



Rim joist insulation & ground cover

Unconditioned Basements

- 3.32 To effectively weatherize a basement to be separated from the conditioned space the following shall be evaluated:
1. Basement ceiling insulation R-value, airtightness and accessibility. Including stairway ceilings.
 2. Above grade wood framed wall insulation R-value, airtightness and accessibility. Including stairway walls. Closed wall cavities shall be insulated according to the procedures stated in the Wall Section starting on 2.15. Open wall cavities shall be insulated as in accordance with the section titled Open or Unfinished Wall Insulation starting on 2.06.
 3. Door(s) separating the basement from conditioned space must be weather-stripped and substantially airtight.
 4. All ducts shall be air sealed and insulated in accordance to all specifications that apply to ducts.
 5. Water pipes shall be insulated in accordance to all specifications that apply to water pipe insulation.
- 3.33 If basement ceiling insulation is installed it must be an R-value of 25 or completely fill the depth of the cavity. Basement ceiling insulation shall be installed in accordance with all specifications that apply to underfloor insulation.
- 3.34 After installing basement ceiling insulation, a covering shall be installed on the bottom of the ceiling joist with a permeable air barrier i.e. house wrap or equivalent that meets Flame Guard R-3035 and has a flame spread of 200 or less. The cover shall be installed with seams overlapping at least 3 inches.
- 3.35 The covering shall be twined as in accordance to Insulation Support Systems, Section 3 Underfloors 3.20.
- 3.36 If crawlspace insulation is installed over an unheated basement and the basement has no exposed soil (i.e. has concrete floors and walls), ground cover and ventilation are not required. Any basement with exposed soil shall be considered on an individual basis regarding ground cover and ventilation specifications.

Conditioned Basements

- 3.37 To effectively weatherize a basement to be included in the conditioned space the following must be evaluated:
1. Rim Joist insulation R-value, airtightness and accessibility.
 2. Above grade wood framed wall insulation R-value, airtightness and accessibility.
 3. Window and door U-value, airtightness and accessibility.
- 3.38 All exposed soil must be covered with ground cover as specified in section 3.45.
- 3.39 If rim joist insulation is installed it must be of minimum of R-15 and extend from the basement wall top plate/or sill plate, up the rim joist, and to the floor sheathing. Acceptable materials and procedures as follows:
1. Insulation board cut to fit joist opening and air sealed around perimeter and any penetrations through the insulation board. Foam board must be faced. Facing must have a perm rating of 1 or less.
 2. Closed cell polyurethane spray foam with an accumulative perm rating of 1 or less. The thickness of spray foam is not to exceed 3 ¼" or a 15 min fire break is required (i.e. sheetrock).

Partial Basements

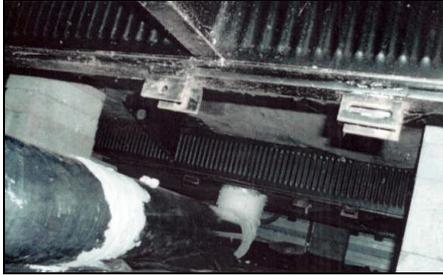
- 3.40 A partial basement is defined as a space below a home that contains both a basement and a crawlspace. The crawlspace may or may not have a wall to separate it or have crawlspace vents installed.
- 3.41 If the crawlspace is vented and a pony wall exists that separates the crawlspace from the basement then the floor above the crawlspace shall be weatherized in accordance with all sections pertaining to underfloors. Special attention must be made to the pony wall to ensure that it is airtight and if wood framed that it is insulated to minimum or R-15. See section 2.11 on pony walls.
- 3.42 If there is no pony wall and no crawlspace ventilation then treat the area as one space. Answer the previous questions to determine if the space should be weatherized to be included with the conditioned space or excluded.
- 3.43 If the crawlspace is vented and there is no pony wall or the pony wall is in poor shape; either try to repair or build the pony wall as an airtight barrier between the crawlspace and basement or seal off the existing crawlspace vents and treat the crawlspace as part of the conditioned space. Note that if there is exposed soil that it must have ground covered installed as in accordance with section 3.24.

Section 4: Water Pipe Insulation

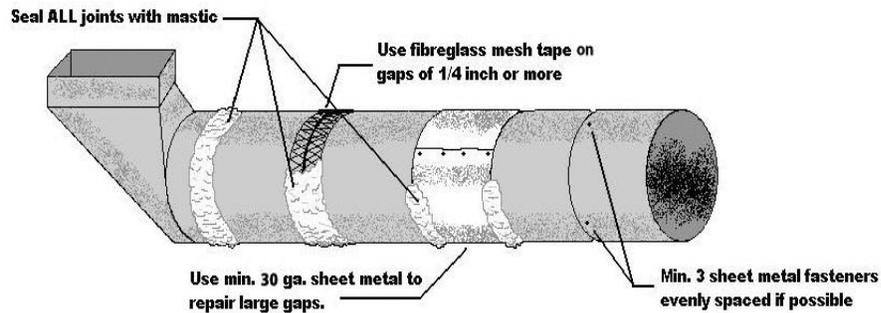
- 4.01 Water pipe insulation should be installed to provide or facilitate freeze protection. The insulation shall resist degradation from extreme moisture, light, and temperature.
 - 4.02 Heat tape or strip insulation designed to be spirally wrapped around the pipe is not allowed.
 - 4.03 The minimum insulation value after installation is R-3 for preformed pipe insulation or R-11 batt insulation.
 - 4.04 Tag all water pipe valves and/or controls that may be covered with insulation. Tags should hang below the final insulation for easy location.
 - 4.05 Do not cover the operable part of pressure relief safety valves or devices.
 - 4.06 Flame spread of insulation wrap: the insulation shall be material having a flame spread rating of 25 or less.
 - 4.07 The water pipes shall be properly supported and free of leaks.
 - 4.08 If using pre-formed water pipe insulation, cover the entire water pipe with properly sized pre-formed insulation. It should have a minimum lifetime of 10 years without degradation.
 - 1. Preferred installation of pre-formed pipe insulation is with the slits facing downward.
 - 2. Cut, fold, and/or mold the insulation to completely cover elbows, unions, T-connections, etc.
 - 3. Secure the insulation with twine, wire, plastic ties, adhesive, etc., without compressing it.
- NOTE: Cloth backed duct tape is prohibited.**
- 4.09 Provide physical protection to insulation from pets, rodents, etc. (i.e., if skirting is not present in mobile home).
 - 4.10 Agency may allow water pipe heat tape. If installed, it shall be thermostatically controlled.

Section 5: Ducts

- 5.01 General: material shall be installed according to the provisions of current Oregon Building Code or other applicable codes and shall meet the requirements of the agency weatherization program. Any exceptions shall be approved in writing in advance by the agency.
- 5.02 Sealing mastic shall be water-based (not solvent-based) material that will adhere easily to glass or mineral fiber, polyurethane or polystyrene foam, sheet metal, and cellular glass.
- 5.03 Duct sealants shall be applied in accordance with manufacturer's specifications and recommendations. Mastic shall be applied in sufficient quantity to assure proper adhesion and coverage. Mastic shall not be applied to wet materials.



Ducts



- 5.04 Remove any loose duct tape prior to sealing. If asbestos tape exists, encapsulate the tape in mastic.

- 5.05 If any part of the duct system needs to be replaced, the replacement shall be a manufactured piece of like material preferably 30 gage-galvanized metal. If existing ducts are too short to be joined together and secured with sheet metal screws, a manufactured duct section of proper size shall be installed and secured by at least 3 sheet metal screws at each joint in place before installing the mastic.



Damaged Flex Duct



Repaired With Rigid Insulated Duct

- 5.06 Installation of flexible ducts and pre-formed fiberglass (duct board) is discouraged. However if conditions require the installation of flexible ductwork, documentation must be included in the file. Flexible ductwork installed must have a minimum R-value of R-8. All connections must be sealed with mastic and the ductwork must be properly supported. Crawlspace must be sufficiently sealed to ensure the ductwork is properly protected from animals.



Before Mastic Sealing

- 5.07 If a gap is wider than $\frac{1}{4}$ inch, before applying mastic to the areas to be sealed, the installer shall first install a 2-inch strip of fiberglass mesh tape. If this is not feasible in a given area, the installer may apply the mastic without the mesh tape being installed.



Mastic Being Applied

5.08 All ducts must be sealed as airtight as possible before insulating ductwork. The agency may require removal of existing insulation in order to seal the ducts. Duct sealing must include, but is not limited to the following areas:

1. Joints on the furnace plenums, furnace plenum connections.
2. Joints and seams on cold air return and supply ducts.
3. Where the boots connect to the interior floor surface and elbow gores.



Before



In-progress



After

4. If a cold air return is located within a floor joist, then the sheet metal shall be sealed to the wood joist and it shall be sealed to the sub-floor. All possible joints, holes, cracks, seams, couplings, unions, connections, and furnace air handler cabinet shall be sealed.
5. Air leakage from the air handler should be sealed as possible.



Example of floor joist duct

5.09 Seal cold air return (CAR): before installing duct insulation, all supply air ducts shall be air sealed.

5.10 The entire system located in unconditioned spaces, including plenums, cold air returns and boots shall be insulated. Lined ducts and lined plenums shall be insulated. Ducts and plenums shall be insulated with a minimum R-11 fiberglass batt or blanket. The compressed, installed value of at least R-9. If the ducts are located in an attic area, a minimum of R-19 fiberglass batts or blankets shall be installed. Insulate ducts before insulating attic or rake area. (See Section 1.38 for details.)

5.11 Types of insulation and appropriate usage:

1. Unfaced insulation is allowed for ducts in all areas not subject to human contact, but vinyl or FSK faced insulation is recommended for added durability. Vinyl or FSK faced insulation must be installed when ducts are used for cooling.
2. Ducts subject to routine human contact (i.e. garage, basements and attics used for storage) shall be insulated with material that has suitable facing cover that provides physical protection from the insulation and has a flame-spread rating of 25 or less. Seams and joints shall be taped with tape having a rating of FS 25 or less.
3. Insulation shall be secured with twine, installed in a circular fashion and spaced no wider than 18 inches on center. Every effort shall be taken to minimize compression of the insulation.

5.12 Ducts located in crawl spaces shall be supported off the ground and secured to the floor structure with corrosion resistant wire or galvanized metal hangers. When ducts are in contact with ground extruded rigid polystyrene foam (such as Dow Styrofoam™ “blue board”) shall be used between the duct and the ground.



5.13 The surface of any pan joist cavity used as a duct in an unheated area shall be insulated to recommended levels or as specified on work order.

5.14 When sealing ducts in human contact area, ducts shall be sealed, insulated, and covered with Tyvek™ or equivalent. Twining shall be installed in a circular fashion and spaced no greater than 18 inches on center, or in the case of rectangular ducts, twined and stapled to the floor structure. (See Section 3).

Section 6: Air Leakage

- 6.01 General: material shall be installed according to the provisions of current Oregon Building Code or other applicable codes and shall meet the requirements of the agency weatherization program; see Appendix N. Any exceptions shall be approved in writing in advance by the agency.
- 6.02 Air sealing shall be addressed on all residences accepted for low-income weatherization.
1. The forced air heating and cooling distribution (duct) system may be required to be sealed, including plenums, boots and registers. All accessible forced air heating or cooling ducts shall be sealed. Supply ducts are a top priority for sealing.
 2. Combustion safety testing shall be completed after duct sealing any residence with combustion appliances.
 3. All broken glass or missing panes in prime windows shall be replaced if it poses a safety hazard.
 4. All large, obvious leaks in the building envelope shall be sealed.
- 6.03 Comfort air sealing: may be on work order to alleviate drafts. It is best done at the end of all weatherization work since many drafts may have been sealed by the installation of other measures.
- 6.04 Caulking for air sealing purposes shall only be performed on the inside surfaces of the structure except when otherwise stated on the work order. Installers shall follow the manufacturer's instructions for application of caulk.
- 6.05 All dirt, loose or peeling paint, caulking and other debris shall be removed from the surface where caulking is to be applied.
- 6.06 The depth of caulk shall not be greater than the width of the joint.
- 6.07 Filler materials, such as polyurethane foam, backer rod or other suitable materials shall adequately support the caulk when cracks are deeper than ½ inch.
- 6.08 Single-component polyurethane foam sealants may be used as filler material or as a caulking material provided the manufacturer's installation standards are met.
- 6.09 Exterior caulking used as sealant for window glazing replacements shall be one component polyurethane or polysulfide meeting the standards of TT-S-230c.
- 6.10 Bypasses shall be defined as any gap in the envelope of a house between a conditioned and unconditioned space. Bypass locations include, but are not limited to the following areas: chimneys (masonry and metal); soil stacks and plumbing vents; open plumbing walls, top plates of interior partition walls and exterior walls; housing of exhaust fans and recessed lighting fixtures; dropped ceilings; beneath knee walls; around duct work; electrical penetrations; clothes chutes and dumb waiters; party walls and attic access points. (See Appendix C)
- 6.11 One coat of tape and one coat of mud are required when sheetrock is installed.

- 6.12 Under kitchen sink and bath sinks: any method of sealing is accepted that meets all flame spread requirements and will provide an airtight seal, i.e. sheetrock, 1 inch rigid board, or cardboard with flame spread facing. Bead board is not acceptable.



- 6.13 Chimney/fireplace masonry chimneys with flues used for wood burning, natural gas or for oil burning purposes shall have the bypasses sealed with a draft stop of sheet metal sealed to the chimney or flue and ceiling structure with a high temperature caulk.
- 6.14 Sealing of all penetrations through the floor shall be included in all floor insulation work. Particular attention is necessary under bathtubs, shower stalls, heating registers, and where plumbing or electric devices penetrate the floor. Caulking or spray foam meeting the material requirements in Section 5 shall be used to seal plumbing and wiring penetrations. Any method of sealing is acceptable that will provide a permanent airtight seal. Stuffing with insulation is prohibited.
- 6.15 Walls between conditioned and unconditioned spaces, such as pony walls, knee walls and rake areas, shall have all penetrations (except access doors) sealed and insulated to at least R-13 with R-21 preferable.
1. Use of blower door to identify air leaks is the most effective.
 2. If high-density insulation is being installed, seal big leaks first and complete any remaining sealing after the insulation is installed. Do not use blower door directed sealing until after the walls are insulated.
- 6.16 Door weatherstripping shall be one of the following types:
1. Low temperature vinyl or silicone with rigid flange.
 2. Interlocking metal.
 3. Neoprene.
- 6.17 Self-attaching weatherstripping (self-stick or glue type) is prohibited for doors with the exception of metal outswing doors that are designed to utilize self-attaching weatherstripping.
- 6.18 Weatherstripping material shall be installed in accordance with the manufacturer's instructions.
- 6.19 Surface-mounted weatherstripping material shall be installed to ensure that the weatherstripping sufficiently contacts both surfaces and that the gap is adequately sealed.

- 6.20 Weatherstripping shall be installed in one continuous strip, if possible, along each side of the door or window. The material shall fit tightly at the corners to maintain continuity around the perimeter of the door or window.
- 6.21 All mounting screws, nails, staples or other fastener devices shall be of a non-corrosive material compatible with the weatherstripping material installed.
- 6.22 Weatherstripping material shall be secured with mounting screws, nails, or staples spaced a maximum of 4 inches apart, unless metal or metal-backed weatherstripping is used and supplied with pre-drilled holes. Door weatherstripping shall be secured at the bottom of each side of the weatherstrip; the fastener shall be located no higher than 2 inches from the threshold. In no case shall fasteners be over 12 inches apart.
- 6.23 Door bottom weatherstripping may be threshold, interlock or door-bottom mounted vinyl bulb (door shoe). Door bottoms shall not have a surface sweep that rubs against the floor. Installation of fixed door sweeps requires prior approval from the agency. A fixed door sweep is a door sweep that is permanently attached to the bottom of a door. For the definition of a door sweep see glossary.
- 6.24 Upon completion of the job, all windows and doors that have had weatherstripping installed shall operate properly without undue force and provide a complete air infiltration resistant seal in the most restrictive position. Both door lock and deadbolt lock set shall work without undue force caused by the weatherstripping.

Section 7: Windows and Doors



- 7.01 General: material shall be installed according to the provisions of current Oregon Building Code or other applicable codes and shall meet the requirements of the agency weatherization program. Any exceptions shall be approved in writing in advance by the agency.

Windows contribute to the total heat loss in most homes in three ways:

1. Conduction of heat through windows and their frames.
2. Air infiltration through the cracks around the windows.
3. Radiation through the glass.



In some cases where the existing prime windows are in poor condition, replacing the existing sashes or the entire window and casing with a double pane unit may be the best approach.

- 7.02 Glazing for windows is restricted to glass. Permission may be given by agency to use plastic glazing in special circumstances.

7.03 Safety Requirements

1. Safety glazing shall be used when appropriate. The installer of the glazing is responsible for this. See the section on Safety Glass requirements, Section 7.16 for details.
2. Egress requirements: If a new window is installed in a sleeping room or basement with habitable space and the existing opening size is altered, then the appropriate egress requirements must be met. If the existing opening size is not altered, egress requirements do not have to be met.

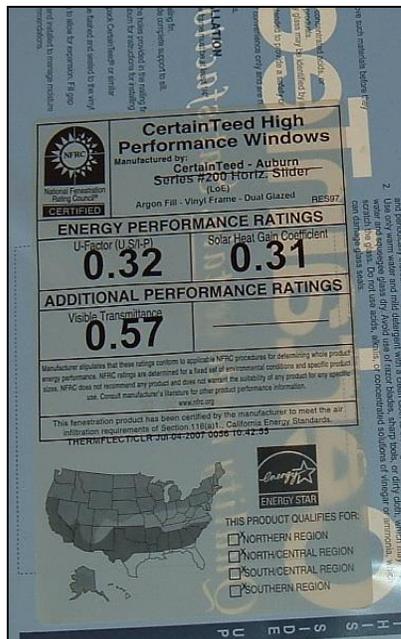
- 7.04 Any exposed wood, either existing or added, shall be finished with a sealer to prevent future warping, swelling or rotting. Acceptable alternatives are to use naturally decay-resistant wood such as cedar or to use chemically treated wood. Prior approval by client is necessary.



- 7.05 Hardware shall be durable, function properly and not create interference. Hardware and fasteners shall be aluminum, stainless steel, or other non-corrosive materials chemically and visually compatible with the window frame. Cadmium or zinc-plated steel, where used with aluminum windows shall meet the requirements of ASTM B-633-78 or A-1 6580.
- 7.06 Windows shall have no burrs, splinters or other potentially hazardous conditions that could cause harm to the occupant.
- 7.07 After installation, windows and patio doors shall operate smoothly and properly. When closed, the entire assembly shall provide a complete weather barrier for the entire opening.
- 7.08 Any vinyl or metal shavings or other debris shall be cleaned up.
- 7.09 Screens shall be furnished with all operable window systems; however, exceptions are allowed. For outward opening window types where there are no existing screens or where the existing screens remain fully functional. In addition, screens for other window types need not be supplied where existing screens remain fully functional or where the prime windows were never designed to have screens.

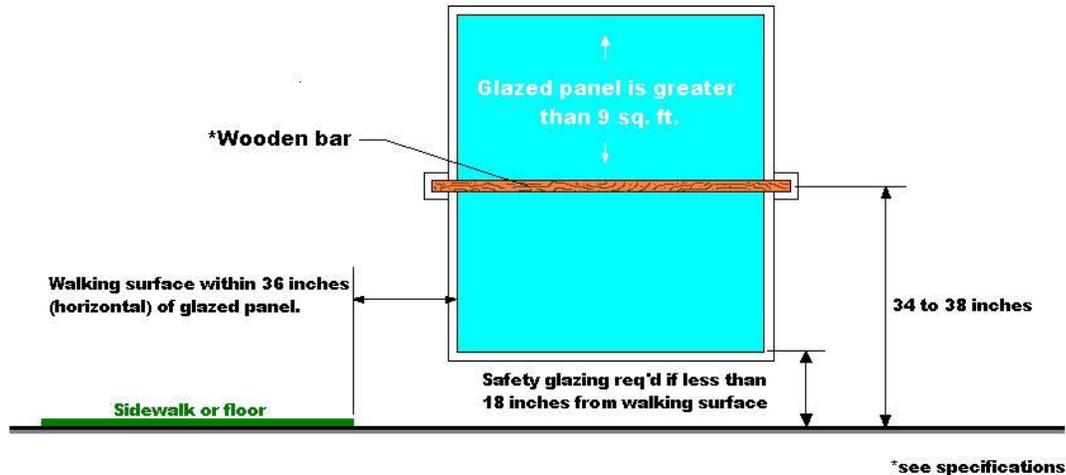
Replacement Glazing, Including Replacement Windows, Replacement Sliding Glass Doors, and Multi-glazing Insert Kits

- 7.10 Replacement windows and patio doors shall have a tested energy class rating of .35 (U=0.35) or better. Windows funded under utility programs may have additional requirements.
 1. Replacement glazing shall also incorporate Sealed Insulated Glass Manufacture’s Association (SIGMA)-approved Class sealed-glass units. The manufacturer shall mark and certify units in one of the of the following three ways:
 - A. By a stamp on the spacer bar,
 - B. By an etching on the glass itself,
 - C. By a label between the panes of glass.
 2. The identification shall include the agency, which certified the unit (e.g. the Associated Laboratories, Inc. ALI or National Fenestration Rating Council-NFRC), the class or classes that the unit meets, and the date manufactured.



- 7.11 Flashing shall be used on the tops of windows and patio doors when all three conditions below are met:
1. A block window (without nailing fins) or a block patio door is being installed; and
 2. The frame of the new glazing extends beyond either the house siding or any existing window trim; and
 3. The upper frame of the glazing when exposed to the outside weather. To determine if a glazing system is exposed to the outside elements use the "Two-to-One Ratio" system. The distance between the glass and the overhang must be twice the distance than the distance from the overhang to the bottom of the window. If it is not, add flashing.
- 7.12 Cracks between the window frame or patio doorframe and the frame of the rough opening shall be caulked both interior and exterior.
- 7.13 Multi-glazing shall not be installed where sash material has deteriorated or does not possess adequate strength, support, or anchorage for the multiple panes. Structural repairs or replacements shall be accomplished prior to weatherization.
1. Any worn or damaged rollers shall be replaced with metal rollers. Deteriorated track systems shall be replaced or repaired with track covers.
 2. Worn or damaged weatherstripping shall be replaced unless noted otherwise on the audit. This includes replacement of the meeting rail weatherstripping.
 3. All materials used shall be compatible to the manufacturer's slide system and be a permanent repair or replacement.
- 7.14 Multi-glazing should replace existing single-pane glazing in entrance doors located between conditioned and unconditioned space when repairing doors.
1. Edges of multi-glazed units shall have no edge damage no hairline cracks at the periphery and no holes in the edge sealants. Materials damaged in shipment or installation shall not be used.
 2. Glazing compounds and gaskets shall be installed with a slope to ensure water runoff. Such compounds shall not contact the seal of the multi-glazed unit or the material shall be shown to be chemically compatible with the seal of the multi-glazed unit.
 3. Follow requirements for determining if safety glass is required. See Section 7.16.
- 7.15 Spacer blocks shall be installed according to the manufacturer's installation recommendations.

Safety Glazing Requirements



- 7.16 Safety glass requirements in addition to other requirements all safety glass shall conform to the Safety Glazing Certification Council (SGGC) labeling requirements.
1. Certified and permanently labeled laminated glass may be cut into smaller pieces after being manufactured.
 2. If it is not practical for each smaller piece to bear a manufacturers permanent label, the window manufacturer shall apply a permanent label etched to each smaller piece.
 3. The etching shall identify the window manufacturer and certify that the material as cut from properly labeled safety glazing.
- 7.17 When measuring glazing, measure only the area of glass (sash is not to be included).
- 7.18 Sidelights – A sidelight is the pane of glass next to a door. Safety glass is required if all three of the following conditions exist:
1. The glazed panel is within 12 inches of the door opening and
 2. The glazed panel is within 60 vertical inches of the floor and
 3. The window is in the same plane as the door when the door is closed.
- 7.19 Safety Glass is required in fixed or operable panels adjacent to a door where the nearest exposed edge of the glazing is within a 24 inch arc of the vertical edge of the door in a closed position and where the bottom edge of the glass is less than 60 inches above the floor or walking surface unless there is an intervening wall or permanent barrier between the door and the glass.

- 7.20 Other Glazed Panels - Safety glass shall be installed where panes of glass, other than sidelights, are located in hazardous areas. This standard applies when these three conditions exist:
1. Glazed panel is greater than 9 square feet when measured from the inside of the sashes
 2. The lowest edge of a glazed panel is less than 18 inches above a walking surface and
 3. There is a walking surface, for example, a sidewalk or floor within 36 horizontal inches of a glazed panel.

An alternative to using safety glazing if these requirements are met is to put a wooden bar across the window opening. It shall be at least 1 ½ inch wide. It shall be attached between 24 and 36 inches above the walking surface and be on the same side as the walking surface. If there is a walking surface on both sides of the window, then bars need to be used on both sides of the window. The bars shall have the deflection strength of a 2 inch by 2 inch #1 lumber. Bars shall not be used on sidelights.

- 7.21 All storm doors, sliding glass doors, and prime doors with glass panes shall use safety glass if a 3 inch or larger sphere can pass through the glazing opening.
- 7.22 Windows within bathtub and shower enclosures shall be of safety glass unless the bottom of the window is 60 inches or greater from the bathtub drain.
- 7.23 Plastic glazing shall not be used in place of safety glass.
- 7.24 Fixed panels of glass contained in one window surrounded but separated by structural mullions, do not need to be safety glass if they are not located in a hazardous area.

Exterior Doors

- 7.25 Replacement slab doors shall be solid core, weatherstripped, caulked and be sealed on all edges in accordance with manufacturer's printed instructions.
- 7.26 Replacement insulated entrance door units shall have a minimum thermal rating of R-7 caulking or foam shall be applied between the jamb of the door and the rough opening.
- 7.27 New doors shall operate freely and not bind; no gaps or openings shall exist around the perimeter.
- 7.28 The door unit shall have a lockset. The unit shall operate properly to meet egress requirements.
- 7.29 Weatherstripping shall meet specifications in Section 6.

Section 8: House Performance Assessment

- 8.01 General: weatherizing homes with combustion appliances, moisture problems, and pressure imbalances has created the need for increased testing, and in some situations, corrections. The following is a list of testing and possible correction procedures.
- 8.02 One hundred percent of the homes require pre and post blower door tests. Documentation of the results of these tests shall be included in the occupant or homeowner file. In the event that either test cannot be preformed, documentation is required. (See Appendix B sample test form).
1. One hundred percent of housing with four or less units require pre and post blower door tests. Documentation of the test results shall be included in the job file. In the event that either test cannot be preformed, documentation is required.
 2. Performing pre and post blower door testing on every unit in low rise (≤ 3 stories) garden style buildings having 5 or more units would be best practices, but that is not always practical. Testing a representative sample of the units is acceptable, consisting at a minimum of testing of 20% each different type unit based on floor level, volume, inside or outside unit, etc. Utilize the following sampling procedure to determine the level of testing necessary:
 - A. Perform "initial sample" blower door shell testing on 10% of the units with each floor plan or three units, whichever is greater.
 - B. Average the sample blower door tests and add 15%. This is your acceptable maximum CFM50 shell leakage (AMSL)
 - C. Perform a blower door on an additional 10% with each floor plan or three units, whichever is greater.
 - D. If the leakage rate in the additional 10% sampling is within the AMSL, the 20% sampling is sufficient.
 - E. If the leakage rate exceeds the AMSL on any of the additional units, a minimum of 30% of each floor plan must be tested.
 - F. Documentation of each testing sample is required.
 3. In the event of a low rise (≤ 3 stories) garden style apartment complex with many buildings of similar design consisting of 4 or less units. The above testing protocol is acceptable. Documentation of the testing process is required.
 4. High Rise Apartments - The Weatherization Assistance Program (WAP) does not require high-rise residential buildings to be blower door tested. Prescriptive air sealing is required in high-rise buildings in lieu of blower door testing.



- 8.03 If combustion appliances including woodstoves or fireplaces are present, a **worst-case** depressurization test is required. Worst case depressurization combustion appliance zone (CAZ) with reference to (WRT) outside shall not exceed the HDL found in Appendix Q. Draft flue pressures shall meet the minimum acceptable draft pressures as listed in Appendix O. Test results shall be recorded on the test data form and included in the occupant or homeowner file.
- 8.04 **Spillage** occurs commonly on initial fire up of atmospheric appliances. Spillage of more than 30 seconds is called back drafting. Back drafting is a hazardous condition and unacceptable. Spillage test measures the amount of time it takes for appliance to establish a draft with a cold flue and all exhaust fans on and the house set up in worst case. Test shall be for back drafting or spillage of combustion gases for more than 30 seconds. Test shall be done using chemical smoke or mirror and shall be done on all sides of the draft hood. Test results shall be recorded on the test data form and included in the occupant or homeowner file. Refer to Appendix R.
- 8.05 Ambient carbon monoxide (CO) test shall be performed 5 minutes after appliance startup. All homes with natural gas, oil, propane, or wood fueled appliances are required to be tested for carbon monoxide levels both pre-weatherization and post-weatherization. Test results shall be recorded on the test data form and included in the occupant or homeowner file. Maximum allowable ambient CO concentration level is 9 Parts Per Million (ppm) Refer to Appendix S.



- 8.06 Combustion appliance CO level tests the CO level of each combustion appliance at the location described below by letting them run for approximately five minutes, allowing them to reach steady-state efficiency before taking a reading. Installer test results are to be included on the test data form provided at the time the project work order is issued. Refer to Appendix P.
1. Maximum CO concentration levels 100 ppm for gas oven.
 2. 100 ppm in the flue pipe after 5 minutes.
 - A. For oil furnaces, CO should be measured in the breech section of the flue pipe before the barometric damper.
 - B. For atmospheric draft gas furnaces, measure CO before the draft diverter.
 - C. For induced draft gas furnaces, measure CO in flue pipe.
 - D. For sealed combustion gas furnaces, measure CO at termination.
 - E. For gas water heaters, measure CO at top of water heater before draft diverter hood, as possible.
 - F. For gas ovens, measure CO from the oven exhaust port.

8.07 Draft testing should be performed in the following areas:

1. For oil furnaces, draft should be measured in the breach section of the flue pipe before the barometric damper.
2. For atmospheric draft and induced draft furnaces, measure draft in flue pipe.
3. For atmospheric draft water heaters, measure draft in the flue pipe.
4. For sealed combustion or power vented appliances, no draft testing is required.

8.08 Pre and post measurements of duct leakage are required on all homes with forced air systems. Test results shall be recorded on the test data form and included in the occupant or homeowner file.

Test Results shall be recorded on the test data form and included in the job file.

1. Duct blaster test: Follow set-up directions & specifications for duct leakage (Appendix X).
 - A. All ducts must be sealed as airtight as possible before insulating ductwork or installing insulation in a mobile home floor. The goal is to seal ductwork as airtight as possible.
 - B. Duct sealing must include, but is not limited to the following areas:
 - i. Joints on the furnace plenum and the furnace plenum connection.
 - ii. Joints and seams on cold air return and supply ducts.
 - iii. Where the boots connect to the interior floor surface and elbow gores.
 - iv. Air leakage in the air handler should be sealed as possible.
 - v. Metal sweeps or rigid insulation board blocks must be installed and sealed where duct runs extend beyond the last register.
 - C. Based on the protocol for testing "Duct Leakage to the Outside" (appendix X), duct leakage at CFM 50 in a retrofitted system must:
 - i. Be reduced to 10% of the floor area or less after sealing; or
 - ii. If the duct leakage at CFM 50 cannot be attained after all joints and seams are sealed, then a 50% reduction from pre-test levels is acceptable. There must be documentation in the file explaining why the 10% standard was not achievable.



2. Pressure pan may be used for troubleshooting leakage in specific ducts only. Refer to Appendix W.

Pressure Balancing

Homes with pressure imbalances have created the need for increased testing and in some situations, corrections; see Appendix U, Room-to-Room Testing Procedures. Many of the pressure balancing procedures listed below can be intrusive; inform occupant or homeowner of procedure prior to installing. The following is a list of possible correction procedures:

- 8.09 Installer shall inform occupant or homeowner of proposed intentions to undercut door. This item shall include removing door, cutting the bottom, and rehangng the door so that it will open and close freely. Installer shall not scar, mar, or otherwise rendered door unusable. All work shall be done in a professional workmanship manner and in accordance with Uniform Mechanical Code (UMC) and agency weatherization specifications.
- 8.10 Bypass grille installation shall include installer informing occupant or homeowner of proposed intentions. This item shall include installing non-closeable grilles opposite each other on each side of wall or door. Opening for grille shall be finished so that there are no unsightly holes or air bypasses. All work shall be done in a professional workmanship manner and in accordance with UMC and agency weatherization specifications.
- 8.11 See Section 5: Duct, pages 26-28.
- 8.12 Installer shall inform occupant or homeowner of procedure prior to installing jump-over ducts. This installation shall include installing a crossover duct and connecting to bypass grilles, the duct shall be insulated flex duct with the seams sealed at the flex duct and the connector. Mastic shall be used after securing with screws. Duct tape is prohibited from sealing or securing duct and connector.



Through the wall bypass grille



Ceiling jump-over duct grille

Moisture Mitigation

Homes with moisture problems have created the need for increased testing and in some situations corrections are needed. Appendix L provides information on improving moisture problems. Occupant or homeowner is to receive and sign a copy of Moisture and Mold-Related Weatherization Procedures form (in Appendix M) and a copy shall be placed in the client file.

The following is a list of possible correction procedures:

- 8.13 Furnish, install and vent a new bath fan and 24-hour timer or add timer to existing fan. Inform occupant or homeowner of installer's intentions. This measure shall also include ducting fans. Use of existing roof vents is acceptable as long as attic ventilation requirements are maintained. If an appropriate roof vent does not exist, one shall be added meeting approved codes.
1. All fans shall have dampers.
 2. The duct shall be at least the same diameter as the fan connection.
 3. Duct shall not have traps or reversing horizontal runs.
 4. The duct shall be substantially airtight to the outside.
 5. Fan should be equipped with a 24-hour timer or humidistat when appropriate. Proper sizing of fan is the responsibility of the installer and shall meet HDL and minimum acceptable appliance draft levels.



60 minute bathroom fan timer

6. Explain operation of timer or humidistat and leave written instructions with the occupant or homeowner.
 7. All work shall be done in a professional workmanship manner and in accordance with UMC and agency weatherization specifications
- 8.14 Installation of kitchen fan shall include informing occupant or homeowner of installer's intentions. This installation shall include furnishing new kitchen fan, ducting of not less than 26 gauge galvanized sheet metal, substantially airtight and extended vertically, directly into a code-approved metal vent cap.
1. Proper sizing of fan is the responsibility of the installer and shall meet HDL and minimum acceptable appliance draft levels.
 2. The duct shall have no horizontal or 90-degree bends and shall be installed to meet all local building codes.
 3. All work shall be done in a professional workmanship manner and in accordance with UMC and agency weatherization specifications.

- 8.15 Combustion air (CA) enters the combustion appliance zone (CAZ) through intentional or unintentional openings in the building shell or through a dedicated pipe from outdoors. Use worst case draft testing to help determine whether or not to add additional combustion air. Additional CA should only be added when testing indicates that additional CA is needed. In the event that testing proves additional CA is necessary, it must be installed to the following guidelines:

Location	Dimensions
Two direct openings to an adjacent space.	Minimum area each: 100 sq inches 1 sq inch per 1000 BTUH input each opening Combined room volume must be \geq 50 cubic feet/ 1000 BTUH input
Two direct openings or vertical ducts to outdoors.	Each vent should have 1 sq inch for each 4000 BTUH input
Two horizontal ducts to outdoors.	Each vent should have 1 sq inch for each 2000 BTUH input
Single direct or ducted vent to outdoors.	Single vents should have 1 sq inch for each 3000 BTUH input

1. CA supply location.
 2. Informing occupant or homeowner of installer's intentions.
 3. Dampers, grilles or registers installed for the purpose of controlling the supply airflow shall not be considered as obstructions in sizing calculations.
 4. All work shall be done in a professional workmanship manner and in accordance with UMC and agency weatherization specifications.
- 8.16 Installation of cold air return may be required if the existing return air system is determined inadequate. (i.e. requires 2 square inches per 1,000 Btu output) or an additional return is needed to facilitate pressure balancing in another zone of the residence. Additional and/or relocating cold air return shall include informing occupant or homeowner of installer's intention. This installation shall include installing a new grille connected to manufactured 30 gauge sheet metal or insulated flex duct, adequately sized to the existing cold air return ducting. New rigid metal ducting requires ducts to be secured with sheet metal screws and adequately supported. All rigid metal ducts shall be insulated per Section 5: Ducts.
- 8.17 Installation of 24-hour timer for existing fan shall include:
1. Furnishing and installing 24-hour timer for existing fan.
 2. Wire the clock timer in parallel with manual spot ventilation control.
 3. Installer shall explain operation of 24-hour timer and leave written instructions explaining timer operation with occupant or homeowner.
 4. A licensed electrician shall do all wiring.
 5. All work shall be done in a professional workmanship manner and in accordance with UMC and agency weatherization specifications.

- 8.18 Humidistat installation shall include furnishing and installing humidistat for existing fan. This item shall include explaining operation of humidistat.
1. Installer shall leave written instructions explaining operation with occupant or homeowner.
 2. The product shall be certified by the Association of Home Appliance Manufacturers.
 3. All work shall be done in a professional workmanship manner and in accordance with UMC and agency weatherization specifications.
- 8.19 In-line damper installation for fan shall include furnishing the proper sized damper to match the fan's exhaust port opening. All work shall be done in a professional workmanship manner and in accordance with UMC and agency weatherization specifications.
- 8.20 Furnish and install Energy Star™ or equivalent dehumidifier (minimum 25-35 pint). Installer shall leave manufacturer's instructions with the occupant or homeowner. The installation shall:
1. Maintain the humidity level as per Appendix L.
 2. Be certified by the Association of Home Appliance Manufacturers (AHAM).
 3. Be installed according to manufacturer's instructions and in compliance with UMC and agency weatherization specifications.
- 8.21 Dehumidifier shall be installed when the following conditions have been met:
1. When weatherization measures have been installed and the dew point temperature exceeds 55° F at least one hour after any cooking or bathing has taken place.
 2. If the relative humidity is higher than the one listed in the table, then the dew point temperature exceeds 55° Fahrenheit.

The following table represents a 55°F dew point temperature for various indoor air temperatures and relative humidities:

Air Temperature (degrees F)	Relative Humidity
65°	70%
66°	68%
67°	66%
68°	64%
69°	62%
70°	60%
71°	58%
72°	56%
73°	54%
74°	52%
75°	50%

3. The Association of Home Appliance Manufacturers (AHAM) shall certify dehumidifiers.
4. Dehumidifiers shall have a humidistat to maintain the humidity level.
5. The minimum rated capacities are:

Home Area	Capacity
1000 Sq. Ft.	25 pints per day
1001-2000 Sq. Ft.	30 pints per day
2001-3000 Sq. Ft.	35 pints per day
6. Installer shall leave a manufacturer's instruction book with the occupant or homeowner.
7. Dehumidifiers shall be installed according to the manufacturer's instructions and in compliance with all state, agency and local codes

Section 9: Mechanical Ventilation

- 9.01 **General:** The Oregon WAP program follows ASHRAE 62.2-2013 guidelines. The requirements of ASHRAE 62.2-2013 must be met to the greatest extent possible. Ventilation levels must be determined by using the ASHRAE 62.2–2013 formulas. The Appendix A – alternative compliance path is allowed under the program. (SWS 6.6201.1c)

Mechanical ventilation is used primarily to replace inside air with fresh air from the outside. As homes are tightened to reduce energy costs, normal infiltration and exfiltration has been reduced. Therefore, we cannot rely on natural forces to provide ventilation at all times of the year. Mechanical ventilation helps lessen the amount of indoor air pollutants and moisture that becomes trapped in the home.

ASHRAE 62.2 requires calculations be performed to determine a whole building ventilation rate for the home. Ventilation rates must be calculated using formulas included in the ASHRAE 62.2-2013 standard.

Properly sizing fans installed under the program is critical. Over sizing fans can cause comfort issues and unnecessary energy penalties. Whole house continuous flow rates shall not exceed the calculated whole building continuous ventilation rates by more than 50%.

This section is not all inclusive of all ASHRAE 62.2-2013 requirements. For complete details, refer to the newest version of ASHRAE 62.2-2013 standard.

9.02 System Type

1. Whole Building Ventilation: Whole building ventilation rates must be calculated on all projects and flow rates set at final inspection. Documentation of whole house ventilation calculations must be present in the job file.
 - A. The whole building ventilation system shall consist of one or more exhaust fans.
 - B. Local exhaust fans are permitted to be part of the whole building system.
 - D. Controls & operation: Controls must be provided to allow the whole house ventilation without intervention of the occupant. A readily accessible override control must be provided to the occupant. Controls must be labeled as to their function.
Controls will be used that can meet the following conditions:
 - Run fan continuously or intermittently depending upon the intended schedule of operation
 - Operate fan to produce the intended flow for each intended flow setting(SWS 6.6202.1a-b)
 - E. The whole house ventilation system may operate on a continuous or intermittent basis. Continuous run fans must be rated for continuous use.
 - F. Sound Rating: Whole building ventilation or continuous local exhaust shall be rated for sound at a maximum of 1.0 sone. (SWS 6.6288.1a & 6.6288.2a)
2. Local Exhaust Ventilation: A local mechanical exhaust system may be installed in bathrooms & kitchens if needed. Existing fans **do not** have to meet the fan flow requirements listed below.
 - A. New bath fans installed must be either rated at 80 cfm on an intermittent basis or 20 cfm continuous run. It is allowable to install a fan operating continuously at 20 cfm without meeting the 80 cfm intermittent flow rate. (SWS 6.6201.1a, c,&b) Note: 80 cfm requirement is an Oregon specific requirement and exceeds SWS and ASHRAE requirements.
 - B. New kitchen fans installed must be rated at 150 cfm. Kitchen fans require the 150 cfm intermittent rate even if they are being utilized for continuous use at a lower flow rate.

(SWS 6.6201.1a, c,&b) Note: 150 cfm requirement is an Oregon specific requirement and exceeds SWS and ASHRAE requirements.

- C. Kitchen fans installed require a range hood unless a ceiling mounted fan can provide a minimum of 5 kitchen air changes per hour.
- D. Control & operation: Bathroom local ventilation fans installed must have dehumidistat, delay off timer or similar means of automatic control.
- E. Sound Rating: Demand controlled local exhaust fans shall be rated for sound at a maximum of 3 sone, unless the maximum airflow exceeds 400 cfm. (SWS 6.6288.1b & 6.6288.2b)

9.03 Venting

1. Vent runs shall be as short as possible. Exhaust fans shall be equipped with an operating back-draft damper.
2. Duct shall be smooth, rigid duct vent, mechanically fastened and shall meet venting requirements of ASHRAE 62.2-2013 table 5.3 (see Appendix N). Ducts should not have traps or reversing horizontal runs. It shall be substantially airtight to the outside. Flexible duct is not allowed in the Oregon WAP program.
3. Duct will be connected and sealed to termination fitting as follows:
 - Round metal-to-metal will be fastened with a minimum of three equally spaced screws
 - Other metal-to-metal connections will be securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic-plus-embedded-fabric systems, or tapes
 - Other specialized duct fittings will be fastened in accordance with manufacturer specifications
 - In addition to mechanical fasteners, duct connections will be sealed with [UL](#) 181B or 181B-M listed materialFasteners will not inhibit damper operation (SWS 6.6002.2c)
4. A termination fitting with an integrated collar will be used. The collar will be at least the same diameter as the exhaust fan outlet; if collar is larger than exhaust fan outlet, 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 (SWS 6.6002.2b)
5. Vent terminations shall use screen material with no less than ¼" and no greater than ½" hole size in any direction. Installation will not inhibit damper operation or restrict air flow (SWS 6.6002.2e)
6. Terminations will be installed:
 - 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
 - As required by authority having jurisdiction.(6.6002.2f)
7. Galvanized steel, stainless steel, or copper will be used for termination fitting for kitchen exhaust. (SWS 6.6002.2g)
8. Installation of vent terminations must be weatherproof.
 - Exterior termination fitting will be flashed or weather sealed.
 - Installation will not inhibit damper operation.
 - Manufacturer specifications will be followed(SWS 6.6002.2d)

9. All existing fans must be vented to daylight using these requirements.

9.04 All fans intended for continuous use must have a sone rating of 1.0 or less. All fans used on an intermittent basis must have a sone rating of 3.0 or less. Existing fans do not have to meet sone requirements.

9.05 If an existing fan is to be used for continuous use, it must be rated for continuous use.

9.06 If the whole house continuous mechanical ventilation is run on an intermittent cycle, flows must be increased in accordance with table 4.2 (see Appendix N) from the ASHRAE 62.2-2010 standard.

9.07 **Determining Fan Flow**

1. All existing exhaust fans must be flow tested to determine actual airflow.
2. If a fans air flow cannot be measured, the fans flow must be assumed to be zero.
3. All fans installed under the program must have flow rates measured and documented in the file. If the fan is used for continuous and intermittent use than the flow rate of each mode must be measured separately. (SWS6.6201a-c)

9.08 **Other Requirements**

1. Adjacent spaces: To prevent air movement between conditioned spaces and adjacent spaces such as garages, attics and crawlspaces, air sealing must be performed between the conditioned space and unconditioned areas. This will involve sealing all penetrations and applying seals (weather stripping) to access doors. Doors between dwelling units and common interior hallways must be weather stripped unless the ventilation system requires communication between the hallway and the conditioned unit. (SWS6.6003.5b)
2. Instructions and labeling: Instructions as to the proper operation and maintenance of the installed equipment must be supplied to the occupant. All controls for continuous run fans must be labeled as to their function. (SWS 6.6202.1a-b)
3. Clothes dryers: All clothes dryers shall be exhausted directly to the outdoors. (See appendix M) (SWS6.6005.1a)
4. Combustion and solid fuel appliances: When an atmospherically vented combustion appliance or solid fuel burning appliance are included anywhere in the structure, pre and post worst case combustion testing is required ensure that the appliances are drafting adequately or the housing depressurization limit (HDL) has not been exceeded. If either of these tests indicates a problem, then the exhaust fan flow may be reduced, pressure balancing the home or providing compensating outdoor air is allowed. (SWS 6.6003.5c)
5. Space conditioning duct systems: Any ductwork located outside of the conditioned space, including but not limited to garages, crawlspaces and attics, must be sealed to obtain a total duct leakage to the outside of no more than 10% of the square footage when measured at 50 Pascals. If these levels cannot be achieved, there must be documentation in the job file as to why it was not obtained.

Note: When the duct leakage test is performed, if there are ducts in the garage, the door leading form the garage to the outside must be open.

6. Minimum filtration: All mechanically supplied outdoor air will pass through filter before conditioning.

Filters will have a rating of minimum efficiency rating value 6 or higher. Filter will be located and installed to facilitate access and regular service by occupant/maintenance staff (SWS 6.6202.9 b & c)

7. Carbon Monoxide Alarms: A Carbon Monoxide alarm shall be installed in each dwelling in accordance with NFPA 720.

Section 10: Thermostats

- 10.01 Thermostat installation shall be either low or line voltage thermostats as found on the agency's approved products list or which comply with applicable federal standards.
1. Thermostats with a heat anticipator feature are recommended.
 2. Thermostats have at least two setback periods per day, with separate high and low temperature settings.
 3. If used with heat pumps, thermostats shall be of the intelligent/rapid recovery type that restricts resistance heat during recovery periods.
 4. Existing thermostats on outside walls should be moved to an interior wall. Wiring and any change-over is an allowable expense if authorized by the local agency.
 5. Thermostats shall be installed according to the manufacturer's instructions and in compliance with all state, agency, and local codes.
 6. Installer shall provide verbal operating instructions to the homeowner/renter and/or rental owner.
 7. Installer shall leave written instructions explaining the operation and adjustment of the clock thermostat with the homeowner/rental owner.



Section 11: Water Heaters

Note: Not all water heaters can be wrapped with additional insulation; check tank to see if a water heater warranty will be negated if additional insulation is installed.

- 11.01 General: material shall be installed according to the provisions of current Oregon Building Code or other applicable codes and shall meet the requirements of the agency weatherization programs. Any exceptions shall be approved in writing in advance by the agency.
- 11.02 The water heater insulation wrap shall have an insulation value of R-11 or greater. The insulation wrap shall have a maximum thermal conductivity of $K=0.26$ as tested in accordance to ASTM C-177-85 or ASTM C-518-85. The insulation wrap shall be faced with white vinyl sheeting with nominal thickness of four mils (minimum 3.2 mils). Tape used shall be compatible to the vinyl sheeting of the insulation wrap.
- 11.03 The vinyl shall be continuously laminated to the fiberglass blanket and shall have a flame spread rating of no more than 150 when tested in accordance with ASTM E-84-88.
- 11.04 Water heaters without operable pressure relief valve shall have a pressure relief valve extended to within six inches of floor; relief pipe shall not be threaded on bottom end.
- 11.05 No water heater shall be wrapped which exhibits leaks or other evidence of impending failure.

Pipe Insulation

- 11.06 Starting at the water heater (located in unconditioned space), at a minimum wrap the first 5 feet on both the cold and hot water pipe with R-3 pre-split foam water pipe wrap, or wrap with R-11 fiberglass insulation and secure with twine.

Gas Water Heaters

- 11.07 Clearances between the surface of the wrap and adjacent heat producing appliances including vent connectors shall be maintained according to the recommendations contained in the National Fire Protection Association National Fire Code 89m. When determining the clearance concerning the appliance and/or its vent connector, the clearance shall be increased to the larger amount indicated for possible configuration.



- 11.08 When installing the water pipe insulation in connection with the water heater insulation wrap, the water pipe insulation shall not be installed in a position to interfere with or be within 1" if the flue pipe is made of B Vent or 6" if made of single wall flue pipe.
- 11.09 When installing insulation on water heater clean top of heater and wipe dry.

- 11.10 Vinyl covered insulation wrap shall be on the outside and top edge flush with the top of the water heater. Leave exhaust draft at top of water heater clear. Top of a gas water heater shall not be insulated.
- 11.11 Bottom of insulation shall be at least 3 inches from bottom of water heater in order to leave combustion air passage. Clearance shall be provided around the thermostat and control panel.
- 11.12 Pilot light and controls shall be accessible.

Section 12: Mobile Home Building Codes

- 12.01 General: material shall be installed according to the provisions of current Oregon State Manufactured Dwelling Administrative Rules or other applicable codes and shall meet the requirements of the agency.
- 12.02 Insulation safety standard shall be installed according to the provisions of the Federal Mobile Home Construction and Safety Standard, Title 24, CFR 3280, the Uniform Building Code, other applicable codes, and the requirements listed below.
- 12.03 Insulation flame spread of materials used shall meet the flame spread and smoke developed requirements of Sections 1713 and 1714 of the 1991 UNC. Only blown fiberglass insulation is allowed in mobile home ceiling cavities.
- 12.04 Only non-combustible insulation tested to ASTM 136-92 may contact masonry chimney. This includes existing insulation.
- 12.05 Before installing a single ply membrane roof, the three-tab roofing must be removed completely.

Section 13: Water Heater Closet

- 13.01 Do not seal operating combustion air vents. Maintain code-required clearances between the insulation and the water heater and/or flues.
- 13.02 Seal all penetrations through the ceiling, floor, exterior walls, and interior walls of the closet with approved materials. Seal those penetrations to the heated spaces, and others with polyurethane or urethane foam. Seal all wiring and plumbing penetrations around the water heater.



Water heater/bathtub penetration

- 13.03 If the water heater is located in a water heater closet with an exterior access, it should be considered outside the thermal boundary.
1. Insulate and weather-strip the closet door. Closet door shall be insulated to a minimum of R-11 if clearance allows.
 2. If batt insulation is attached to the access door, it shall be covered with house wrap.
 3. Seal around the access door and ensure it fits securely.
 4. If water heater cannot be brought inside thermal boundary wrap water heater and insulate walls with minimum R-11.
 5. If water heater is a combustion type, be sure to leave intake for combustion air open and clear.



Water heater closet door insulated with foam board

Section 14: Mobile Home Roof Cavity



- 14.01 General: material shall be installed according to the provisions of current Oregon Building Code or other applicable codes and shall meet the requirements of the agency weatherization program. Any exceptions shall be approved in writing in advance by the agency.
- 14.02 Depending upon the type of roof or cavity, agency approved materials include insulation, shields for heat producing fixtures and ventilation, attic ventilation devices, roof sealant, etc.
- 14.03 Insulation materials shall meet the flame spread and smoke developed requirements.
- 14.04 All penetrations through the ceiling (e.g. marriage lines, closets, electrical and plumbing penetrations, and all gaps between exhaust fans, swamp coolers, and the envelope) shall be sealed before insulation is installed. The vertical clearance that existed prior to the single ply membrane roof installation for all vents and flues shall be maintained after the single ply membrane roof is installed.



- 14.05 Non-rated recessed lighting fixtures or fan/light combinations shall be shielded with solid flame resistant material. Refer to specification 1.05.
- 14.06 Recessed fluorescent fixtures with thermal protection may be covered with insulation.
- 14.07 Install shields around all lights and heaters that do not meet the requirements of 1.05 or 14.05 heat-producing fixtures. The shields shall be a solid, flame-resistant material that is attached to the ceiling structure and provides a minimum clearance of 3 inches and a maximum clearance of 4 inches. Fiberglass batts DO NOT meet this requirement.
- 14.08 All existing and added insulation shall be kept at least 3 inches away from single wall metal flues by using shielding material.

- 14.09 Wood stove chimneys shall have clearances maintained per manufacturer's instructions or local code; whichever is more restrictive. Manufactured chimneys (i.e."metalbestos" or Type B vent) shall be shielded like any heat-producing fixture. All insulation shall be kept a minimum of 3 inches from metal flues.
- 14.10 Installer shall close off and seal all ceiling registers and the return air opening in the ceiling of the furnace closet. See Section 17.09 for providing return air.

Interior Ceiling Blow Access Method

- 14.11 Installers shall protect and cover the floors and furniture.



- 14.12 Holes shall be evenly spaced and in straight line. Holes shall be drilled two feet in from each edge and another hole in the center of each truss cavity.
- 14.13 A plug shall be installed in each hole with sealant between the plug and the ceiling to stop air bypasses to the roof cavity.

Ventilation

- 14.14 For pitched roofs with an air space above the insulation: attic ventilation may be increased.

Exterior Roof Insulation

- 14.15 Three-tab roofing must be removed before installing single ply membrane roofing.
- 14.16 Use rigid extruded polystyrene or rigid polyisocyanurate insulation, single ply membrane roof covering with a minimum thickness of 45 mil rubber, rubber boots, extend plumbing stacks, fender washers, screws long enough to achieve positive penetration, butyl tape and termination bar.
- 14.17 The installer is responsible for determining that the ceiling system is structurally adequate to support the combined weight of all materials imposed on the ceiling and for all damage occurring during installation, leaks caused by improper sealing, and damage due to combined weight of materials on the interior ceiling. If insulation is installed on the exterior of the roof cavities: all crank vents used for ventilation shall be removed.
- 14.18 Remove existing exhaust fan termination, flashing, or other objects that would interfere with installing the rigid insulation.
- 14.19 Insulate roof cavity to the highest R-value achievable.



- 14.20 The rigid insulation shall be mechanically fastened using screws with 3 inch galvanized deck washers. All screws shall penetrate the roof structure (trusses) a minimum of $\frac{3}{4}$ inch to ensure insulation remains in contact and minimizes independent movement. All rigid insulation shall fit tightly together with no gaps to prevent thermal boundary breaks.



- 14.21 New roof coverings shall:

1. Be extended down the wall and over the top edge of the wall covering and be secured to the wall using non-corrosive, self-tapping hex-head with a minimum length of $1 \frac{1}{4}$ inch metal screws with butyl tape installed between the termination bar and the roof covering. Screws shall be anchored no more than every four inches.
2. Roof insulation and covering shall be sufficiently rigid to prevent “ponding” of water on the surfaces after installation.



- 14.22 All plumbing vents, kitchen fans, bath fans, wood stoves, and other fixtures are required to vent to the outside of the new roof and be adequately flashed and sealed. All vents and chimneys shall be extended through the new roof with quick disconnects. If a swamp cooler or a vent is to remain in place after the insulation and covering is installed, it shall be adequately flashed and sealed. If swamp cooler is removed, patch hole in an approved method.

- 14.23 All pre-existing roof drainage systems shall function properly after the insulation and the new roof covering have been installed.

Section 15: Mobile Home Wall Insulation



- 15.01 General: material shall be installed according to the provisions of current Oregon Building Code or other applicable codes and shall meet the requirements of the agency weatherization program. Any other exceptions shall be approved in writing in advance by the agency.
- 15.02 Insulating cavities with wall heaters is prohibited unless fire stops are present.
- 15.03 Materials vary depending upon the type of installation and may include agency approved insulation, fill tube, batt stuffing, corrosion-resistant screws, polyethylene, and caulking.
- 15.04 Only non-combustible insulation tested ASTM-136-82 shall be installed in cavities adjacent to masonry chimneys.
- 15.05 Exposed insulation facing material shall meet flame spread and smoke development requirements of section 1713 and 1714 of the 1991 UNC.

Blow in/ Batt Stuffing Methods

- 15.06 Insure that both interior and exterior materials of the walls to be insulated are in good repair and well attached. Visually inspect for dry rot, pest infestation, water leaks, or other problems. Any problems shall be repaired at owner's expense.
- 15.07 A self-tapping screw shall be installed through each crimp joint in the exterior metal siding 3-5 inches from the bottom of the wall to prevent panel separation.
- 15.08 Wall-to-wall attachments (bonding straps, screws, bolts, etc.) shall be secured or repaired.

Blown-in Method

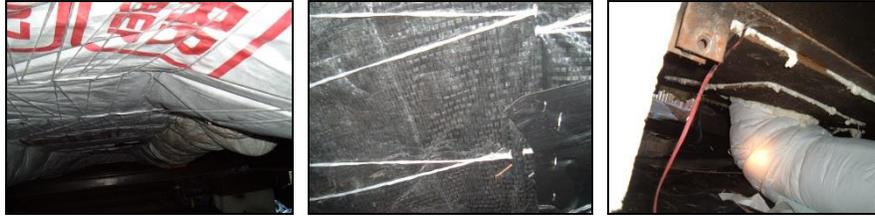
- 15.09 Insulation shall be installed between the exterior side of the existing insulation and the exterior wall.
- 15.10 The metal siding shall be attached with corrosion-resistant sheet metal screws. Tapered screws such as wood screws or drywall screws are prohibited.
- 15.11 The upper joint of the exterior wall panels shall be properly secured and sealed. Sealing the bottom end of the wall panels is prohibited.

Batt Stuffing Method

- 15.12 Insulation shall be installed to the top of the cavity. Note: If there is no existing vapor retarder, the polyethylene may be left in the cavity. When a vapor retarder is present on the interior side of the existing insulation, install the new, unfaced batt on the exterior side of the existing insulation and remove the polyethylene.
- 15.13 The metal siding shall be reattached with corrosion-resistant sheet metal screws. Tapered screws such as wood screws or drywall screws are prohibited.

Section 16: Mobile Home Floor Insulation

- 16.01 General: material shall be installed according to the provisions of current Oregon Building Code or other applicable codes and shall meet the requirements of the agency weatherization program. Any other exceptions shall be approved in writing in advance by the agency.
- 16.02 Exposed insulation facing material shall meet flame spread and smoke development requirements of section 1713 and 1714 of the 1991 UNC.
- 16.03 Facings used on pipe and duct insulation shall meet the flame spread and smoke developed requirements.



- 16.04 Structural members and components shall be sound and free of insect infestation, dry rot, decay and other damage before measures are installed. Any repairs shall be completed before the insulation is installed.
- 16.05 Operating combustion air intakes penetrating through the belly board shall not be sealed.
- 16.06 Electric forced air or heat pumps with air intakes penetrating through the belly board shall be sealed.
- 16.07 All gaps, holes, joints, and seams shall be sealed before installing underfloor insulation. Inspect all HVAC ducts and plenums for leaks and openings.

Note: See the Air Sealing Section 18 for more information.
- 16.08 All gaps around plumbing penetrations through the floor (bathtubs, clothes washers, sinks, etc.) shall be sealed before installing underfloor insulation.
- 16.09 All exhaust ducts (kitchen ranges, dryers, etc.) and condensation lines shall be extended outside the perimeter of the mobile home.
- 16.10 Appliance exhaust fan vents (e.g. exhaust fans, kitchen range exhaust etc.) shall terminate outside the residence using manufactured duct and be equipped with a back-draft damper. Any new ducts installed under the program shall be made of rigid metal with smooth interior surfaces. Ducting shall be supported in a level position, every 3 feet. Bends or reversing horizontal runs in ducts shall be eliminated. Kitchen range exhaust fan ducting shall meet the material standards in Section 1.08.
- 16.11 Dryer vent duct system may contain up to 3-feet of flex duct connecting the appliance to the rigid duct. Note screws or other fasteners shall not protrude into the duct.

Insulation through Rodent Barrier Method

- 16.12 All tears, holes or other damage to the rodent barrier/belly board shall be patched with a material of equal or greater strength than the existing rodent barrier/belly board, and stapled in place using an outward clinch stapler, (AKA stitch stapler). Holes in excess of 9 square feet shall be supported to secure the patch. Large holes in the barrier/board may be insulated with batts if the batts are protected with a material of equal or greater strength than the existing rodent barrier/belly board material and they do not interfere with the blowing operation.
1. All penetrations shall be sealed prior to installing insulation.
 2. Twine patch with polypropylene or polyester twine shall have a breaking strength of at least 150 pounds.
 3. Support the air barrier with twine attached at every point it crosses a stud. Attaching twine shall not exceed 12 inches on center.
 4. Twine shall be installed in a zigzag pattern not to exceed 12 inches.
 5. 5/8-inch staples of at least 18 gauge corrosion resistant materials shall be used to attach twine.
 6. The air barrier shall be cut in an "X" pattern in each cavity.
 7. Install approved loose fill fiberglass insulation.
 8. It is highly recommended to seal all patches with an adhesive in addition to the previously stated specifications.



16.13 Insulation shall be in contact with the sub-floor and each joist cavity shall be completely filled.

16.14 Insulate all spaces around and below HVAC ducts.



When blowing in insulation through rim joists:

16.15 Each cavity shall be drilled, filled and wooden plug inserted and glued to complete the application.

Batt Insulation

See Section 3: Floor Insulation

Ventilation

- 16.16 When skirted, the entire enclosed underfloor crawlspace area shall be ventilated by openings in the skirting. Provide a net free ventilation area of 1 sq. ft. for each 300-sq. ft. of underfloor area or less, if approved by the agency.
- 16.17 Vents shall be placed as close to the corners as practical, with the balance evenly distributed (on opposing walls) for cross ventilation. Vents shall be covered with corrosion-resistant wire mesh, with maximum mesh openings of ¼ inch. Existing vent openings, which are covered with wire mesh, do not have to be changed if they are serviceable and clean.
- 16.18 All gaps & penetrations shall be sealed. This shall include but not be limited to gaps around plumbing penetrations through the floor (e.g., bathtubs, clothes washers, sinks, etc.) and electrical penetrations (conduit, wiring, etc) before installing underfloor insulation. All penetrations shall be sealed between the open crawl space area and the rodent barrier and/or belly board. If the belly board/rodent barrier is being completely removed, seal the penetrations in accordance with Section 3. Repair all tears, holes, or other damage to the rodent barrier/belly board. Large holes in the barrier/board may be insulated with batts if the batts are protected with a material of equal or greater strength than the existing rodent barrier/belly board material. Insure that rodent barriers are properly supported. Provide additional support at every joist where needed to blow the insulation properly.

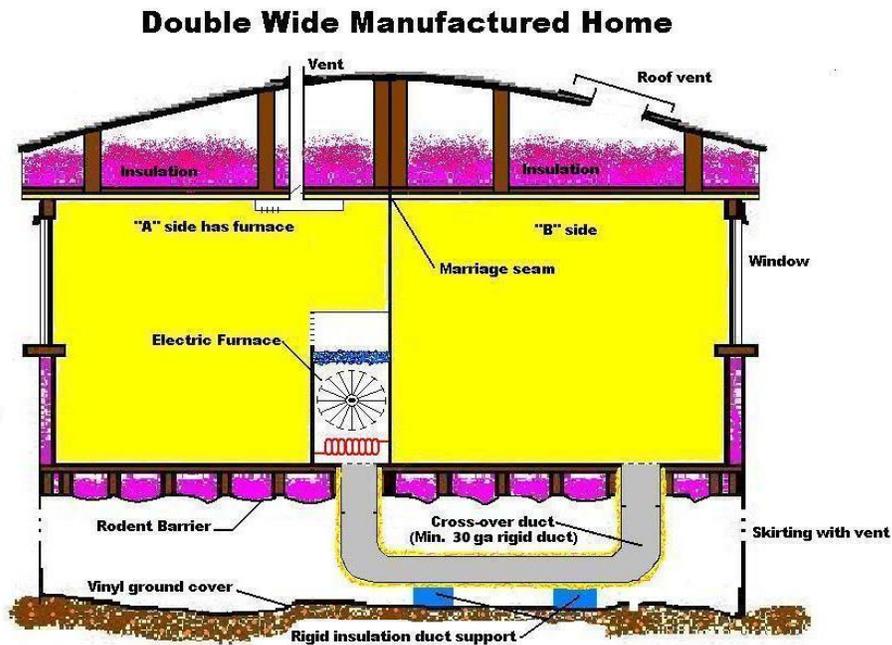
Ground Cover

- 16.19 If installing ground cover, install a 6-mil, polyethylene ground cover. All exposed soil shall be completely covered with no rips or tears in the cover. All existing undamaged ground covers of 4-mil thickness are acceptable.
- 16.20 The ground cover shall not contact any wood members. All joints shall be over lapped 12 inches.
- 16.21 Where practical, all debris shall be removed from the crawl space before the new ground cover is installed.
- 16.22 The agency may waive the requirement for a ground cover.



Section 17: HVAC Mobile Home

- 17.01 General: material shall be installed according to the provisions of current Oregon Building Code or other applicable codes and shall meet the requirements of the agency weatherization program. Any other exceptions shall be approved in writing in advance by the agency.



- 17.02 Inspect, seal, and insulate all HVAC ducts in unconditioned areas.
- 17.03 Rigid crossover duct shall be a minimum of 30-gauge metal.



- 17.04 Pre-fabricated flexible crossover ducts, if installed, shall have a minimum rating R-8 (as determined by the Air Diffusion Council method), have an exterior vapor barrier of 1.0 perm or less, and have an interior layer with a spring-steel wire helix bonded with 2 layers of 57-gauge or thicker Mylar™, or equivalent; ensure rodents cannot destroy.
- 17.05 Flame spread on duct insulation: facings on duct insulation shall have a flame spread rating of 50 or less and smoke developed rating that meets code requirements.

- 17.06 Seal ductwork as airtight as possible. Ducts must be sealed before floor insulation is installed. Duct sealing must include, but is not limited to the following areas:
1. Joints on the furnace plenum and the furnace plenum connections.
 2. Joints and seams on ducts.
 3. The boot / interior floor connection and elbow gores.
 4. Metal sweeps or rigid insulation board blocks must be installed and sealed where duct runs extend beyond the last register.

Reconfigure Return Air System

- 17.07 Eliminate any existing return air systems by closing off and sealing all return air openings that might be located in the floor or ceiling. This shall include the return air opening in the floor of the furnace closet.
- 17.08 All eliminated return ducts shall be filled with insulation and sealed airtight at the register.
- 17.09 Return air shall then be provided as follows: Provide two square inches of net free area for every 1000 Btu. (i.e. 10 KW furnace you will need 68.2 square inches of NFA; 15 KW you will need to provide 102.3 square inches of NFA).

Metal Ducts

- 17.10 Wrap all exposed metal ducts, plenums, boots, etc. with a minimum of R-11 insulation. Types of insulation and appropriate usage:
1. Unfaced insulation is allowed for ducts in all areas not subject to human contact, but vinyl or FSK faced insulation is recommended for added durability. Vinyl or FSK faced insulation must be installed when ducts are used for cooling.
 2. Ducts subject to routine human contact (i.e. garage, basements and attics used for storage) shall be insulated with material that has suitable facing cover that provides physical protection from the insulation and has a flame-spread rating of 25 or less. Seams and joints shall be taped with tape having a rating of FS 25 or less.
 3. Insulation shall be secured with twine, installed in a circular fashion and spaced no wider than 18 inches on center. Every effort shall be taken to minimize compression of the insulation.
- 17.11 Permanently secure the duct insulation, with minimal compression, according to agency site-built specifications.
- 17.12 Securing twine shall be installed in a circular fashion and spaced no wider than 18 inches on center.
- 17.13 Ducts located in crawl spaces shall be supported off the ground and secured to the floor with corrosion resistant wire or galvanized metal hangers. Extruded rigid polystyrene foam (such as Dow Styrofoam™ "blue board") may be used between the duct and the ground.

Crossover Ducts

- 17.14 If the existing crossover metal duct is in good repair, (e.g., mechanically attached and sealed at the connections with mastic, has no sharp bends, holes, stress, or compression, is installed free of standing water, and has an existing level of insulation less than R-8) it shall be insulated to a minimum of R-11 insulation.

Types of insulation and appropriate usage:

1. Unfaced insulation is allowed for ducts in all areas not subject to human contact, but vinyl or FSK faced insulation is recommended for added durability. Vinyl or FSK faced insulation must be installed when ducts are used for cooling.
2. Ducts subject to routine human contact (i.e. garage, basements and attics used for storage) shall be insulated with material that has suitable facing cover that provides physical protection from the insulation and has a flame-spread rating of 25 or less. Seams and joints shall be taped with tape having a rating of FS 25 or less.
3. Insulation shall be secured with twine, installed in a circular fashion and spaced no wider than 18 inches on center. Every effort shall be taken to minimize compression of the insulation.

- 17.15 When installing new crossover ducts, installer shall use rigid metal, minimum 30 gauge. The crossover duct shall be screwed together, sealed with mastic, insulated to R-11 and suspended or supported off the ground with extruded polystyrene.

1. Avoid excessive compression of the duct/insulation.
2. Avoid sharp bends.
3. Cut it to the proper length.
4. Avoid standing water.

- 17.16 Flex-duct may be used when hard duct crossover cannot be installed. See pictures below as to why flex ducts are not acceptable except in the extreme cases.



Examples of why not to use flex ducts

Section 18: Installation Requirements for Air Sealing in Mobile Home

- 18.01 General: material shall be installed according to the provisions of current Oregon Building Code or other applicable codes and shall meet the requirements of the agency weatherization program. Any other exceptions shall be approved in writing in advance by the agency
- 18.02 Unless providing adequate mechanical ventilation, airtightening shall not exceed Minimum Ventilation Level (MVL) for square footage, housing type and number of bedrooms



Heating register



Washer machine plumbing hook ups



Air leakage inside of a duct



Plumbing penetration

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Appendix A: Minneapolis Blower Door Test



Blower Door Test

Begin with the Frame and Hoses already set-up (with the green hose extended through the door a minimum of 5 feet away from fan) and the fan still covered with the rings.

1. **Connect** Hoses to Manometer
2. Turn Manometer **on**.
3. Press **MODE** Button **2 times**.
4. Press **BASELINE** Button **1 time**.
5. Press **START** Button **1 time**.
6. **Wait** until number is **steady**, then press **ENTER** Button **1 time**.
7. Take cover off of fan.
8. **Slowly** adjust fan speed to reach **50 Pa** on **Channel A**.
Note: Channel B will automatically estimate CFM50 once Channel A reaches 15 Pa for the house pressure. Accuracy is +/- 1% when House Pressure reads between 45 and 55 Pa.
9. As House Pressure nears 50 Pa, you may press the **TIME AVG** Button until it says **LONG**. Record reading when it becomes steady. Press **START** Button once to restart **TIME AVG** if necessary.

If CFM50 is Less Than 2400, reduce fan speed to zero and **install Ring A**. Press **CONFIG** Button until it reads **A1**

Compliments of Rees Byars South Carolina Weatherization Program

The blower door is a diagnostic tool designed to measure the airtightness of buildings and to help locate air leakage sites. Building airtightness measurements are used for a variety of purposes including:

1. Documenting the construction airtightness of buildings.
2. Estimating natural infiltration rates in houses.
3. Measuring and documenting the effectiveness of air sealing activities.
4. Measuring duct leakage in forced air distribution systems.

The blower door consists of a powerful, calibrated fan that is temporarily sealed into an exterior doorway. The fan blows air into or out of the building to create a slight pressure difference between inside and the outside. This pressure difference forces air through all holes and penetrations in the exterior envelope by simultaneously measuring the airtightness of the entire building envelope. The tighter the building, e.g. fewer holes, the less air you need from the blower door fan to create a change in building pressure.

The most common blower door test procedures used to assess overall building airtightness are the One Point Test and the Multi Point Test. The One Point Test utilizes a single measurement of fan flow needed to create a 50 Pascal (Pa.) change in building pressure. The One Point Test provides a quick and simple way to measure building airtightness without the need to have a computer to analyze the blower door test data.

The multi-point test procedure involves testing the building over a range of pressures (typically 50 Pascals down to 15 Pascals) and analyzing the data using a blower door test analysis computer program. Making multiple measurements allows some of the errors introduced by fluctuating pressures and operator error to be averaged over several measurements, thus increasing test accuracy. In addition, a multi-point test allows the operator to estimate the leakage area of the building. Leakage area values are used in detailed infiltration models and can be a useful way to express the results of the blower door test.

Basic Airtightness Test Results:

CFM 50 is the airflow (in cubic feet per minute, cfm) from the blower door fan needed to create a change in building pressure of 50 Pa. (0.2 inches of water column). A 50 Pa. pressure is roughly equivalent to the pressure generated by a 20 mph wind blowing on the building from all directions. CFM 50 is the most commonly used measure of building airtightness and gives a quick indication of the total air leakage in the building envelope. When conducting a One Point Test at 50 Pa. of building pressure, you are directly measuring CFM 50.

Appendix B: Building Airtightness Test Form

TEST DATA FORM

Client Name _____
 Address: _____
 Phone: _____

Project# _____
 Date: _____
 Heat Source: Gas / Oil / Electric

of Occupants ____
 # of Bedrooms ____
 # of Rooms ____
 Volume: _____

Physical Mechanical Inspection (i.e damage, age, general condition)

see additional comments

General House Set-Up Description (i.e. IAQ/Health and Safety Issues)	Spillage: Furnace Yes / No DWH Yes / No Roll-Out: Furnace Yes / No DWH Yes / No <input type="checkbox"/> see additional comments
--	--

CO AMBIENT (in house)	PRE:	PPM	POST:	PPM
------------------------------	------	-----	-------	-----

CO @ air handler (or nearest supply)	PRE:	PPM	POST:	PPM
---	------	-----	-------	-----

House Room Balancing (pressure in each room, doors closed [Room WRT main body, clockwise])				
	Room	Repair	Pre	Post
1				
2				
3				
4				
5				
6				
7				

Worse Case Depressurization				Draft Testing in worse case		CAZ Testing in worse case		Worst Case Depressurization Test for Combustion Appliances a) Perform test with all combustion appliances turned on (i.e. furnace, water heater, range, and oven). b) Close and latch all exterior doors and windows. c) Turn on all exhaust appliances including kitchen fans, bath fans, clothes dryers (clean the lint filter first), central vacuum cleaners, and anything else that exhausts air from the house. d) Close interior doors to rooms that do not have exhaust fans and open interior doors to rooms that do. If a bedroom has an attached bathroom with an exhaust fan, leave both the bedroom and bathroom doors open e) Open the door to the combustion appliance zone, whether basement or furnace room. f) Set the pressure gauge so that it is stable, level, plumb, and within two feet of the combustion zone appliance. "Zero" the gauge with the tube disconnected. Extend the tube to outdoors (sheltered location is best). Attach tube to the gauge and record results in client file. g) Repeat the test with the combustion zone door closed to see if depressurization increases. Record in client file. h) Consult the House Depressurization Limits Chart to determine if there is a potential problem and record in client file.
Equipment	CO							
Unit	Pre	Post	Pre	Post	Pre	Post		
Furnace								
Port 1								
Port 2								
Port 3								
Port 4								
DWH								
Oven								
Stove Top 1								
Stove Top 1								
Stove Top 1								
Stove Top 1								
Pellet Stove								
Woodstove								
Other								

Furnace				House Depressurization Limits (HDL's)			
Serial #:		Btu's	KwH				
Manufacturer:							
Model:							
		Pre	Post				
				Appliance	Chimney Height to closest foot	Unlined chimneys on exterior walls	Metal lined insulated or interior chimneys
	CO			Gas Furnace or Water Heater	12 or less 13 to 20 21 or more	-5 pa. -5 -5	-4 pa. -6 -7
	Oxygen			Gas induced draft appliances	All heights	-10	-10
	CO Air Free			Oil furnace or water heater	12 or less 13 to 20 21 or more	-4 -4 -4	-4 -4 -6
	Ambient/ Combustion Air Temp			Fireplace (wood or gas)	All heights	-3	-4
	Temp Differential			Direct vent stove or fireplace	All heights	-10	-10
	Stack Temp			Sealed combustion	All	-10	-10
	Efficiency						
	CO2						
	Excess Air						
	Supply Temp						
	Return Temp						
	Temp Rise						
	Supply Static Pressure						
	Return Static Pressure						
	Total External Static Pressure						
Water Heater		Model #:		Serial Number:			
	CO	Pre	Post				
	Oxygen						
	CO Air Free						
	Ambient/Combustion Air Temp						
	Temp Differential						
	Stack Temp						
	Efficiency						
	CO2						
	Excess						

Pressure Diagnostic Testing Report				Pre	Post	Ring			
Total CFM 50 IF: house pressure less than 50 Pa, find CRF factor:						A B O			
Record Baseline Pressure =>						Location			
(Natural) Zonal Pressures:									
Zone: ID Duct Zones			Pre	Post	Notes:				
1. Attic	WRT House								
2. Crawl Space	WRT House								
3. Garage (Attached)	WRT House								
4. Bsmt (Door Closed)	WRT House								
5. Other	WRT House								
6. Other	WRT House								
Pressure Pan Test (clockwise from front door, house WRT duct.)									
Location		Pre	Mid	Post	Location		Pre	Mid	Post
1					7				
2					8				
3					9				
4					10				
5					11				
6					12				
Air Handler "ON"/ House Pressure: Main body WRT Outside (all interior doors open)									
Duct Blaster: Total Leakage CFM									
Duct Blast: Total duct leakage to outside									
Duct leakage not to exceed 10% CFM50 x floor area (Sq.Ft.) if existing. New construction must be 6% OR be reduced by 50% by comparing leakage to the outside before and after sealing. of heated floor area.									
Primary problems (concerns)									
Proposal for improvement/mediation/retro-fit (if any):									

Pre-Inspection Signature of Qualified Diagnostic Technician: _____

Date: _____

Post-Inspection Signature of Qualified Diagnostic Technician: _____

Date: _____

Appendix C: Attic Bypass Sealing

Installer shall seal all attic bypasses before insulating. Use appropriate material depending on size of the opening. These materials may include:

1. High temperature caulk,
2. Silicone caulk, urethane caulk, and silicon latex caulk,
3. Polyethylene rod (also called backer rod in different thickness),
4. Expanding foam (polyurethane one part expanding and non-expanding, including high temperature and two-part urethane foam),
5. Gypsum board, sheet metal, plywood, extruded polystyrene,
6. Rigid insulation board,
7. Densely packed cellulose.

The following is a list of suggested areas for attic bypasses:

1. Top plates of interior wall partitions (where sheetrock/plaster attaches to 2 inch x 4 inch),
2. Housing of exhaust fans and recessed lights (where housing and ceiling join),
3. Soil vent stacks and plumbing vents (where they penetrate the ceiling),
4. Around duct work (where HVAC ducts penetrate the ceiling),
5. Electrical light boxes (where a box and ceiling join), Electrical wiring (where wires or conduit penetrate the ceiling),
6. Other building materials which pierce the finished ceiling. These areas shall be caulked or foamed depending on the size (diameter) of the opening.
7. Open top plates of interior partition walls (where no top plate exists),
8. Exterior walls (balloon framed construction or missing top plates),
9. Clothes chutes and dumb waiters (if they penetrate the ceiling, seal at that point), and any other larger openings that terminate through the ceiling.

The aforementioned areas shall have gypsum board, plywood or rigid foam insulation cut larger than the opening and then caulked and fastened to the ceiling finish. As an alternative for the smaller of these openings, install an unfaced fiberglass batt into the cavity or space leaving about 3 inch to 4-inch void area below the surface penetration. Then, fill the exposed section of cavity or space with polyurethane foam (two part), making sure that it creates a good sealing contact with the ceiling on each side and with the cavity or space wall studs. Be sure to allow for expansion of the foam.

Appendix D: Story and a Half Air Sealing

Story and a half air sealing is like sealing the attic bypasses in any other attic. The only exception is the space beneath the kneewall. Air can leak into the ceiling joist space from the heated area. Insulating and ventilating the rake area without air sealing can actually increase air leakage and condensation problems; therefore, blocking needs to be installed underneath the knee wall if none exists. If solid bridging exists underneath the knee wall, then caulk or foam the board in place.

If no bridging exists, there are two approved methods by which blocking may be completed.

1. Cut a piece of rigid foam insulation to fit each joist space but slightly oversized. Friction fit the foam insulation into place, lining it up vertically with the inner (room side) face of the knee wall as nearly as possible. Apply sealant around the perimeter of the rigid foam insulation.
2. Two part foam may be used in conjunction with fiberglass batts.

Appendix E: Intentionally Left Blank

Appendix F: Access to Special Locations for Insulation



1. Gain access to porches, eyebrow roofs, add-on attics and other roof areas by installing a roof vent or by pulling a shingle and drilling a hole and insulating the determined area. If walls can be insulated in these small roof areas, then insulation of these areas may not be cost effective. If the areas are part of the thermal envelope then proceed to insulate in the most cost-effective method possible.
2. Insulating cantilevered floors, rim joist areas and other similar areas will be determined by the method of entry being used on the remainder of the house. If this is not possible, then gain access through the most cost effective and professional means available.

Appendix G: Wall Insulation Blowing Procedure



1. After drilling holes and before blowing the insulation, probe the wall cavity for fire stops and other obstructions, which will necessitate an additional hole. Ensure that all possible cavities are accessible by checking from side to side and up and down for diagonal bracing, fire stops or blocking.
2. For cellulose-only blower, as the material packs up and stops flowing, pull the hose out 6 inches to 1 foot at a time. Continuously try and push the tube through the insulation that has just been installed. Adjust the air gate to pack an 8-ft. wall cavity in 4-6 minutes.

For positive displacement insulation blower, (i.e. Force II) a different procedure is used. As the cavity packs tight, the blower will continue to supply material at the same rate even though much less material leaves the tube. This lowers the density in the wall and clogs the hose. Therefore, as the cavity fills and walls start to pack tight, switch off the feeder and allow the air to run. This prevents excess material from building up in the hose as you finish the wall cavity.

Appendix H: Lead Paint Notification Form

SAMPLE PRE-RENOVATION FORM

This sample form may be used by renovation firms to document compliance with the Federal pre-renovation education and renovation, repair, and painting regulations.

Occupant Confirmation

Pamphlet Receipt

- I have received a copy of the lead hazard information pamphlet informing me of the potential risk of the lead hazard exposure from renovation activity to be performed in my dwelling unit. I received this pamphlet before the work began.

Printed Name of Owner-occupant

Signature of Owner-occupant

Signature Date

Renovator's Self Certification Option (for tenant-occupied dwellings only)

Instructions to Renovator: If the lead hazard information pamphlet was delivered but a tenant signature was not obtainable, you may check the appropriate box below.

- Declined** – I certify that I have made a good faith effort to deliver the lead hazard information pamphlet to the rental dwelling unit listed below at the date and time indicated and that the occupant declined to sign the confirmation of receipt. I further certify that I have left a copy of the pamphlet at the unit with the occupant.
- Unavailable for signature** – I certify that I have made a good faith effort to deliver the lead hazard information pamphlet to the rental dwelling unit listed below and that the occupant was unavailable to sign the confirmation of receipt. I further certify that I have left a copy of the pamphlet at the unit by sliding it under the door or by (fill in how pamphlet was left).

Printed Name of Person Certifying Delivery

Attempted Delivery Date

Signature of Person Certifying Lead Pamphlet Delivery

Unit Address

Note Regarding Mailing Option — As an alternative to delivery in person, you may mail the lead hazard information pamphlet to the owner and/or tenant. Pamphlet must be mailed at least seven days before renovation. Mailing must be documented by a certificate of mailing from the post office.

For Additional Information:

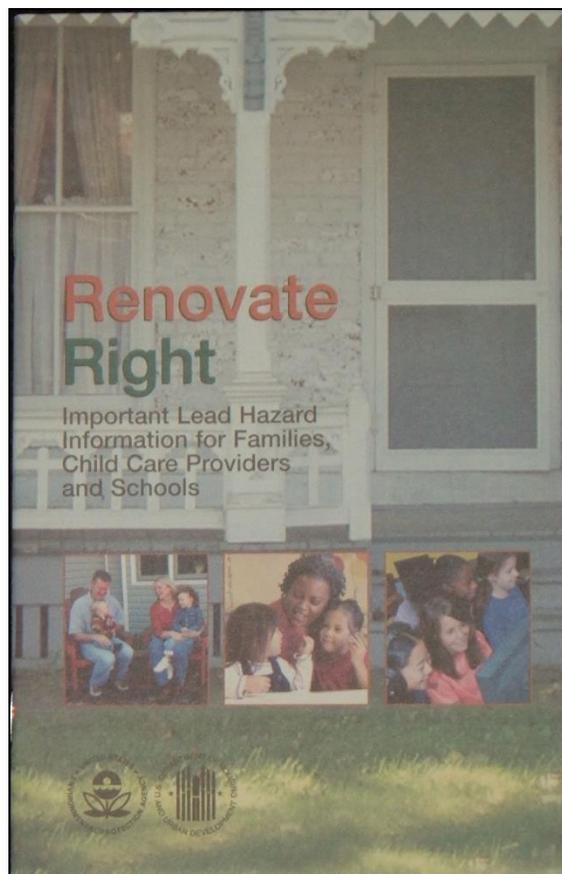
You may need additional information on how to protect yourself and your children while a job is going on in your home, your building, or childcare facility. The National Lead Information Center at 1-800-424-LEAD (5323) or www.epa.gov/lead/nlic.htm can tell you how to contact your state, local, and/or tribal programs or get general information about lead poisoning prevention.

State and tribal lead poisoning prevention or environmental protection programs can provide information about lead regulations and potential sources of financial aid for reducing lead hazards. If your state or local government has requirements more stringent than those described in this pamphlet, you must follow those requirements.

Local building code officials can tell you the regulations that apply to the renovation work that you are planning. State, county, and local health departments can provide information about local programs, including assistance for lead-poisoned children and advice on ways to get your home checked for lead. The National Lead Information Center can also provide a variety of resource materials, including the following guides to lead-safe work practices. Many of these materials are also available at:

- <http://www.epa.gov/lead/pubs/renovaterightbrochure.pdf>
- <http://www.oregon.gov/CCB/lead-based-paint.shtml>
- <http://www.oregon.gov/DHS/ph/lead/docs/RRPFirmApplication.pdf>
- <http://www.epa.gov/lead/index.html>
- Lead Paint Safety, a Field Guide for Painting, Home Maintenance, and Renovation Work
- Protect Your Family from Lead in Your Home
- Lead in Your Home: A Parent's Reference Guide

For the hearing impaired, call the Federal Information Relay Service at 1-800-877-8339 to access any of the phone numbers in this brochure.



Appendix I: Set-Up for Blowing High Density Wall Insulation



1. The recommended filler tube is 1-1/4 inch inside diameter with 1/8 inch walls in 10 foot lengths. The installer should purchase a summer tube (for use above freezing) that is #220 hard industrial vinyl and a winter tube (for use below freezing) that is #224 soft industrial vinyl. The installer should also purchase a 1-1/8 inch inside diameter tube, made of the same material and the same length, for filling smaller cavities when the larger tube will not operate correctly.



2. The preferred insulation blower hose would be as follows: a 3-inch hose off the blower for 50 foot to 100 foot; add a 2-1/2 inch tubing for each additional 10 foot to 50 foot. From there a 2 inch hose for about 10 feet. Connectors should be metal reducers and be clamped or duct taped in place to allow for a quicker disconnect when the hoses clog up. The end of the filler tube should be cut at a 45-degree angle (filed smooth) to allow for easier access into the cavity.



Magnahelic Gauge

3. The blower, at the port, should measure 80 inch of water column (W.C.).

Appendix J: Accessing Wall Cavities from Exterior For Insulation Installation



1. **Wood lap siding:** use a thin edge pry bar to slide between laps and gently lift out nails. Start in the middle of the piece if the ends of the siding bind. Nails can be driven through the siding by using a nail punch. Remove nails from two courses and drop out the lower board. Tack the board on the house or put it in a safe place nearby. Replace any broken pieces with primed new siding that matches the original siding. Re-nail to code with galvanized or aluminum 6p-7p siding nails.



2. **Wood shakes and shingles:** score the paint vertically on each shake to be removed. Pry loose and pull side to side and down to remove the shake or shingle. If the first method doesn't work, score the top of the shake or shingle at a 45-degree angle at the point where it meets the underlayment course. Drill the hole through the underlayment and the underlayment shake/shingle. Replace by tapping up the shake/shingle or by applying a small bead of caulking at the 45-degree cut and installing in the original position. Face nail the shake/shingle to code with a required size of shake nail or a 3p-5p galvanized box nail, whichever is appropriate.



3. **Aluminum, steel or vinyl siding:** start at either a corner or a seam, if it has continuous corner ports. Pull open the J-lock at the bottom of the piece above the one, which is to be removed. Use a zip tool or flat bar to start the process. Clothesline rope with a knot at one end can be pulled along inside the lock-seam to open the siding without bending it. As an alternative, a flat bar can be pulled along the lock-seam, but shall avoid damaging the siding with the flat bar. The channel trim around doors, windows, and other protrusions shall be bent, in most cases to completely remove the siding. Vinyl is easy to handle but should not be done when it is cold.

Oxidized aluminum siding is more difficult to remove. Remove nails from the top of the siding, push it down, the J-lock should open and the siding will come off. Tack it or store it near so that it will be protected. When reinstalling the siding, snap it back on the bottom and put nails through the same hole to center it where it was before the removal. Use the zip tool to re-hook the J-lock.



4. **Cement/asbestos shakes:** cement asbestos shakes are either face nailed or blind nailed. For face nailed applications, pull the nails out with pliers or end cutters. Be careful not to drop the shingle. For blind nailed applications, pull the nails from two runs. Remove the blind nails from the top of the lower shake with a pry or flat bar. Do not force it. If house is back-plastered or full of fire stops, it may be easier to insulate the wall and patch the plaster or gypsum board from the inside. Never drill or saw asbestos shakes.



5. **Stucco:** break a 2 inch to 2-9/16 inch hole through the stucco with a rock pick, air chisel or rotary hammer. Pry open the wire lath, drill and fill as usual. In most cases a very sharp, carbide tooth drill bit will cut through the stucco, lath, and sheathing. Patch the holes with stucco patching material. Be sure to match the stucco as close to the original texture as possible.



6. **Masonite lap siding & LP Board:** Do not attempt to pry it off. Drive the nail head through the siding with a nail punch. Be careful not to damage the siding during the removal process. Reinstall the siding with 4p - 6p galvanized siding nails. Use outdoor spackling in the old nail holes while reinstalling the siding.

7. **Asphalt shingles:** remove nails by various methods from three runs and then remove the shingles like siding. Fold the tar paper back and drill through the sheathing. Reinstall the shingles in the original position with 5p - 8p galvanized box nails. Insulating walls with this type of siding is not recommended when the weather is hot.



8. Drill through the sheathing with a low speed drill (400 - 600 rpm) fitted with a self-feed or planar bit. The drill bit size, under most conditions shall be 2 - 2 ½ inches. If possible, angle the hole up and down in the direction the tube will have to be inserted. Installer is responsible for not damaging the structural integrity of the sheathing while drilling the holes.

Appendix K: Accessing Wall Cavities From Inside the House For Wall Insulation



Inside surface drilling is the fastest method if the house is empty and/or receiving other rehabilitation measures. This system is also used as a backup for other methods in trouble spots and can stand alone as a method.

1. Have the occupant or homeowner move all furniture and stored items 4 feet back from the outside wall. Prepare the occupant or homeowner for intrusion of workers and major dust. Have occupant or homeowner sign an acceptance for having this work performed. The installer is responsible for any damage that occurs as the result of blowing wall insulation.
2. Mask contents of house with polyethylene drop cloths. Extra care should be taken on electrical equipment such as stereos, home computers, TV's, VCR's, etc.
3. Drill at least 2 inch to 2-9/16 inch holes in the plaster or sheet rock with a carbide-tipped hole saw, planar bit, or other drill bit of installer's choice. Don't cut into the same lath on both sides of the stud. This prevents cracks from showing up later. Use the two-hole procedure for normal cavities.
4. Fill cavities as normal. Unless probing proves it unnecessary, the exterior run of the partition wall should also be filled to prevent bypass. Use trickle feed for cavities too narrow to tube fill, e.g. back-plaster.
5. After filling the cavities, install a piece of unfaced fiberglass in the hole prior to installing the patching material.
6. Patch the base coat as soon as possible. Use mixtures such as Structolite™ and Durabond™ 30-60 mixed stiff enough not to sag. Never put on too much. Apply as many coats as needed to completely fill the hole; (topcoat with joint compound or spackle, if needed). Other patching products are acceptable, as long as the finished product matches the existing surface.
7. Roll up the poly, clean up any spilled cellulose, and other debris.



Appendix L: Moisture Control

Moisture problems can occur any time of year. Traditionally recognized indoor moisture problems are dampness, odors, mold, and stains on surfaces, condensation on windows and pipes whose temperature is below the dew point temperature of the indoor air. These conditions not only have an adverse effect on building components but also occupant's health. Steps are to be taken to eliminate such conditions when they exist.

Interview the occupant or homeowner and perform a careful visual inspection to determine the extent of the problem. All parts of the residence should be inspected including inside the house, in the attic, crawl space or basement and exterior surfaces. The optimum level is between 30% to 50% relative humidity. However, when preventing mold and mildew, the suggested indoor relative humidity levels are below 50%. Levels of approximately 30% may be necessary to minimize window condensation, especially in cold weather.

Recommendations for kitchen and bathroom exhaust fans are 80 cfm for each bathroom supplied on an intermittent basis when a bathroom is used. 100 cfm for kitchen exhaust on an intermittent basis when required.

Bathroom exhaust fan airflow rates measured in cubic feet per minute (cfm) are often well below 50 cfm, in large part because of the way they are ducted to the outside. The Energy Conservatory Exhaust Fan Flow Meter or a flow hood can be used to measure airflow.

The first step in moisture control is to reduce or eliminate unneeded sources. Examples include: fixing gutters, downspouts and foundation drains, venting a clothes dryer outdoors, covering containers while cooking, removing excessive amounts of firewood stored indoors (a large moisture source), reducing the number of indoor plants, emptying fish tanks. The exposed ground in a crawl space can be a major source of indoor moisture due to evaporation from its surface. When accessible, it is important to cover any exposed crawl space ground and install foundation vents.

Exhaust fan ducting shall be extended through the roof when vented into an attic. Adequate venting is required to remove excess moisture. If the fan cfm is too low, it often can be increased up to 40% simply by replacing the three-inch diameter ducting with four-inch ducting. Replacing flex duct with rigid metal duct also will increase the flow rate up to 40%. Successful moisture control strategy includes energy education, including but not limited to: regular use of kitchen and bathroom exhaust fans for 10-20 minutes longer than bathroom/kitchen use; when fans do not exist, installing a quiet (1.5 Sone or less) fan and timer switch.

Appendix M: Mold & Mildew Protocol

Mold Protocol Checklist

Dwelling Inspection: Moisture and Mold Checklist

Item for Inspection	Y / N	Explanation, if necessary
Are the air filters clean?	_____	_____
Is there any sign of water damage?	_____	_____
Are there any unique or objectionable odors (mold mildew)?	_____	_____
Is there any blockage/obstruction to the supply or exhaust fans?	_____	_____
Do the bathrooms lack exhaust fans?	_____	_____
Are there any signs of mold or mildew growth?	_____	_____
Do the combustion appliances lack flues?	_____	_____
Do any drains lack traps?	_____	_____

Confirmation of Receipt of Mold and Moisture Pamphlet (Required if any inspection items are marked "yes"
I have received a copy of the pamphlet, *A Brief Guide to Mold, Moisture, and Your Home*, informing me of the potential risks, clean-up and prevention of mold problems in my dwelling unit. I received this pamphlet before the work began.

Printed name of recipient _____

Date _____

Signature _____

Self-Certification Option (for tenant-occupied dwellings only)

If the mold pamphlet was delivered but a tenant signature was not obtainable, you may check the appropriate box below.

Refusal to sign—I certify that I have made a good faith effort to deliver the pamphlet, *A Brief Guide to Mold, Moisture, and Your Home*, to the rental dwelling unit listed below at the date and time indicated and that the occupant refused to sign the confirmation of receipt. I further certify that I have left a copy of the pamphlet at the unit with the occupant.

Unavailable for signature – I certify that I have made a good faith effort to deliver the pamphlet, *A Brief Guide to Mold, Moisture, and Your Home*, to the rental dwelling unit listed below at the date and time indicated and that the occupant was unavailable to sign the confirmation of receipt I further certify that I have left a copy of the pamphlet at the unit by sliding it under the door.

Print name of person certifying mold pamphlet _____

Attempted delivery date and time delivery _____

Signature of person certifying mold pamphlet delivery _____

Unit Address _____

Note Regarding Mailing Option – As an alternative to delivery in person, you may mail the mold pamphlet to the owner and/or tenant. Pamphlet must be mailed at least seven days before renovation. (Document the date with a certificate of mailing from the post office.)

The Oregon Low-Income Weatherization Assistance Program does not encompass mold remediation. DOE funds are not to be used to test, abate, remediate, purchase insurance or alleviate existing mold conditions identified during the assessment, the work performance period or the quality control inspection. Where multiple funding sources are used, the performance of any of the aforementioned activities must be expensed to a non-DOE funding source. However, DOE funds may be used to correct energy-related conditions and/or to assure the immediate health of workers and occupants.

Weatherization of a home and air sealing in particular could potentially increase the risk of moisture and mold in a home, thereby causing structural damage and/or health risk to the inhabitants. As well, existing mold could pose a health risk to both the occupants and the weatherization crew.

Moisture Assessment

All homes should be checked for previous or existing moisture problems:

1. Mold in homes arises from conditions of excess moisture. During initial inspection, field coordinators are to assess the homes with special attention to the following signs:
 - A. Evidence of condensation on windows and walls indicated by stains or mold.
 - B. Standing water, sumps, open wells, dirt floors, water stains, etc. in basements. Also, check to see if firewood is stored in the basement and whether laundry is hung there to dry during the winter months;
 - C. Leaking supply or waste pipes;
 - D. Attic roof sheathing shows signs of mold or mildew.
2. Identification of existing or potential moisture problems shall be documented in the occupant or homeowner file.
3. If existing moisture problems are found, no air sealing should be done unless the source of the moisture can be substantially reduced or effective mechanical ventilation can be added to cost-effectively remove the moisture. In some cases, air sealing must be done in order to reduce the source of the moisture (i.e. sealing off crawlspace from the house, or sealing attic leakage to eliminate condensation on the roof deck).
4. Because airtightening may cause an increase in relative humidity, energy education should include information about moisture problems and possible solutions.
5. In the course of weatherization, any low-cost measures that help reduce the humidity levels in the house should be installed. Examples of these activities are venting dryers, venting existing bath or kitchen exhaust fans or installing ground cover on dirt floors.

Repair moisture problems that might:

1. Result in health problems for the occupant.
2. Damage the structure over the short- or long-term, or
3. Diminish the effectiveness of the weatherization measures, must be done before the weatherization job is completed.
4. Moisture problems can be reduced or eliminated by controlling the source of the moisture. This can involve:
 - A. Install 6 mil ground cover on a crawlspace floor;
 - B. Vent dryers to the outside of the building;
 - C. Seal the foundation;
 - D. Provide positive drainage away from foundation;
 - E. Repair the roof, flashing, gutter, and downspout;
 - F. Educate the occupant about the sources of moisture that they are able to control.
5. Moisture problems can be reduced or eliminated by ventilating areas where excessive moisture is produced, such as bathrooms and kitchens. This should include installation of a high quality exhaust fan in the subject area and informing the occupant of the related moisture issues and the proper operation and use of the fan.

Dryer Vents

1. All dryers must be vented to the daylight and terminated with an operable dryer vent hood.
2. Mobile home dryer vents must be extended through the skirting to daylight.
4. Dryer vent ductwork must be smooth surfaced, adequately supported and vented to daylight utilizing the shortest run possible. Use of elbows should be limited to the least possible number to ensure unobstructed venting.
5. All joints must be secured using UL – 181 tape (metal tape).
6. Flexible vent pipe may be used between the dryer and the hard pipe connection if it does not exceed three feet in length.
7. Dryer vent pipe must not be installed with sheet metal screws or other intrusive fasteners that will collect lint.
8. Whenever possible, the dryer vent must be installed with a downward slope to the outside to allow for condensation drainage.

Mold Protocols: Mold Assessment/Clean-up

All homes should be checked for mold during the initial inspection. If a mold condition is discovered during the initial inspection of the home that cannot be adequately addressed by the weatherization crew, then the dwelling unit should be referred to the appropriate public or non-profit agency for remedial action. As well, occupants must be notified and informed of the presence of mold in their homes, and are to be given a copy of the pamphlet *A Brief Guide to Mold, Moisture and Your Home*. If the moldy area is less than 10 square feet (about 3 feet by 3 feet) then the job can most likely be handled by the weatherization crew.

1. Professional should be contacted when:
 - A. The mold covers more than 10 square feet.
 - B. There is evidence of extensive water damage.
 - C. It is suspect that the heating/ventilation/air conditioning (HVAC) system may be contaminated, i.e. there is mold near the intake of the system. The HVAC is not to be run, as it could spread mold throughout the house.
 - D. The water and/or mold damage was caused by sewage or other contaminated water.
 - E. There is a health concern.
2. Instances when the moldy area is less than 10 square feet, the following steps may be taken:
 - A. Eliminate or repair all moisture problems using the aforementioned moisture protocols.
 - B. Scrub mold off hard surfaces with detergent and water and dry completely.
 - C. Absorbent materials, such as ceiling tiles and carpet, may have to be thrown away when they become moldy. Mold can grow on or fill in the empty spaces and crevices of porous materials, so the mold may be difficult or impossible to remove completely.
 - D. Avoid exposing yourself or others to mold.
 - E. Do not paint or caulk moldy surfaces. Clean up the mold and dry the surfaces before painting. Paint applied to the moldy surfaces is likely to peel.
 - F. When unsure about how to clean an item, or if the item is expensive or of sentimental value, a specialist should be consulted.
 - G. Avoid breathing in mold or mold spores. In order to limit your exposure to airborne mold, N-95 respirators are recommended when working in moldy areas.
 - H. Wear gloves. Long gloves that extend to the middle of the forearm are recommended.
 - I. Wear goggles. Goggles that do not have ventilation holes are recommended.
 - J. Revisit the site(s) shortly after clean up to make sure that it shows signs of water damage or mold growth.



<u>Moisture Source</u>	<u>Estimated Daily Average Amount (pounds/hour)</u>
Bathing: tub (excludes towels and spillage)	0.005
Shower (excludes towels and spillage)	0.022/5-minute shower
Clothes washing (automatic, lid closed)	0+/load (usually nil)
Clothes drying: vented outdoor	0+/load (usually nil)
not vented outdoors or indoor line drying	0.195 to 0.258/load (more if gas dryer)
Combustion—unvented space heater	0.317/gallon of kerosene burned
Cooking: breakfast (family of four, avg.)	0.015 (plus 0.024 if gas cooking)
lunch (family of four, avg.)	0.022 (plus 0.28 if gas cooking)
dinner (family of four, avg.)	0.051 (plus 0.066 if gas cooking)
simmer at 203° F, 10 min.	<0.0004 if covered, 0.005 if not covered
6 inch pan, (plus gas)	
boil 10 min. 6 inch pan (plus gas)	0.020 if covered, 0.024 if not covered
Dishwashing: breakfast, lunch, dinner (four people)	0.044
Firewood storage indoors (cord of green wood)	0.092-0.183
Gas range pilot light (each)	0.015
House plants (5-7 average plants)	0.036 to 0.040
Refrigerator defrost	0.043 (average)
Saunas, steambaths, and whirlpools	0 to 0.113+
Evaporation form materials: seasonal	0.264 to 0.705/average day
new construction	0.417+/average day

Appendix N: ASHRAE 62.2 Reference Tables

Table 4.1a

Floor Area SQFT	Bedrooms				
	1	2	3	4	5
<500	30	38	45	53	60
501-1000	45	53	60	68	75
1001-1500	60	68	75	83	90
1501-2000	75	83	90	98	105
2001-2500	90	98	105	113	120
2501-3000	105	113	120	128	135
3001-3500	120	128	135	143	150
3501-4000	135	143	150	158	165
4001-4500	150	158	165	173	180
4501-5000	165	173	180	188	195

Table 5.3 Prescriptive Duct Sizing

Fan rating in CFM@ 0.25 IN W	80	100	125
Diameter in.	Maximum Length		
3"	X	X	X
4"	35	5	X
5"	135	85	55
6"	NL	NL	145
7" and above	NL	NL	NL
This table assumes no elbows. Deduct 15' of allowable duct length for each elbow.			
NL = <i>no limit in duct length of this size</i> X = <i>not allowed</i>			

Appendix O: Minimum Acceptable Draft Pressures

The action level (AL) will be when the appliance tested does not meet minimum acceptable draft pressure, listed below, with the combustion appliance zone (CAZ) set up set up in the worst case depressurization test. If the minimum acceptable draft requirements are not met, then action shall be taken to achieve the minimum required draft pressure with the CAZ set up in worst case.

Minimum acceptable draft pressures are the combustion appliance (CA) vent/flue with reference to (WRT) to the combustion appliance zone (CAZ) with the CAZ under worst case:

Field calculations of minimum draft can be calculated using the following formula:
 outside temperature minus 100 divided by 20 (outside temp. $-100 / 20$)

	Outside Temperature	Draft	
1.	Below 20° F	Draft	-5.0 pa
2.	20° F	Draft	-4.0 pa
3.	22° F	Draft	-3.9 pa
4.	24° F	Draft	-3.8 pa
5.	26° F	Draft	-3.7 pa
6.	28° F	Draft	-3.6 pa
7.	30° F	Draft	-3.5 pa
8.	32° F	Draft	-3.4 pa
9.	34° F	Draft	-3.3 pa
10.	36° F	Draft	-3.2 pa
11.	38° F	Draft	-3.1 pa
12.	40° F	Draft	-3.0 pa
13.	42° F	Draft	-2.9 pa
14.	44° F	Draft	-2.8 pa
15.	46° F	Draft	-2.7 pa
16.	48° F	Draft	-2.6 pa
17.	50° F	Draft	-2.5 pa
18.	52° F	Draft	-2.4 pa
19.	54° F	Draft	-2.3 pa
20.	56° F	Draft	-2.2 pa
21.	58° F	Draft	-2.1 pa
22.	60° F	Draft	-2.0 pa
23.	62° F	Draft	-1.9 pa
24.	64° F	Draft	-1.8 pa
25.	66° F	Draft	-1.7 pa
26.	68° F	Draft	-1.6 pa
27.	70° F	Draft	-1.5 pa
28.	72° F	Draft	-1.4 pa
29.	74° F	Draft	-1.3 pa
30.	76° F	Draft	-1.2 pa
31.	78° F	Draft	-1.1 pa
32.	80° F	Draft	-1.0 pa

Appendix P: Worst Case Depressurization Test of Combustion Appliances

With this test procedure, the goal is to measure worst-case depressurization in all combustion rooms with natural draft appliances and fireplaces. This measurement gives us an indication of the likelihood of exhausts and air handler fans causing the combustion appliances to back draft and spill. The procedures below measure worst case depressurization under three separate operating conditions; running exhaust fans only, running exhaust and air handler fans, and running the air handler fan only. These tests are very sensitive to wind effects, and on windy days, it can be very difficult to get accurate results.

Initial Preparation: Close all exterior windows and doors and be sure furnace and water heater and other vented combustion appliances are off. Close all interior doors. Set up a digital gauge to measure the pressure difference between the combustion appliance zone (CAZ) with reference to (WRT) outside, record the base pressure.

COMBUSTION APPLIANCE ZONE AND WORST CASE DRAFT TESTING

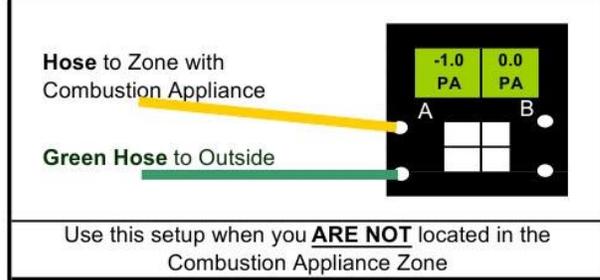
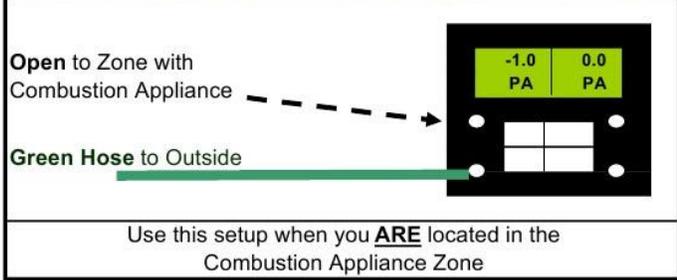
You are in CAZ

House Should be in Winter Mode with Blower Door Fan Covered
Setup Hoses to Measure:
CAZ with reference to Outside on Channel A and
Vent with reference to CAZ on Channel B (based on your location)

1. Connect Hoses to Manometer
2. Turn Manometer on.
3. Press **BASELINE** Button 1 time.
4. Press **START** Button 1 time.
5. Wait until number is **steady**, then press **ENTER** Button 1 time.
6. Follow Procedure to Determine Worst Case Depressurization **on the back of this sheet**
7. **Recreate Worst Case Depressurization and Perform Worst Case Draft Test on each Appliance starting with the smallest BTU.**
8. You may press the **TIME AVG** Button until it says **LONG**. Record reading when it becomes steady. Press **START** Button once to restart TIME AVG as necessary.

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Weatherization Program

Combustion Appliance Zone (CAZ) Testing



- a. VISUALLY INSPECT VENTING (of each Combustion Appliance)
- b. TURN OFF ALL COMBUSTION APPLIANCES.
- c. CLOSE ALL OPERABLE VENTS AND DAMPERS.
- d. CHECK DRYER VENT and LINT FILTER
- e. CHECK FURNACE FILTER (clean or replace if needed)
- f. OPEN ALL INTERIOR DOORS.

NOTE: IF BLOWER DOOR IS SET UP, BE SURE FAN IS COVERED.

1. Setup Manometer and Pressure hoses to measure CAZ (WRT) Outdoors
2. Take Baseline Pressure & Subtract it Manually from All Readings if Manometer doesn't have baseline function. _____ Pa
3. Turn on all exhaust fans (do not turn on whole-house fans).
4. Close all interior doors to rooms that do not have exhaust fans.

	Appliance 1		Appliance 2		Appliance 3	
	Pre	Post	Pre	Post	Pre	Post
5. Open door, if present, between CAZ and Main Body of house. Record reading.	Pa	Pa	Pa	Pa	Pa	Pa
6. Close door between CAZ and Main Body of house. Record reading. (If no door, skip to Step number 8)	Pa	Pa	Pa	Pa	Pa	Pa
7. Turn on Furnace Blower. Check position of interior doors with smoke puffer for worst case. If the smoke blows towards the CAZ, leave the door shut.	Pa	Pa	Pa	Pa	Pa	Pa
8. Open door between CAZ and Main Body of house. Record reading. (If no door, skip step)	Pa	Pa	Pa	Pa	Pa	Pa

9. Recreate Worst Case Conditions for each CAZ (Complete this and following steps on each Heating Inspection form)
10. Perform Worst Case Draft and Combustion Tests for each appliance under this worst case condition

* **If Ambient CO gets above 35 ppm, discontinue testing and remove CAZ from worst case conditions.**
 * **There should be no spillage after 1 minute of Worst Case and draft should be established after 5 minutes**

Dominant Duct Leakage Test (Main Body WRT outdoors) Baseline _____ PA Dominant Duct _____ PA														
Pressure in Individual Rooms (Room WRT Main body)														
Room	Bef	Int	PR	Aft	Room	Bef	Int	PR	Aft	Room	Bef	Int	PR	Aft
1.					4.					7.				
2.					5.					8.				
3.					6.					9.				

Exhaust Fans Only:

Turn on all exhaust fans found in the survey (for dryer, clean out lint filter before turning on). Determine the worst case position of interior doors with the smoke test below:

Smoke Test: While standing in the main body of the house, squirt smoke under each door containing an exhaust fan (except the CAZ currently being tested). If the smoke goes into the room, open the door. If the smoke comes back into the main body of the house, keep the door closed. Now squirt smoke under the CAZ door (while continuing to stand in the main body). If smoke goes into the CAZ, leave the CAZ door shut. If smoke comes back into the main body of the house, open the door.

Measure the depressurization of the CAZ with respect to (WRT) outside caused by the exhaust fans. Depressurization should not exceed the appropriate House Depressurization Limits (HDL) limits listed in Appendix Q. If it is windy, it is often necessary to turn fans off and on several times to obtain good pressure readings.

Fireplace Zones: For fireplace zones, repeat the same procedure and measure and record depressurization of fireplace zone WRT outside from exhaust fan operation. Depressurization should not exceed the appropriate HDL limits listed.

1. Air Handler and Exhaust Fans:

With exhaust fans continuing to run, turn on the air handler fan (note: air handler fan only when possible) and close supply registers in combustion appliance room. For both CAZ and fireplace zone tests, re-determine worst case position of all interior doors with the smoke test described above. If cooling is available, be sure air handler fan is running at high speed. Repeat worst case depressurization measurements.

2. Air Handler Fan Only:

Turn off all exhaust fans and leave air handler operating (if cooling is available, be sure air handler is running at high speed). For both CAZ and fireplace zone tests, re-determine worst case position of all interior doors with the smoke test described above. Repeat worst case depressurization measurements.

***If HDL limits are exceeded for any of the worst case depressurization tests above, pressure relief is needed. Pressure relief could include duct system repair, undercutting of doors, installation of transfer grilles, eliminating or reducing exhaust fan capacity, or instructing homeowner on safe exhaust fan operation. If negative pressures in the combustion appliance zone (or basement) are a function of return leaks in that area, check for leaks in the return ductwork, plenum, filter access door and air handler cabinet. Pay particular attention to panned under floor joist (used as returns) as they typically have many leaks.

Appendix Q: House Depressurization Limits (HDLs)

Fuel Type	Appliance Type	Chimney Height	Appliance Draft For Unlined Chimneys On Exterior Walls	Appliance Draft For Metal-Lined, Insulated Or Interior Located Chimneys	
Natural Gas or Propane	Natural Draft Appliance (70% Efficient Furnace & DHW)	13' or less	-5	-5	
		14' to 20'	-5	-6	
		21' or more	-5	-7	
	Draft Induced Appliance (80% Efficient Furnace)	Sealed Combustion Appliance (90% Efficient Furnace)	N/A	-10	-10
			N/A	-10	-10
			N/A	-3	-4
			N/A	-10	-10
Oil #2	Natural Draft Appliance or Induced Draft Appliance (70% or 80% Efficient Furnaces and	13' or less	-4	-4	
		14' to 20'	-4	-4	
		21' or more	-4	-6	
Wood	Fireplace or Non Direct Vent Stoves	N/A	-3	-4	
	Direct Vent Fireplace or Stove (Requires outside combustion air)	N/A	-10	-10	

Appendix R: Spillage Test

(natural draft and induced draft appliances)

This test identifies actual spillage of combustion byproducts into the living space under worst case depressurization conditions:

1. With house set up in worst case depressurization mode (as specified in previous Appendix N) fire up each combustion appliance.
2. If appliances are common vented, conduct test on smallest input appliance first, then test with both appliances running.
3. When burner lights, check for flame rollout (stand away from burner).
4. Check for spillage (using chemical smoke) at the end of the spillage test period. For natural draft appliances, spillage is tested at the draft diverter. When an induced draft heating system is vented in common with a natural draft water heater, spillage is checked at the water heater draft diverter. For a single induced draft appliance, spillage is checked at the base of the chimney liner or flue, typically using the drip tee at the bottom of the liner.
5. Spillage of combustion products for more than 30 seconds is unsatisfactory.
 - A. If spillage occurs, beyond the spillage test period, remove the negative pressure in combustion room by turning off fans and/or opening an exterior window or door.
 - B. Re-check for spillage. If spillage stops, there is a pressure induced spillage problem. If spillage continues, check flue and chimney for obstructions, and check compatibility of appliance BTU input with chimney size.
 - C. If the problem is a blocked flue or chimney, or inadequately sized flue or chimney, consult a professional heating installer.
 - D. If the problem is pressure induced, provide pressure relief. Re-check for spillage following attempt to provide pressure relief. If spillage continues, contact a professional heating installer.

Draft Test

This test measures flue draft pressure in the venting systems of all natural and induced draft combustion appliances under worst case depressurization (**not to be done for sealed combustion appliances**).

1. Drill a small hole in the vent pipe approximately 2 feet downstream of the draft diverter, inducer fan or barometric damper. Insert a static probe/tap.
2. Measure draft pressure (vent WRT combustion room) with digital pressure gauge after 5 minutes of operation.
3. Compare measured draft with minimum draft pressures in Appendix O.

If measured draft is below the minimum draft pressures in Appendix O, check for flue or chimney obstructions, disconnected vents, open chimney cleanout doors, etc. Also remove sources depressurization (e.g. turn off exhaust fans) and test again to determine if CAZ depressurization is contributing to poor draft.

Appendix S: Carbon Monoxide (CO) Test

Carbon Monoxide Test: This test measures carbon monoxide levels in all operating combustion appliances.

CO testing for vented furnaces, room heaters and water heaters

After 5 minutes of appliance operation, measure the CO level in the flue products of all vented combustion appliances.

Natural draft furnaces or water heaters - CO must be measured before appliance draft diverter or barometric damper. In multi-burner furnaces, each exhaust port must be tested separately. On water heaters, check CO levels on each side of the baffle.

Induced draft furnaces – CO can be measured in the hole drilled in the vent.

Sealed combustion condensing furnaces – CO must be measured at the termination of the vent. Do **NOT** drill the PVC vent pipe.

Sealed combustion manufactured home furnaces – CO must be measured at the termination of the vent. Do **NOT** drill concentric vent pipe.

Sealed combustion condensing furnaces that have condensate line ports that are not utilized and are above the water table may be used to test combustion gasses including CO.

CO levels must be below 100 ppm in all flues.

CO testing for Gas Ranges

Oven testing

1. Set the oven to bake on the highest temperature
2. Let the oven warm up for 5 minutes
3. Measure CO levels at the exhaust port



Range Tops

Since all range top burners will produce CO at various levels depending on the duties they are performing, no action level is specified in these specs. However, the following are recommended whenever a gas cook top is present in the home:

1. If the burners do not ignite properly or do not burn properly, have the appliance serviced to assure proper operation.
2. If there is no exhaust fan present in the room that the cook top is located, install a new kitchen exhaust fan vented to the outside. If not possible to install a fan, documentation as to why a fan cannot be installed must be in the file.

Action levels

1. When CO levels are below 100 ppm on the oven; NO further action is necessary
2. When CO levels are above 100 ppm on the oven; have the appliance serviced to bring CO down to acceptable levels.
3. If after servicing, the appliance CO production cannot be brought down to within acceptable limits, confirm that there is an existing exhaust fan in operating properly and vented to the outside. If no fan is present, install a new kitchen exhaust fan vented to the outside. If not possible to install a fan, documentation as to why a fan cannot be installed must be in the file.
4. All kitchen fans installed must have a minimum 150 cfm rating for range hoods or provide 5ACH if ceiling mount while on the highest speed and be rated at no more than 3 Sones.

Measure ambient CO level in house

1. Start your digital CO tester outside before entering the house. Note outside levels of CO.
2. Measure the ambient CO level in all living areas of the house. Be sure to measure ambient CO levels in kitchens and in combustion appliance rooms.
3. Subtract the outside CO levels from levels noted inside the home.
4. Investigate any ambient CO level above 2 ppm.

Maximum CO concentration guidelines

9 ppm for 8-hour exposure (OECA)
35 ppm for 1-hour exposure (NIOSH)
200 ppm single exposure (OSHA)

Ambient CO concentrations at or above these levels require immediate remedial action.

CO Alarms

At least one operable CO alarm meeting UL 2034 requirements shall be installed on each floor or any home with any type of combustion appliance. The alarms must be installed according to the manufacturers' instructions. A CO release form signed by the client must be included in the client file.



Combustion Analyzer (CO measuring equipment)



CO Alarm

Appendix T: Carbon Monoxide Alarm Release Form

Staff of the agency will install and test the carbon monoxide alarm.

To: _____ Date: _____

Address: _____

Release (Please read before signing)

I understand that _____
agency makes no warranties of any kind regarding the following items, or their installation, at the above listed
address:

Carbon Monoxide Alarm. (This alarm will detect carbon monoxide (CO) only for the next five (5) years from
this date:_____.

In consideration for the provision and installation of this carbon monoxide alarm at the above-described address
for me, I agree to release and hold harmless its officers, agents, and employees from all claims, demands, and
damages of any kind, to persons or property, resulting from the failure of the carbon monoxide alarm.

Further, by signing this document, I also certify that the carbon monoxide alarm is in working condition when
installed.

Signature of owner/occupant

Date:_____

Appendix U: Room To Room Pressures Test Procedure

The room pressures test measures the pressure differences created in rooms when the air handler is operating while the interior doors are closed. Pressurization can drive moisture into building components (walls, ceilings, floors, etc) creating durability and health issues. Depressurization can draw in outside air (containing water vapor, soil gases, mold spores, residual pesticides and herbicides, etc.) or depressurize combustion appliance zones (CAZs). Pressure imbalances increase a home's infiltration/exfiltration rate creating efficiency and comfort issues.

Significant pressures may be generated in individual rooms because often they have supply registers but no return registers. When interior doors are shut, these rooms become pressurized and the main body becomes depressurized. The amount of pressure change generated depends on how much supply air is delivered to the room, how well connected the room is to the outside, and how well connected the room is to the rest of the house. Basements and furnace closets can also be depressurized from air leaks in the return plenum, the filter access, the air handler cabinet, or the return ducts, which can affect the ability of combustion appliances to draft properly (causing dangerous back drafting or flame roll out) and also pull in moisture and soil gases into the home.

Test Procedure: The room pressures test measures the pressure difference between each room in the house with reference to (WRT) the main body of the home while the air handler is operating:

1. Close all windows, exterior and interior doors, open supply registers, and ensure that a clean air filter is installed in the air handler.
2. Turn the air handler on (to high speed if more than one speed).
3. Use a digital manometer pressure gauge (DG-700, DG-3, etc.) and an air hose.
4. While standing in the main body of the home, place the hose from the gauge under each interior door into the room being careful not to put the end of the hose into an air stream.
5. Record the test results for each room on the diagnostic form, including the basement and air handler closet (pressure in the room WRT the main body).
6. Consider pressure balancing for rooms pressurized or depressurized by more than three pascals, especially if a back draft situation is created while performing worst case testing (Appendix P).

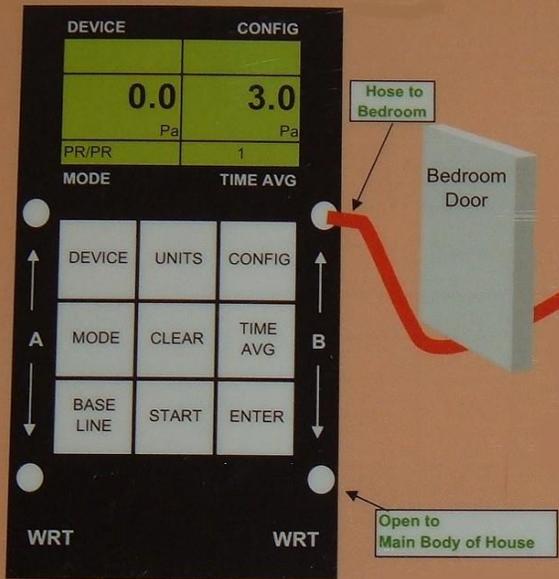
Prior to performing pressure balancing complete all shell air sealing measures, perform duct sealing and ensure that all flex ducts are properly installed. Prior to initiating pressure balancing, must clearly discuss with the homeowner the pressure balancing problems, plans and options.

Pressure Balancing Methods: Improve the return air pathway (to equalize air pressure) between the main body of the house and the bedrooms.

1. Install bypass grills in doors or walls (if possible, offset the grills for privacy).
2. Install jumper ducts through the attic or floor (at least one size bigger than the supply duct to that room).
3. Undercut bedroom and hallway doors.
4. Reduce air handler's fan speed (if doing so will not greatly affect the furnaces temperature rise).
5. Install a return duct to rooms that are pressurized (preferably, off of the plenum).
6. Install a supply duct to rooms that are depressurized (preferably, off of the plenum).
7. Always post test the home.

Note: Room pressure testing is required on all homes.

Room Pressure Testing



Setup House in Winter Mode
CLOSE Interior Doors

Setup Channel B to Measure Room WRT House

1. Connect Hose to Manometer
2. Turn Manometer On.
3. Turn Air Handler Fan On
4. Place end of hose under Closed Room Door
5. Measure Pressure between Room and Main Body
6. Any Pressures above 3pa Positive should have pressure relief measures installed *especially if creating a backdraft situation when doing CAZ Testing
7. Use tape measure or door gauge to measure amount of door opening needed, then use multiplier below to determine amount of square inches of relief that is needed.

PRESSURE RELIEF TABLES

Door Height	Opening at Top & Side		
	30	32	36
6'	79.5	80	81
6'4"	83.5	84	85
6'8"	87.5	88	89

Door Height	Top, Side and Bottom		
	30	32	36
6'	87	89	91
6'4"	91	92	94
6'8"	95	96	98

Format Compliments of Rees Byars South Carolina Weatherization Program

Appendix V: Dominant Duct Leakage Test

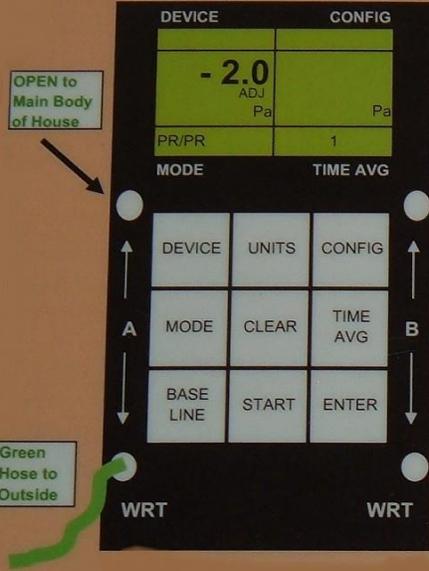
This test measures whole house pressurization or depressurization caused by duct leakage to the outside during operation of the air handler fan. A pressure change due to duct leakage can cause safety, durability, comfort, and efficiency problems. In some cases, duct repair can cause a problem or make it worse. Diagnosing which side of the system is causing a dominant pressure helps determine a safe and effective treatment strategy.

1. Be sure all exterior doors and windows in the building are closed. Replace all HVAC filters (be sure they are clean). Open all interior doors and check that all exhaust fans, including clothes dryer, and air handler fan are off. Set up a gauge to measure (DG300) should be set to low range (200.0).
2. Turn on the air handler fan and record the change in building pressure indicated on the gauge.
3. Greater leakage on the return side of the duct system will typically cause the building to become pressurized since the return ductwork is drawing outside air into the ductwork. In this case, there will be a positive reading on pressure gauge. The size of the pressure change will depend on both the amount of imbalanced duct leakage and the tightness of the building being tested.
4. Greater leakage on the supply side of the system will typically cause the building to become depressurized since the supply ductwork is exhausting building air to the outside, just like an exhaust fan. In this case, there will be a negative reading on pressure gauge. The size of the pressure change will depend on both the amount of imbalanced duct leakage and the tightness of the building being tested.
5. If there is no change in building pressure, this means that there is either equal supply and return leakage to the outside, no leaks to the outside, or the building itself is too leaky for the duct leakage to create a measurable pressure change.

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. Keep in mind that sometimes wall or floor cavities are used as part of the supply or return system. Even without any pressurization or depressurization of the entire house, there could still be leaks between the ductwork and the outside. In cold climates, pressurizing a house to even one Pascal could lead to moisture problems caused by forcing warm, moist air into the walls and attic. In warm humid climates, depressurization by one Pascal can also cause severe moisture problems. If there are natural draft combustion appliances, or if radon is a problem, depressurizing a house by 1 Pascal may also be a problem.

THESE TESTS ARE DONE WITH ONLY AIR HANDLER ON

Dominant Duct Leak Test



Setup House in Winter Mode
OPEN Interior Doors

Setup Channel A to Measure House WRT Outside

1. **Connect** Hoses to Manometer
2. Turn Manometer **On**.
3. Press **BASELINE** Button **1 time**.
4. Press **START** Button **1 time**.
5. **Wait** until number is **steady**, then press **ENTER** Button **1 time**.
6. Turn Air Handler Fan **On**
 Measure Pressure Difference when fan comes on
7. **May need to repeat a few times to get better number**

- Negative Pressure	Dominant Supply Leaks
+ Positive Pressure	Dominant Return Leaks
No Pressure Change	Tight Ducts, Equal Leaks, or House to Leaky to Hold Pressure

Compliments of Rees Byars South Carolina Weatherization Program

Appendix W: Pressure Pan Testing

An alternative method for diagnosing duct leaks with the blower door can be performed with a gasketed cake pan with pressure taps attached (pressure pan). This method involves placing the pressure pan completely over each register and taking a quick pressure reading while the blower door is depressurizing or pressurizing the house by 50 pascals. For very large registers, taping over the register and inserting a hose through a small hole in the paper will do just as well. This simple pressure measurement provides a quick and reliable indication of whether significant duct leaks are located near the register being tested. In addition, it can be used to tell crews if they have done a good job of duct sealing.

For example, if the duct being tested is completely sealed, the pressure pan will read zero pressure between the register and the room. If the duct leading to the register is completely disconnected in an attic or crawlspace, the measured pressure will be close to the zonal pressure of the area containing the ductwork. Testing to date has shown that well sealed ductwork (new construction and retrofit) will almost always register less than 1 Pascal using the pressure pan method.

Zonal Testing

Pressure Pan Testing

Directions for Baseline (Zonal and Pressure Pan):

1. Turn Manometer **on**.
2. Press **BASELINE** Button 1 time.
3. Press **START** Button 1 time.
4. Wait until number is steady, then press **ENTER** Button 1 time.
5. **Slowly** adjust fan speed to reach **50 Pa** on Channel A.
6. **Connect** Zone or Pressure Pan Hose to **Channel B & Read Pa**

Compliments of Rees Byars South Carolina Weatherizaion Program

Compliments of Rees Byars South Carolina Weatherization Program

Appendix X: Duct Testing

Total Duct Leakage Test

Instructions for the Minneapolis Duct Blaster and DG-700-Digital Gauge or follow instructions from other manufacturer's equipment:

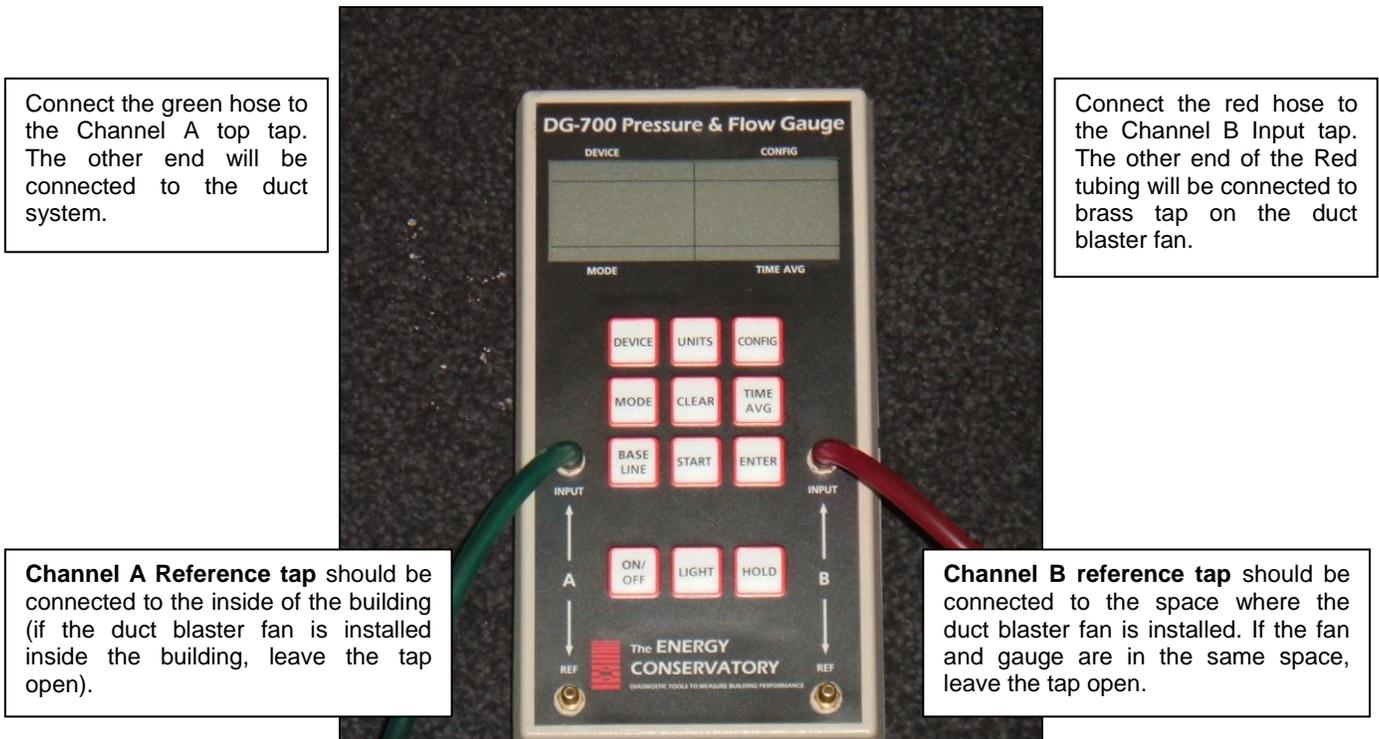
1. Connect the duct blaster to the duct system
 - A. Choose a location to install the duct blaster fan. In single, double or triple returned systems, the largest and closest return to the air handler is usually the best choice. Note: In multi-return systems (a return in every room), installing at the air handler cabinet is often best.
 - B. Remove any remote filters from the chosen return and then connect the black square transition piece to the return using temporary tape. Completely seal the remaining open area of the return with tape.
 - C. Pull the duct blaster fan and flex duct out of the carrying case. Disconnect the flex duct from the fan and insert the foam flow conditioner into the round transition piece. Connect the flex duct along with one of the flow rings to the inlet side of the fan. (i.e. the side without the metal guard) using the round transition piece and connect trim. When installing the flow ring, sandwich it between the round transition piece and the fan inlet flange. Use the flow ring which you think best matches the needed fan flow. Connect the open end of the flex duct to the square transition piece using the Velcro™ strap on the flex duct
 - D. Connect the fan speed controller to the fan and plug it into a 110V outlet.

Fan Configuration	Flow Range (CFM)
Ring 1	800-225
Ring 2	300-90
Ring 3	125-20

2. Prepare the duct system and house for the test.
 - A. Adjust the HVAC system controls so that the air handler does not turn on during the test.
 - B. Temporarily seal off all remaining supply and return registers, and combustion or ventilation air inlets that are connected to the duct system. Use Duct Mask™ temporary register sealing material provided with your duct blaster, or use painters tape and paper.
 - C. Turn off any exhaust fans, vented dryers, and room air conditioners.
 - D. Remove all central filters (i.e. in air handler or return plenum).
 - E. Open a door or window between the house and outside to prevent changes in house pressure when the duct blaster is running.
 - F. If the duct blaster is installed in an attic, garage, or crawlspace open vents or access panels or doors from these spaces to the outside.
3. Connect hoses to DG-700 Pressure Gauge
 - A. Select a location to measure duct pressure. The best location for measuring duct pressure is often in the supply trunk line or plenum. Drill a small hole (1/4inch to 3/8 inch OD) into the duct to allow a static pressure probe to be installed. Install the static pressure probe with the end of the probe pointing into the air flow from the duct blaster fan. If the duct system is reasonably airtight (e.g. less than 200 cfm 50 of leakage), duct pressures can be measured at any supply register by inserting a hose through the temporary register seal.
 - B. Use channel A to measure duct pressure, and channel B to measure duct blaster fan flow. Connect hoses to the DG-700 as shown in the diagram.

Gauge Hose Connections for Pressurization Testing

The duct blaster comes with 2 pieces of color coded hosing: 1) a 15 foot length of green hosing for measuring duct system pressure, and 2) a 10 foot length of red hosing to measure fan pressure and flow. Connect the hoses to the gauge(s) as shown below:



Conducting a Total Leakage Pressurization Test

The total leakage pressurization test is used to measure the duct leakage rate in the entire duct system (including leaks in the air handler cabinet), when the duct system is subjected to a uniform test pressure. The total leakage pressurization test measures both duct leakage to the outside of the building (e.g. leaks to attics, crawlspaces, garages and other zones that are open to the outside), and duct leakage to the inside of the building. This test procedure requires use of a duct blaster system only. (Test pressure of 50 Pa.) with duct blaster fan installed at air handler. The airflow through the duct blaster fan required to pressurize the duct system to the test pressure is the measured total duct leakage rate.

The following instructions assume you have set up the duct blaster system for a pressurization test as outlined above. Information on how to conduct a total leakage depressurization test (i.e. pulling air out of the duct system) located below.

Conducting the Test

1. Turn on the gauge by pressing the on/off button.
2. Press the mode button two times to put the gauge into the PR/FL mode. In this mode, Channel A is used to measure duct system pressure while Channel B is used to display estimated total duct leakage at a test pressure of 50 Pascals.
3. Check (and adjust if necessary) the selected test device (i.e. fan) and configuration (i.e. flow ring) shown in the upper part of the gauge display to match the fan and flow ring being used in the test. For example, the device icon for the Series B duct blaster fan is DB B, and the configuration icon for Ring 2 is B2. Press the device button to change the selected fan. Press the configuration button to change the selected flow ring.
4. Turn on the duct blaster fan by slowly turning the fan controller clockwise. As the fan speed increases the duct pressure displayed on Channel A should also increase. Continue to increase the fan speed until the duct pressurization shown on Channel A is at 50 Pascals.
5. Channel B will now display the One Point 50 Pascal total duct leakage estimate. Record this number. If the leakage estimate is fluctuating more than desired, try changing the time averaging setting on the gauge by pressing the time average button and choosing the 5 or 10 second or long-term averaging period.
6. If low appears on Channel B in the PR/FL mode the DG 700 cannot calculate the leakage estimate. If possible, you should change the flow ring and test configuration to match the flow rate being measured (i.e. install a flow ring or a smaller ring).

Note: If you change the flow ring on the fan, be sure and change the configuration setting on the gauge to match the installed ring.

Gauge Settings for DG-300

1. Turn the mode switch to the fan “select” position and choose the duct blaster fan and current flow ring configuration. To change the fan type to the Minneapolis Duct Blaster fan, toggle the “select” switch up twice.
-8-0 This indicates that you have chosen the Minneapolis Duct Blaster fan, and that the fan is in the “open” inlet configuration (e.g. no flow rings installed).

To change the flow ring configuration for the Duct Blaster fan, toggle the “select” switch down

- 8-1 Duct Blaster with ring 1 installed
- 8-2 Duct Blaster with ring 2 installed
- 8-3 Duct Blaster with ring 3 installed

2. Put the range switch in the “high range” position (200 Pa), and turn the channel knob to “A”.
3. Turn the mode switch to “pressure”.

Conducting the Test

1. With the channel knob set to “A”, turn on the duct blaster fan by slowly turning the fan controller clockwise. As the fan speed increases, duct pressure indicated on Channel A should also increase. Increase fan speed until the duct system is pressurized to the specified test pressure (typically 50 Pascals).
2. While leaving the fan speed unchanged from, turn the channel knob to “B”, and turn the mode switch to “flow”.
3. The gauge will now display the total duct leakage reading in cubic feet per minute (cfm). If the cfm leakage reading displayed on the gauge is blinking, either install a flow ring, or install the next smaller flow ring. If you change flow rings, be sure to use the fan select feature to update the gauge with the new flow ring installed before conducting the leakage test. Note: Never monitor Channel A (duct pressure) with the mode switch in the “flow” position.

Leakage to the Outside Test Procedure

One-Point 50 Pascal Leakage to Outside Pressurization Test (blowing air into the duct system)
Using the Minneapolis Duct Blaster™ DG-700 Digital Gauge and Minneapolis Blower Door™

1. Connect the Duct Blaster fan to the duct system.
 - A. Choose a location to install the Duct Blaster fan. In single, double or triple returned systems, the largest and closest return to the air handler is usually the best choice. Note: In multi-return systems (a return in every room), installing at the air handler cabinet is often best.
 - B. Remove any remote filters from the chosen return and then connect the black square transition piece to the return using temporary tape.
 - C. Completely seal the remaining open area of the return with tape.
 - D. Pull the Duct Blaster fan and flex duct out of the carrying case. Connect the flex duct to the *exhaust side* of the fan (i.e. the side with the metal guard) using the round transition piece and connect trim. Connect the open end of the flex duct to the square transition piece using the Velcro™ strap on the flex duct.
 - E. Connect the fan speed controller to the fan and plug it into a 110V outlet.
 - F. Install the Flow Ring which you think best matches the needed fan flow.

2. Prepare the duct system and house for the Test.
 - A. Adjust the HVAC system controls so that the air handler does not turn on during the test.
 - B. Temporarily seal off all remaining supply and return registers, and combustion or ventilation air inlets which are connected to the duct system. Use Tape temporary register sealing material provided with your Duct Blaster, or use painters tape and paper.
 - C. Turn off any exhaust fans, vented dryers, and room air conditioners.
 - D. Remove all central filters (i.e. in air handler or return plenum).
 - E. If the Duct Blaster is installed in an attic, garage or crawlspace - open vents or access panels or doors from these spaces to the outside.
 - F. Install the Blower Door system (including a gauge to measure building pressure with reference to outside) in a centrally located exterior door. Set up the Blower Door fan to pressurize the house (blowing air into the house). Because we will not be measuring air flow through
 - G. the Blower Door fan during the test, the fan can be set up in pressurization test mode, or it can be set up in the standard depressurization test mode with the fan direction switch reversed to blow air into the house.
 - H. Prepare the house for a Blower Door test as described in the Blower Door manual.

3. Connect tubing to the Duct Blaster Gauge.
 - A. Select a location to measure duct pressure.
 - B. Install the static pressure probe with the end of the probe pointing into the air flow from the Duct Blaster fan.
 - C. Connect tubing to the DG-700 from the static pressure probe to the input tap on the “A” side and form the duct blaster to the “B” side input tap.

4. Conducting the Test.

- A. Turn on the Blower Door fan and pressurize the house to 50 Pascals.
- B. Turn on the Duct Blaster DG-700 gauge by pressing the ON/OFF button.
- C. Press the MODE button once to put the gauge into the PR/ FL Mode. In this Mode, Channel A is used to measure duct system pressure while Channel B is used to display air flow through the Duct Blaster fan.
- D. Check (and adjust if necessary) the selected test Device (i.e. fan) and Configuration (i.e. Flow Ring) shown in the upper part of the gauge display to match the fan and Flow Ring being used in the test. For example, the Device icon for the Series B Duct Blaster fan is DB B, and the Configuration icon for Ring 2 is B2. Press the DEVICE button to change the selected fan. Press the CONFIG button to change the selected Flow Ring.
- E. With the Blower Door fan continuing to run, turn on the Duct Blaster fan by slowly turning the fan controller clockwise. Continue to increase the fan speed until the pressure between the duct system and the house (Channel A on the Duct Blaster DG-700) reads zero.
- F. Now re-check the Blower Door building pressure gauge and if necessary, re-adjust the Blower Door fan speed to maintain a building pressure of 50 Pascals.
- G. Re-check the Duct Blaster DG-700 and if necessary, re-adjust the Duct Blaster fan until Channel A reads zero. Channel B on the Duct Blaster DG-700 will now display the CFM50 leakage to the outside estimate. Record this number. If the leakage estimate is fluctuating more than desired, try changing the Time Averaging setting on the gauge by pressing the TIME AVG button.

5. "LO" appearing on Channel B. Whenever "LO" appears on Channel B in the PR/ FL Mode, the DG-700 cannot display a reliable fan flow reading. The message "LO" appears on Channel B under the following two conditions:

- A. "LO" is continuously displayed when there is negligible air flow through the test device.
- B. "LO" alternates with a flow reading when the air flow reading through the device is unreliable (i.e. you are trying to measure a flow outside of the calibrated range of the test device in its current configuration). If possible, you should change the test device configuration to match the flow rate being measured (e.g. install a Flow Ring or a smaller Flow Ring).

Note: If you change the Flow Ring on the fan, be sure to change the Configuration setting on the gauge to match the installed Ring.

Appendix Y: Diagnostic Testing Data Form

Client Name: _____ Project #: _____ # of Occupants: _____
 Address: _____ Date: _____ # of Bedrooms: _____
 Phone: _____ Heat Source: Gas / Oil / Electric # of Rooms: _____
 Volume: _____

DIAGNOSTIC TESTING REPORT							PRE	POST	
1.	Wind speed: if in excess of 15 mph STOP and return when better conditions exist								
	Calm	Light	Windy	Very Windy					
	1 2 3 4 5	6 7 8 9 10	11 12 13 14 15	15+					
2.	Outside temperature (Fahrenheit)			Inside Temp					
3.	Blower door location (what door)								
4.	Blower door configuration(O = open, all rings off , A = 1 ring on, B = 2 rings on)								
5.	Total CFM 50 IF: house pressure less than 50 PA, find CRF factor:								
6.	PRE MVL:								
7.	Record Baseline Pressure								
Zonal Pressures:									
8.	Zone: ID Duct Zones			Pre		Installer	CRF Factor:		
	1. Attic	WRT House					25...1.6		
	2. Crawl Space	WRT House					30...1.4		
	3. Garage(Attached)	WRT House					35...1.3		
	4. Bsmnt(Door closed)	WRT House					40...1.2		
	5. Other	WRT House					45...1.1		
	6. Other	WRT House							
9.	Pressure Pan Test (clockwise from front door, house WRT duct)								
	Location		PRE	Post	Location		Pre	Post	
	1				7				
	2				8				
	3				9				
	4				10				
	5				11				
	6				12				
10	Dominant Duct Leak Test: Main body WRT Outside (all interior doors open) Furnace on								
11	Duct Blaster: Total Leakage cfm:								
	Outside leakage cfm								
	Inside leakage cfm								
12	Ambient CO								

Description of house set up:

13	Testing		
		Pre	Post
	CO		
	Draft Natural		
	Worse Case		
	Draft w/WC		

16					
				Pre	Post
		Room	List corrective measures installed		
	1.				
	2.				
	3.				
	4.				
	5				
	6.				
	7.				
	8.				
	9				
	10				
	11				
	12				
	13				

17.	Add A Hole		Pre	Post
	Attic			
	Basement			
	Crawl Space			
	Other			
	Other			

Comments:

Signature of Auditor _____
Date

Signature/Qualified pressure Diagnostician/pressure balancing Technician _____
Date

Signature of Inspector _____
Date

Appendix Z: Zonal Pressure Diagnostics (ZPD)

A zone pressure is a diagnostic test to determine the location and effectiveness of a buildings pressure boundary (or air barrier) between conditioned space and a buffer zone. Buffer zones (or intermediate zones) include the attic, crawlspace, basement, mobile home belly, garage, porch, or soffit areas. Zonal pressure diagnostics (ZPD) can also determine how interconnected interior walls or floor cavities between stories are with the outside (or unconditioned space). ZPD assist weatherization crews in aligning the insulation and the air barrier (or thermal boundary).



Procedure

1. Install a blower door and set up the house for a blower door test.
2. Record the baseline pressure of the house with reference to (WRT) outdoors.
3. Typically, depressurize the house to -50 pascals.
4. Connect a probe to the input port of a digital manometer and insert the probe (drill a small hole if necessary) into the intermediate zone to be tested.
5. Record the pressure in the zone WRT the house (conditioned space).
6. To verify the accuracy of the zonal pressure test, measure the pressure outside WRT the zone and add the two test results together. They should always add up to approximately 50 Pa.

Interpreting ZPD Test Results

Example: Pressure in the attic WRT the conditioned living space.

1. If the pressure in the attic is approximately **50 pascals**, then the ceiling is the primary air barrier and that the roof is much leakier than the ceiling (at least 14 times). Commonly, the attic is said “to be outside the home”.
2. If the pressure in the attic is approximately **25 pascals**, than the ceiling and the roof are equally leaky and that the attic is equally connected to the inside and the outside.
3. If the pressure in the attic is approximately **0 Pascals**, than the roof is the primary air barrier and that the ceiling is much more leaky (at least 14 times) than the roof. Commonly, the attic is said “to be inside the home”.

Zonal pressures are relative

Zonal pressure tests measure the airtightness of the primary air barrier relative to the airtightness of the secondary air barrier.

Example: using the airtightness of the ceiling vs. the roof.

1. If the ceiling and the roof both have 400 square inches of holes, or if they both have 40 square inches of holes, the pressure in the attic WRT house is still 25 pascals. Both attics are equally connected to the outside and the inside.
2. The quantity of ventilation in a buffer zone has a huge impact on interpreting the ZPD test results. Roof or crawlspace vents are “holes” in regards to ZPD.

Zonal Pressure and Pressure Pan Numbers

The highest pressure pan reading possible (a completely disconnected duct) is equal to the pressure of the buffer zone containing the ducts. To correctly interpret pressure pan duct leakage test results, a zonal pressure test of the buffer zone containing the ductwork is required. Multiply the pressure pan readings by the appropriate pressure multiplier from the chart below:

Zone Pressure Multiplier

USING ZONE PRESSURES TO INTERPRET RELATIVE HOLE SIZE

Zone Pressure	Pressure Pan Multiplier
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

Zone Pressures to Interpret Relative Hole Size

Pressure in the zone WRT house	House to zone: Zone to outside Hole Size
12	2:1
25	1:1
37	1:2
41	1:3
45	1:4
48	1:8
49	1:13

Advanced zonal pressure diagnostics such as the Add A Hole Method can also be performed to accurately quantify the leakage area of the air barrier to the buffer zone

Zonal Pressure Diagnostics are another tool for weatherization personnel, but they are not a substitute for visual inspections, experience, and judgment.

Appendix AA: Electrical Inspection Report

ELECTRICAL INSPECTION REPORT

Client's Name: _____ Project #: _____

Address: _____ Installer Invoice #: _____

Home Phone: _____ Work: _____ Cell: _____

Other contact if necessary: _____

1. Ceiling:

1. Crown: OK Not approved

2. Slopes: OK Not approved

3. Rakes: OK Not approved

Walls:

1. Knee walls: OK Not approved

2. Outside Walls: OK Not approved

Under floor: OK Not approved

2. Service Size? _____

3. Is the furnace on a dedicated circuit? Y / N

4. Sub Panels: N / Y Location: _____

5. Fusing : OK Not approved

6. "S" Type Fuses Installed # _____ No _____

7. Circuit Breakers Installed # _____ No _____

8. Junction boxes installed # _____ No _____
(flying splices repaired)

⇒ **NOTE: ALL FUSING/BREAKERS CONTROLLING ACTIVE KNOB AND TUBE WIRING MUST NOT EXCEED 15 AMPRE** ←

Name of Installer: _____ Date of Inspection: _____

Name of Inspector: _____ License #: _____

Installer Comments: Repairs and Cost estimates: _____

Agency's Auditor's Comments: _____

Appendix BB: Insulating Electric Water Heaters

1. Electric water heaters shall be insulated in either one of two ways:
 - A. With one piece sufficiently long, that after completely enclosing the sides; a cylindrical extension is created above the top of the water heater tank. This extension shall then be carefully placed down over the tank top by removing selected pieces of fiberglass blanket from the vinyl facing, folding the facing and taping the seams;
 - B. With two pieces, the first forming a cylindrical wrap of the tank sides and extending approximately 3 inches above the tank top and the second cut into a circle with a diameter equal to the tank to be placed across its top.
2. Cutouts shall be neatly made around the tank drain valve and pressure relief valve on electric water heaters.
3. The location of the thermostat access panels shall be indicated on the outside surface of the wrap. This may be done either by cutouts and then taping the cutouts back in place or by marking clearly on the surface of the vinyl facing the outline of the panels.

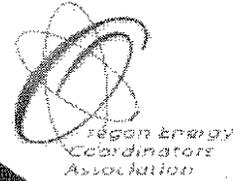


Appendix CC: Insulating Gas Water Heaters

1. Gas water heaters shall be insulated in the following manner:
 - A. Clean top of heater and wipe dry.
 - B. Determine necessary height and length of material needed by wrapping the heater with insulation blanket, vinyl to the outside and top edge flush with the top of the water heater. Leave exhaust draft hood at top of heater clear.
 - C. Bottom of insulation should come just to the bottom edge of water tank and be at least 3 inches clearance from the heater's burner access panel at the bottom of the water heater. Do not insulate natural gas water heaters on top. Cut out access to pilot light and controls.
 - D. Wrap heater with blanket laying flap over seam. Check to be sure there is enough material and that blanket is positioned properly to allow easy access to pilot light and controls. Use tape to secure the seam (horizontally) and tape the seams (vertically). Starting at bottom of seam, tape completely up the seam. Allow 4 inches of tape at top and secure to the heater. Using other pieces of tape, apply tape to the top of the heater to secure insulation blanket to the top of the gas water heater.



Appendix DD: Sample Insulation Certificate



<input type="checkbox"/> CEILING Area insulated (sq ft): _____ Type of insulation installed: _____ Amount of insulation installed (bags): _____ R-Value of insulation installed: _____ Final R-Value of insulation: _____
INSULATION CERTIFICATION FORM
<input type="checkbox"/> WALLS Net area insulated (sq ft): _____ Type of insulation installed: _____ Amount of insulation installed (bags): _____ Pounds per bag: _____ Final R-Value of insulation: _____
Name and address of agency/contractor: _____ _____ _____
I, _____, certify that this residence was insulated and the installation was conducted in conformance with applicable codes, standards, and regulations.
Authorized Signature _____ Date _____
<input type="checkbox"/> FLOOR Area insulated (sq ft): _____ Type of insulation installed: _____ Amount of insulation installed (bags): _____ R-Value of insulation installed: _____ Final R-Value of insulation: _____

Appendix EE: Sample Coverage Chart

Insulation has been installed in the following areas
 In conformance to applicable codes, standards and regulations:

Client Name: _____
 Address: _____
 Project #: _____
 Date: _____

Cellulose Coverage Chart...Isolite Fiber Insulation											
R-Value 75° Mean Temp	Open Attic Minimum Thickness (Inches)		Maximum Coverage (Square Feet)			Per Bag			Minimum Bags Per Thousand Sq. Ft)		
			Net	2x6 Framing 16 o.c.	2x4 Framing 24 o.c.	Net	2x6 Framing 16 o.c.	2x4 Framing 24 o.c.	Net	2x6 Framing 16 o.c.	2x4 Framing 24 o.c.
R-11	3"		63.7	69.2	67	15.7	14.4	14.9			
R-13	3.5"		53.9	53.6	56.7	18.6	17.1	17.6			
R-19	5.1"		36.9	40.1	38	27.1	24.9	26.3			
R-22	5.9"		31.8	34.4	32.6	31.4	29.1	30.7			
R-24	6.5"		29.2	31.3	29.8	34.3	32.0	33.6			
R-30	8.1"		23.4	24.6	23.7	42.8	40.7	42.2			
R-32	8.6"		21.9	23.0	22.2	45.7	43.6	45.1			
R-38	10.3"		18.4	19.1	18.6	54.2	52.3	53.8			
R-40	10.8"		17.5	18.1	17.6	57.1	55.1	56.7			
R-44	11.9"		15.9	16.4	16.0	62.8	60.9	62.5			
R-50	13.5"		14.0	14.4	14.0	71.4	69.6	71.2			
SIDEWALLS (BASED UPON FRAMING MEMBERS 16" ON CENTER)											
R-13	3.5" cavity		26.2			29.8					
R-20	5.5" cavity		16.7			46.9					
All coverage's are based upon installation using a pneumatic blowing machine											

Ceiling:	Walls	Floor
Covering Sq. Ft:	Covering Sq. Ft:	Covering Sq. Ft:
R-Value:	R-Value:	R-Value:

Contracting Company Name:
Installer's Address:
Installers Signature:
Date:

Appendix FF: Installing Mobile Home Roof Insulation



Exterior Cut through Method

1. Roofs with sufficient pitch and truss strength, access holes may be cut so that installers may access the roof cavity.
2. When installers cannot access the roof cavity, locate and mark each ceiling truss within 3 feet of the peak for double-wide homes, or in the center for single wide homes. Holes shall be centered over alternate trusses. The holes shall not be larger than 10-inches by 10-inches. REFERENCE STANDARDS.

Exterior Roof Access

3. The entire cavity from the eaves toward the center shall be filled. With pitched roofs, fill from the eaves until a minimum R-38 is achieved and continue R-38 to the center.
4. For pitched roofs, where the cavity is not filled with insulation, install roof jacks over the access holes to provide ventilation.

Gable End Access Method

5. Remove the gable end panels, or cut or drill holes through the gable end panels to determine the type of truss system. Cut or drill more holes as needed to fill the entire cavity.

Three Common Types of Mobile Home Roofs:

Bowstring trusses are common with metal roofs:



Low sloping standard pitched trusses are common with single roofs:



On double-wides, each unit has a half truss roof which combines with the other half to form a gable roof:



6. Insulation shall be installed using a 45° angle or directional nozzle from the middle out to the gable end. Ensure that insulation completely fills the roof cavity. Repeat this process from the opposite end.



7. Gable end panels shall be reinstalled after sealing all access holes so that they are weather tight.

Ventilation

8. Additional attic venting is allowed, but not required. Air sealing the thermal boundary between the attic and the conditioned space is required and is to be verified by visual inspection and pressure diagnostic testing. These changes will not restrict individual agencies from following their current practices.

Post-Installation

9. All plumbing stacks, chimneys, vent caps, and other penetrations shall be secured, properly flashed, sealed, and made weather tight.



Exterior Roof Insulation

10. Use rigid extruded polystyrene or rigid polyisocyanurate insulation, single ply membrane roof covering with a minimum thickness of 45 mil, flashing, rubber boots, slip-joints for plumbing stacks, fender washers, screws long enough to achieve positive wood penetration, termination tape and bar.



11. The installer is responsible for determining that the ceiling system is structurally adequate to support the combined weight of all materials imposed on the ceiling and for all damage occurring during installation, leaks caused by improper sealing, and damage due to combined weight of materials on the interior ceiling. If insulation is installed on the exterior of the roof cavities: all crank vents used for ventilation shall be removed.

12. Remove existing exhaust fan termination, flashing, or other objects that would interfere with installing the rigid insulation.



13. Insulate roof cavity to the highest R-value achievable.
14. The insulation boards shall be mechanically fastened using screws with 3 inch galvanized deck washers. All screws shall penetrate the roof structure (trusses) a minimum of 3/4 inch to ensure insulation board remains in contact and to minimize independent movement. All insulation board shall fit tightly together with no gaps to prevent thermal boundary breaks.



15. New roof coverings shall:

- A. Be extended down the wall and over the top edge of the wall covering and be secured to the wall using non-corrosive, self-tapping hex-head with a minimum length of 1 1/4 inch metal screws with butyl tape installed between the termination bar and the roof covering. Screws shall be anchored no more than every four inches.
- B. Insulation board shall be sufficiently rigid to prevent “ponding” of water on the surfaces after insulation and rubber covering are installed.
16. All plumbing vents, kitchen fans, bath fans, wood stoves, and other fixtures are required to vent to the outside of the new roof and be adequately flashed and sealed. All vents and chimneys shall be extended through the new roof with quick disconnects. If a swamp cooler or a vent is to remain in place after the insulation and covering is installed it shall be adequately flashed and sealed. If swamp cooler is removed, patch hole in an approved method.
17. All pre existing roof drainage systems shall function properly after the insulation and the new roof covering have been installed.



RAMADA ROOF INSULATION

18. Install insulation in the roof cavity of the original mobile home, and in the roof cavity formed by a free standing, self-supported roof (Ramada Roof) over the mobile home.
19. The Ramada roof shall be weatherproof and joined tightly to the mobile home to create an enclosed roof cavity that will contain the insulation and prevent the entry of birds, animals, etc.
20. After closing these openings in the original roof, add insulation over it to achieve a minimum total R-value of R-38, if feasible.
21. Open the original mobile home roof and completely fill the roof cavity with insulation.
22. Bathroom and other exhaust fans may vent through the roof with a direct connection to the outside. The recommended method for ducting exhaust fans is to run the duct directly into a roof jack. Use of existing roof vents is acceptable as long as roof cavity ventilation requirements are maintained. If an appropriate roof vent does not exist, one shall be added.
 - A. If new ducting is required, exhaust fans shall be equipped with an operating back draft damper.
 - B. The duct shall be at least the same diameter as the fan connection. Ducts should not have traps or reversing horizontal runs. It shall be substantially airtight to the outside (i.e. use of roof jack or other positive connector).

Appendix GG: Energy Related Formulas

Air leakage/ventilation heat flow

Infiltration and ventilation heat loss and heat gain have two components: sensible heat and latent heat. Latent heat is usually neglected in heating load and heat loss calculations. These equations are both for heating load. To find annual heat loss, substitute **HDD•24 hr/day** for ΔT , as in transmission heat flow equation above.

$$q \text{ sens} = 1.08 \cdot (\text{ACH}/60) \cdot V \cdot \Delta T$$

q sens is rate of sensible heat gain or loss

ACH is number of natural air changes per hour

V is volume of air

ΔT is the temperature difference between outside and inside air

$$q \text{ lat} = 0.68 \cdot (\text{ACH}/60) \cdot V \cdot \Delta T$$

qlat is rate of latent heat gain or loss

ΔT is the temperature difference between outside and inside air

Air exchange using measured CFM50:

Measuring CFM50 with a blower door allows the energy specialist to estimate other useful values relating to airflow in a home. The first equation gives air changes per hour at 50 Pascals—a sometimes-used standard for home air leakage. The second equation converts that air change rate to air changes per hour at natural conditions. The third equation is for estimating the annual cost of air leakage.

1. $\text{ACH } 50 = \text{CFM } 50 \cdot 60 / V$

ACH 50 is air changes per hour at 50 Pascals house pressure.
CFM 50 is measured airflow through the blower door.
V is house volume.

2. $\text{ACH}_n = \text{CFM } 50 \cdot / (n \cdot V)$

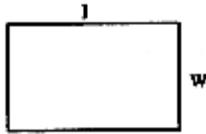
ACH is natural air change rate in changes per hour.
N is the LBL correlation factor.

3. $\text{ALH\$} = 1.08 \cdot \text{CFM } 50 \cdot \text{HDD} \cdot 24 \cdot (n \cdot \text{Ef}) \cdot 0.6$

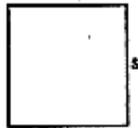
ALH\$ is annual air leakage heating cost.
HDD is annual heating degree days.
Ef is seasonal efficiency.

Appendix HH: Plane/Solid Geometry Formulas

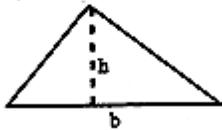
Plane Geometry



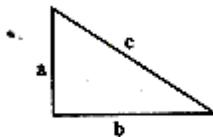
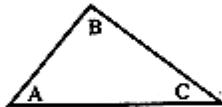
Rectangle
Area: $A = lw$
Perimeter: $P = 2l + 2w$



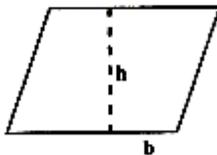
Square
Area: $A = s^2$
Perimeter: $P = 4s$



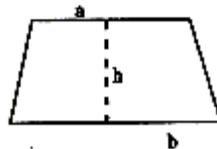
Triangle
Area: $A = \frac{1}{2}bh$
Sum of angles:
 $A + B + C = 180^\circ$



Right Triangle
Pythagorean Theorem:
 $a^2 + b^2 = c^2$



Parallelogram
Area: $A = b \cdot h$

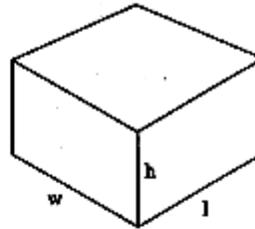


Trapezoid
Area: $A = \frac{1}{2}h(a + b)$

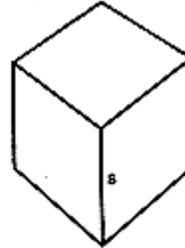


Circle
Area: $A = \pi r^2$
Circumference:
 $C = \pi d = 2\pi r$

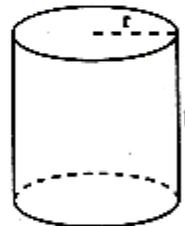
Solid Geometry



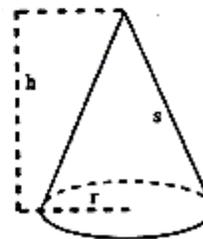
Rectangular Solid
Volume: $V = lwh$



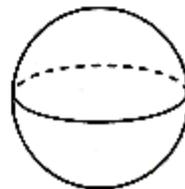
Cube
Volume: $V = s^3$



Right Circular Cylinder
Volume: $V = \pi r^2 h$
Lateral Surface Area:
 $L = 2\pi rh$
Total Surface Area:
 $S = 2\pi rh + 2\pi r^2$



Right Circular Cone
Volume: $V = \frac{1}{3}\pi r^2 h$
Lateral Surface Area:
 $L = \pi rs$
Total Surface Area:
 $S = \pi r^2 + \pi rs$



Sphere
Volume: $V = \frac{4}{3}\pi r^3$
Surface Area: $S = 4\pi r^2$

Appendix II: Insulation R-Values

Material	Type	R-Value per inch	Density lbs./cu.ft.
Fiberglass	Batts/ loose fill	2.9-3.5	.04-1.2
	Dense packed	3.7-4.8	2.0-3.5
	Duct board	4.0	4.0
Mineral Wool	Batts	3.3	1.5-4.0
	Loose fill	3.0	1.5-2.5
Cellulose	Loose fill	3.7	1.2-3.0
	Dense-pack	3.2	3.5-4.5
	Spray-on	3.4	2.8-3.8
Vermiculite	Loose fill	2.7	2-5
Perlite	Loose fill	2.5	4-8
Polyisocyanurate	Rigid board	7.0	1.6-2.0
Polyurethane	Sprayed on	6.2	2.0-3.0
Polystyrene	Rigid board	3.8-4.0	0.9-2.0
	Rigid board	5.0	1.6-2.0

Appendix JJ: Conversion Factors

	To convert from:	To:	Multiply by:
	Length		
1	Meters (m)	Feet (ft.)	3.281
2	Millimeters (mm)	Inches (in)	0.0394
3	Micrometers (µm, microns)	Meters (m)	0.000001
	Area		
4	Square meters (m ²)	Square feet (ft ²)	10.76
		Square inches (in ²)	1550
5	Square yards	Square meters	0.83613
	Volume		
6	Cubic meters (m ³)	Cubic feet (ft ³)	35.3
7	Liters (L)	Quarts (US)	1.057
		Gallons (US)	0.264
8	Milliliters (mL)	Fluid ounce (fl.oz)	0.0338
	Mass		
9	Kilograms (kg)	Pounds(lb)	2.205
10	Gram (g)	Ounce (Oz.)	0.03534
11	Pounds	Grains	7000
12	Tons (metric)	Kilograms	1000
13	Tons	Pounds	2000
14	Tons	Tons (metric)	0.9072
	Force		
15	Newtons (N)	Pounds (lbf) [*]	0.2248
		Kilograms (kgf) [*]	0.1020
	Pressure		
16	Pascal (Pa)	Inches of water (in H ₂ O)	0.004
17	Kilopascal (kPa)	Lb/in ² (psi)	0.1450
18	Inches of mercury (in Hg)	Lb/in ² (psi)	0.491.2
19	Feet of water (head)	Lb/in ² (psi)	0.4335
	Speed, velocity		
20	Meter-per-second (m/s)	Feet-per-second (ft/s)	3.281
21	Kilometers-per-hour (km/h)	Miles-per-hour (mph)	0.622
	Energy, work		
22	British thermal units (Btu)	Foot-pound (ft-lb)	788
23	Btu	Joule	1054
24	Calorie (cal)	British thermal units (Btu)	0.00397
25	Joule (J)	British thermal units (Btu)	0.000948
		Foot-pound (ft-lb)	0.738
		Calorie (cal)	0.238
26	Kilowatt hour (kwh)	British thermal units (Btu)	3413
27	Watt-hours	Calories	860.4
	Power		
28	Watt (W)	Btu per hour (Btuh)	3.412
29	Kilowatt (kW)	Horsepower (h.p.)	1.34
	To convert from:	To:	Multiply by
	Power		

30	Ton (cooling capacity)	Btu per hour (Btuh)	12,000
31	Horsepower (h.p.)	Ft-lb/s	550
32	Boiler horsepower (blr-hp)	Btu per hour (Btuh)	33,480
33	Boiler horsepower (blr-hp)	Pounds of steam per hour	34.5
34	Btu/hr	Calories/min	4.2
35	Btu/hr	Horsepower	0.0003927
Torque, bending moment			
36	Newton-meter (N-m)	Pound-foot (lb-ft)	0.7326
Density (mass/volume)			
37	Kilogram-per-cubic	Pound-per-cubic	0.0643
38	Meter (kg/m ³)	Foot (lb/ft ³)	
Degrees			
39	Angular	Grade (gon)	1.111
		Radians (rad)	0.0175
40	Degrees-per-second	Radians-per-second (rad/s)	0.0175
		Revolutions-per-minute (rpm)	0.167
Light intensity			
41	Foot candle	Lumens-per-square meter (lux)	10.76
Note: to reverse the above conversions, multiply by the inverse of conversion factor			
Temperature conversion formulas			
1	Degrees Fahrenheit (°F) to degrees Celsius (°C)	$^{\circ}\text{C} = 5/9 (^{\circ}\text{F} - 32)$	
2	Degrees Fahrenheit (°F) to degrees Kelvin (K)	$\text{K} = 5/9 (^{\circ}\text{F} + 459.67)$	
3	Degrees Celsius (°C) to degrees Fahrenheit (°F)	$^{\circ}\text{F} = 5/9 (^{\circ}\text{C}) + 32$	
4	Degrees Celsius (°C) to degrees Kelvin (K)	$\text{K} = (^{\circ}\text{C}) + 273.15$	
5	Degrees Rankine (R) to degrees Kelvin (K)	$\text{K} = \text{R}/1.8$	
6.	Degrees Fahrenheit (°F) to degrees Rankine (R)	$^{\circ}\text{R} = ^{\circ}\text{F} + 459.67$	

*The conversion factors for lb force and kg force are accurate only at sea level. They should be adjusted for elevation using the local gravitational acceleration constant.

Appendix KK: Federal Material Specifications and Standards

TABLE 1:

<u>Subject</u>	<u>Applicable Federal Specifications</u>
Mineral Fiber Blankets / Batts	HH-I-521F
Mineral Fiber Loose-Fill	HH-I-1030B
Cellulose Loose-Fill *	HH-I-515D
Perlite	16 CFR 1209
Polystyrene Board	HH-I-524C
Polyurethane and Polyisocyanurate Board	HH-I-530A
Federal Trade Commission Labeling Rule	16 CFR 460
Safety Specification for Architectural Glazing Materials	16 CFR 1201 ANSI Z97.1
Glass Float or Plate, Sheet, Figured (Flat, for glazing, mirrors, or other uses)	DD-G-451D
Glass, Plate (float), sheet figured, and Spandrel (heat strengthened and fully tempered)	DD-G-1403B
Caulking, Silicone Rubber	TT-S-001543A
Caulking, Single Component: Polysulfide or Polyurethane	TT-S-00230C
Caulking, Multiple Components: Polysulfide or Polyurethane	TT-S-00227E
Caulking, Single Component: Acrylic Terpolymer	TT-S-00230C

* Oregon law requires that a U.L. label be on every bag of cellulose loose fill insulation used.

MISCELLANEOUS EQUIPMENT AND MATERIAL SPECIFICATONS

TABLE 2:

<u>Subject</u>	<u>Applicable Federal Specifications</u>
Surface Burning Characteristics of Building Materials	ASTM E-84-80
Behavior of Materials in a Vertical Tube Furnace at 750 C	ASTM E-136-79
Thermal Conductivity (Guarded Hot Plate)	ASTM C-177-76
Thermal Conductivity (Heat Flow Meter)	ASTM C-518-76
Moisture Absorption of Building Materials	ASTM C-272-53
Water Vapor Transmission of Thick Materials	ASTM C-355-73
Aluminum Combination Storm Windows for External Application	ANSI/AAMA 1002.10-1980
Aluminum Windows	ANSI/AAMA 302.9-1977
Wood Windows	ANSI/AAMA I.S. 2-80
Polyvinylchloride Prime Windows	ASTM D-4099-82
Rigid Polyvinylchloride Profile Extrusions	NBS/PS 26-70
Sealed, Insulating Glass Units	ASTM E-774-81
Dew / Frost Point of Sealed Insulating Glass In Vertical Position, Test Method 4	ASTM E-576-76
Aluminum Sliding Glass Doors	ANSI/AAMA 402.9-1977
Wood Sliding Patio Door	ANSI/NWMA I.S. 3-83
Ponderosa Pine Doors	ANSI/NWMA I.S. 5-73
Douglas Fir, Western Hemlock, and Sitka Spruce Doors and Blinds	FHDA 7-79
Dimensional Standard for Insulated Steel Door Systems	ISDSI 100-79
Air Infiltration Standard for Insulated Steel Door Systems	ISDSI-101
Installation Standard for Insulated Steel Door Systems	ISDSI-102
Water Resistance Standard for Insulated Steel Door Systems	ISDSI-104
Mechanical Performance Standard for Insulated Steel Door Systems	ISDSI-105
Finish Performance Standard for Insulated for Insulated Steel Door Systems	ISDSI-106
Hardness of Plastics and Electrical Insulating Materials	ASTM D0785-76
Electrodeposited Coatings of Zinc on Iron and Steel	ASTM B-633-78
Electrodeposited Coatings of Cadmium on Steel	ASTM A-165-80
Haze and Luminous Transmittance of Transparent Plastics	ASTM D-1003-77
Air Infiltration Tate Test	ASTM E-283-73
Water Penetration Test	ASTM E-331-75
Caulking, Latex	ASTM C0834-76
Low Voltage Room Thermostats	NEMA DC 3-1978
Dehumidifiers	AHAM DH-1/ANSI B149.1-1972
AHAM 1980 Directory of Certified Dehumidifiers January 1980 or latest revision	Edition No.1

Appendix LL: Referenced Organizations

- A. AAMA - American Architectural Manufacturers Association, 35 East Wacker Drive, Chicago, Illinois 60601; (312) 782-8256
- B. AHAM - Association of Home Appliance Manufacturers, 20 North Wacker Drive, Chicago, Illinois, 60606; (312) 984-5800
- C. ANSI - American National Standards Institute, 1430 Broadway, New York, New York, 10018; (212) 354-3300
- D. ASHRAE - American Society of Heating, Refrigeration, and Air-Conditioning Engineers, 1791 Tullie Circle NE, Atlanta, Georgia 30329; (404) 636-8400.
- E. ASTM - American Society of Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103; (215) 299-5400
- F. CPSC - U.S. Consumer Product Safety Commission, 1111 18th Street NW, Washington, DC 20207.
- G. FHDA - Fir and Hemlock Door Association, Yeon Building, Portland, Oregon 97204; (503) 224-3930.
- H. FTC -Federal Trade Commission, Pennsylvania Avenue at 6th Street NW, Washington, DC 20580
- I. HVI - Home Ventilating Institute, 4300-L Lincoln Avenue, Rolling Meadows, Illinois 60008; (312) 359-8160.
- J. IGCC - Insulated Glass Certification Council, Attention Claude Robb, Industrial Park, Courtland, New York 13045; (607) 753-6711.
- K. ISDSI - Insulated Steel Door Systems Institute, 1230 Keith Building, Cleveland, Ohio 44115; (216) 241-7333.
- L. NEC - National Electric Code
- M. NEMA - National Electrical Manufacturers Association, 2101 L Street NW, Washington, D.C. 20037
- N. NFPA - National Fire Protection Association, 470 Atlantic Avenue, Boston, Massachusetts 02210; (617) 482-8755.
- O. NWMA - National Woodwork Manufacturers Association, 205 West Touay Avenue, Park Ridge, Illinois 60069; (312) 823-6747.
- P. NVLAP -U.S. Dept. Of Commerce, National Voluntary Laboratory Accreditation Program, National Bureau of Standards, Washington, DC 20234.
- Q. PSTC - Pressure Sensitive Tape Council, 1800 Pickwick Avenue, Glenview, Illinois 60025; (312) 724-7700.
- R. Residential Energy, Cost Savings and Comfort for Existing Buildings, Second Edition, Saturn Resource Management, 324 Fuller Ave., N-13, Helena, MT 59601 (406) 443-3433

- S. SGCC - Safety Glazing Certification Counsel, 1640 West 32nd Place, Hialeah, Florida 33012
(305) 558-1242.
- T. SIGMA- Sealed Insulated Glass Manufacturers Association, 111 East Wacker Drive, Chicago, Illinois 60601,
(312) 644-6610.
- U. The Energy Conservatory, 2801 21st Ave. S., Suite 160, Minneapolis, MN 55407 (612) 827-1117
- V. UBC - Uniform Building Code, International Conference of Building Officials, 5360 South Workman Mill
Road, Whittier, California 90601; (213) 699-0541.
- W. UL - Underwriters Laboratory, 333 Pfinsten Road, Northbrook, Illinois 60062; (312) 272-8800.
- X. UMC- Uniform Mechanical Code
- Y. USDOE - U.S. Dept of Energy, Washington D.C. 20585; (202) 252-5000
- Z. Your Mobile Home, Energy and Repair Guide for Manufacture Housing, Saturn Resource Management, 324
Fuller Ave., N-13, Helena, MT 59601 (406) 443-3433

Appendix MM: Glossary

Air barrier - Any part of the building shell that offers resistance to air leakage. The air barrier is effective if it stops most air leakage. The surfaces at which most of the air leakage of a house is stopped (usually 45 pa. or more when the house is pressurized to 50 Pascals); not always the same surface as the thermal boundary.

Air changes at 50 Pascals (ACH 50) - The number of times that the complete volume of a home is exchanged for outside air when a blower door depressurizes the home to 50 Pascals.

Air handler - A steel cabinet containing a blower with heating and/or cooling coils connected to ducts that transports indoor air to and from the air handler.

Air sealing - is a systematic approach to “tightening” a dwelling units conditioned envelope (or building shell), to reduce uncontrolled heat loss through air leakage points present in the shell.

Air-to-air heat exchanger - A mechanical ventilation device which exchanges air inside a conditioned space with outside air and transfers the heat contained in one air stream to the other air stream.

Air turbine - An attic ventilator with attached blades which allow prevailing winds to spin the turbine. This increases the volume of air removed from the attic space.

Air velocity - The speed at which air moves through a duct measured in feet per minute.

Amp - A unit of measurement of the flow of electrical current.

Attic exhaust fan - A ventilating device connecting the attic space to the residence's conditioned space. The fan ventilates by drawing cool outside air into the residence and exhausting warm inside air through attic vents.

Automatically retractable door bottom closure - A form of weatherstripping that is spring loaded so that it will seal between the door and the floor or threshold when the door is closed, but will retract as the door is opened to prevent its rubbing on the floor or carpet.

Back draft damper - A damper, installed near a fan that allows air to flow in only one direction.

Back drafting - Continuous spillage of combustion gases from combustion appliances.

Backer rod - Polyethylene Foam rope used as a filler in gaps for caulking.

Batt/blanket insulation - Flexible strips or rolls of preformed insulation, with or without a vapor retarder facing.

Bi-metal - Two metals with different rates of expansion that are fastened together. When heated or cooled they will warp and can be made to open/close a switch or valve.

Bite - The distance the edge of any glazing material penetrates the frame supporting the glazing in windows or doors.

Blower door - A device to create a pressure difference between inside and outside or two areas of building in order to estimate air flow or air pressures. Sometimes called a blower door fan.

Blown insulation - Loose-fill insulation blown in by special pneumatic equipment.

Boiling point - the temperature at which the addition of any additional heat will begin a change of state from a liquid to a vapor.

Boot - A duct section that connects between a duct and a register or between round and square ducts.

British Thermal Unit (Btu) - The amount of heat necessary to change the temperature of one pound of pure water one degree Fahrenheit.

Building cavities - The spaces inside walls, floors, and ceilings between the interior and exterior sheeting.

Building permit - An authorization issued by Agency, city, or state officials allowing a specific type of construction at a particular location.

Carbon monoxide - A colorless, tasteless, odorless gas that is a by product of incomplete combustion.

Caulking - A compound used to provide an airtight seal at the points of contact between different types of building materials, thereby preventing infiltration and heat loss.

Cellulose insulation - An insulation material treated with flame retardant and made from used newsprint or virgin wood fiber.

CFM 50 (cfm 50) - The number of cubic feet per minute of air flowing through the fan housing of a blower door when the house pressure is 50 pascals (0.2 inches of water). This figure is the most common and accurate way of comparing the airtightness of buildings that are tested using a blower door.

Chimney effect (or flue effect) - Is essentially a powerful stack effect occurring inside a chimney or flue caused by the rising of air due to temperature derived weight differences; the rising of air caused by temperature derived weight differences in air.

Clock or setback thermostat - A programmable device regulating the demand on the heating or cooling system by automatically switching from one temperature or control level to another.

Combustion air - Air that chemically combines with a fuel during combustion to produce heat and flue gases, mainly carbon dioxide and water vapor.

Conditioned space - The space within a building that is heated or cooled by an active space heating/cooling system.

Condensation point - The temperature at which the removal of any heat will begin a change of state from a vapor to a liquid.

Conduction - The transfer of heat from molecule to molecule within a substance.

Convection - The transfer of heat by a moving fluid.

Coverage label - The label from a bag of loose-fill insulation describing the size of area, depth, weight, and R-value that the material will provide.

Crawl space - The space between the ground and the first floor of the residence in residences not constructed with a basements or "slab on grade" foundation.

Cross member - A structural steel piece that connects the main beams of a mobile home.

Crossover duct - A duct connecting the plenums and duct systems of the two halves of a double-section mobile home.

Cross ventilation - Placement of vent openings so that air flows in one vent, over the insulated space, and out the other vent. Air flow occurs naturally due primarily to wind.

Cubic Foot - cu. ft.

Dew point - Is the temperature at which air becomes saturated and the vapor condenses to water.

Dehumidifier - A mechanical device which removes moisture vapor from the air.

Direct vent - Method of venting appliance whereby all air for combustion is derived directly from the outside atmosphere and all flue gases are discharged directly to the outside atmosphere.

DOE - The United States Department of Energy.

Door sweep - The bottom horizontal portion of a door frame used for adjusting its overall height to fit an existing doorjamb. A bottom expander usually includes some type of weatherstripping.

Dormer - A window set upright in a sloping roof, or the roofed projection into which a window is set.

Double strength glass - Glass of higher physical strength than single-strength glass, usually 1/8 inch thick.

Draft diverter - A device located in gas appliances flue pipe used to moderate or divert draft that could extinguish the pilot light or interfere with combustion.

Dry rot - See Wood Decay.

Emittance - The ability of a material to emit radiant energy from its surface. Also called emissivity.

EPDM (Ethylene Propylene Diene Monomer) - flexible rubber membrane roof system used primarily on mobile homes in weatherization.

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

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

Fenestration - Window and door openings in a buildings walls.

Finish material - A building material, such as gypsum board or wood paneling, exposed to the living space and used to contain or hide construction components.

Fill tube - A plastic tube, 1-3 inches in diameter, connected to the end of a blower hose and inserted into a closed building cavity.

Flame spread rating - Used to indicate the rate at which flame will spread across the surface of a given material. The higher the number, the faster the flame spread. The rating is determined by Standard Test ASTM E-84-80.

Flashing - Sheet metal strips installed to prevent water leakage over windows, doors, etc, and around chimneys and other roof details.

Flue -The ducting to exhaust gases from the furnace.

Foot - ft.

Freezing point - The temperature at which the removal of any heat will begin a phase change from a liquid to a solid.

Frost line - The maximum depth of the soil where water will freeze during the coldest weather; the maximum depth in the ground at which freezing will typically occur in a given geographical area.

Furring - Thin strips of board fastened to the wall to provide an air space for insulation and support for wall materials (such as gypsum board) to be installed over insulation.

Gable vents - Vents located in the wall section of the attic at or near the peak of the roof.

Glazing - Glass or other transparent material (such as vinyl) used in windows and doors. Also, the act of fitting a window with glass or similar material.

Ground cover - A polyethylene sheet (or similar material which has low water-vapor permeance) overlaying the ground within a crawl space.

Gypsum board - Rigid sheets of gypsum attached to the framing of a building to provide a surface suitable for painting or other finishing. Gypsum is made of a hydrated sulfate of calcium occurring naturally in sedimentary rock. Also referred to as sheet rock, dry wall, and gypsum board.

Heat - A form of energy causing the agitation of molecules within a substance.

Heat rise - The number of degrees of temperature increase that air is heated as it is blown over the heat exchange. Heat rise equals supply temperature minus return temperature.

Heat recovery ventilators (HRV) sometimes called Air-to-Air Heat Exchanger (AAHXV) - Provide balance of air flows and transfer part of the heat from exhaust side to incoming air.

Heat transfer - The three methods of heat transfer are conduction, convection and radiation.

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

House pressure - The difference in pressure between the indoors and outdoors as measured by a gauge on the blower door when the blower door is operating.

HUD code - The US Department of Housing and Urban Development's standard for new manufactured homes, known as the Manufactured Home Construction and Safety Standards.

Humidistat - A device which controls the operation of a humidifier or dehumidifier or fan based on the relative humidity present in the air, similar to the way a thermostat works to control temperature.

HVAC - An acronym for heating, ventilating, and air conditioning.

I-Beam - One of two steel beams shaped like a capital i. These beams provide the main support for the mobile home and are the main structural parts of the chassis or trailer.

Inch – in.

Interlocking metal weatherstripping - A two piece unit comprised of a metal strip and interlocking metal retainer which creates an interlocking airtight seal when a door is closed.

Infiltration - Uncontrolled inward air leakage through cracks or openings in building elements, windows, and doors. Infiltration is only one half of the air leakage process. For any air infiltration there shall also be air escaping somewhere else (exfiltration.).

Insulated door - An exterior door containing some type of effective insulation (usually foam) and designed specifically to reduce heat loss through conduction.

Insulation - A material which restricts heat transfer from a hot object to a cold object, usually by creating air spaces.

J-rail - The metal strip that clamps a metal mobile home roof down to the siding around the perimeter of the roof and also acts as a miniature rain gutter.

Jalousie window - A window consisting of several slats of glass (similar to Venetian™ blinds) which open simultaneously by means of a crank, common in older mobile homes.

Jamb - The finished side or top piece of a window or door opening.

Joists - Closely spaced parallel beams supporting a floor or ceiling.

Knee wall - A short wall between an attic floor and a sloping roof.

Knob and tube wiring - A wiring method, often concealed in walls and ceilings, using porcelain or ceramic knobs and tubes for the support of single insulated conductors.

Kilowatt - A unit of electric power equal to 1000 joules per second or 3412 BTUs per hour.

Laminated glass - Two pieces of glass laminated with a plastic sheeting between the glass to help prevent shattering into dangerous shards. This type of glass meets the U.S. Consumer Product Safety Commission Class 2 rating.

Light - The glazed parts of a window, also called the windowpane.

Lineal foot - Lf.

Loose-fill insulation - Insulation material (cellulose, mineral wool, Perlite, vermiculite) manufactured in a loose form, which is usually blown or poured into place.

Low E - Low emissivity, a very thin metallic glass coating to resist the loss of radiant heat.

Low temperature vinyl (weatherstripping) - Vinyl that is designed to remain pliable under cold weather conditions.

Low voltage - Less than 50 volts. Low voltage is frequently used in control signaling circuits and landscape lighting.

Marriage wall - The joint between two sections of a double section or triple section home.

MVL - Minimum ventilation level (for air sealing).

Mastic - Sealant used for duct tightening.

Mechanical Ventilator - Any fan or other motor-driven unit used for ventilating.

Meeting rail - The frame located on one edge of an operable glazed light or screen that forms the center rail of a window or door system. Usually interlocks with a companion rail.

Multi-glazing - An arrangement of two or more layers of glass used to reduce heat loss by providing one or more insulating air spaces between them (also see Sealed Insulating Glass).

Mil - One one-thousandth of an inch.

Mineral I fiber - Thermal insulation material composed of mineral substances such as slag, rock, and glass.

Net free area - The net area of unencumbered venting (i.e., the area without screens or louvers) which provides free air access. Abbreviated NFA.

Noncombustible Insulation - Insulation of which no part will ignite and burn when subjected to fire and which conforms to ASTM E-136-79.

Open combustion - A combustion device that takes its combustion air from the surrounding room air is called open-combustion.

Orifice - A hole in a gas pipe where gas exits the pipe to be mixed with air in a burner before combustion in a heating device.

Outward clinching staple - A staple driven by a special staple gun that will stitch belly paper together without wood backing (also called "stitch stapler").

Pascal (Pa) - A unit of measurement for small air pressures caused by blower doors and wind.

Passive ventilation - Natural air movement due to temperature differences (using no moving parts such as fans, etc) caused by convection.

Perimeter insulation - Insulation installed on the sidewalls of a crawl space or around the edges of a slab on grade.

Perlite - Loose fill insulation material which is made from expanded volcanic rock.

Perm rating - The unit of measurement of permeance to water vapor. It is equivalent to one grain of water vapor passing through a membrane 1 square foot in area when the vapor pressure across the area is 1 inch of mercury. The lower this number, the smaller the amount of water vapor that can pass through the membrane. The rating is determined by Standard Test ASTM E-96-72.

Plenum - The piece of ductwork that connects the furnace to the main supply duct.

Polyisocyanurate - A closed-cell polymer foam often pale yellow in color; similar to polyurethane.

Polystyrene - A closed-cell polymer foam containing a mixture of air and polymer gases, usually white or pale blue in color.

Polyurethane - A closed-cell polymer foam containing gases instead of air.

Pony wall - A short wall, usually on top of a foundation.

Poured insulation - Loose insulation installed by spreading over a surface.

Prehung window or door - A unit manufactured with the frame already fitted.

Pressure drop - The decrease in pressure due to friction of air as it passes through a forced air system.

Pressure/friction channels - Spring or tension-loaded channels in the moving parts of a window; allows window openings to be variable without latches or other supports.

Prime window - The original window to which a storm window or multiglazing is added to provide greater thermal resistance.

Radiation - The transfer of heat without an intervening medium between all objects.

Rake attic - Side attics found in story and a half finished attics or "knee wall" attics.

Recessed fixture - An electrical fixture (usually a light) mounted recessed within a wall or ceiling.

Recessed soffit - A ceiling soffit containing recessed fixtures.

Refrigerant - A substance which produces a refrigerating effect while expanding or vaporizing; refrigerant (common refrigerants are R-22 and R-410A); a special fluid used in air conditioning and heat pumps that heats air when it condenses from a gas to a liquid and cools air when it evaporates from a liquid to a gas.

R-value - A unit of resistance to heat flow. It is expressed as temperature difference required causing heat to flow through a unit area of a building component or material at a rate of 1 heat unit per hour. The inverse of U-value or measurement of heat flow.

Rock wool - Thermal insulation material composed of threads or filaments of slag, produced by reprocessing the residual materials from metals smelting.

Safety glass - Either laminated or tempered glass.

Sashes - The parts of a window, generally movable, in which panes of glass are set.

Sealed combustion - Used to describe a combustion appliance like a furnace or water heater that draws combustion air from outdoors and has a sealed exhaust system.

Sealed insulating glass - A window unit with two or more panes of glass hermetically sealed together at the factory. During the process, the air between the panes is dried so condensation is prevented inside the unit (also known as multiglazing).

Sealer - A paint, lacquer, varnish, or similar material applied to exposed or fresh-cut wood to prevent degradation when installed outside.

Sequencer - A bi-metal switch that turns on the elements of an electric furnace in sequence.

Single strength glass - Standard 3/32-inch-thick pane of glass.

Setback periods - The period during which time controlled thermostats reduce the demand on a heating or cooling system by changing the set point temperatures.

Slab on grade - A concrete foundation poured directly on the ground.

Soffit - The area between the end of the roof overhang and the edge of the residence or, more generally, the underside of any architectural feature, usually not structural.

Soffit vent - An attic vent located in the soffit under the eaves of the roof overhang.

Spillage- Temporary flow of combustion gases from a dilution device.

Spot ventilation - The exhausting outside of moisture or other pollutants at the location they are produced, usually a bath or kitchen fan.

Square foot - sq. ft.

Square inch - sq. in.

Static pressure - the force of the air being pushed by the fan on the sides of the duct usually measured by drilling a small hole in the duct and inserting a static tap connected to a manometer.

Storm Window - A unit consisting of glazing installed in a window opening either inside or outside a prime window, creating an insulating air space to reduce heat flow.

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

Sweep - A vertical, flat, flexible weatherstripping attached to the base of a door.

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

Thermal boundary - consists of the air barrier and the insulation, which should be in substantial contact with each other.

Thermal break - A relatively low heat/cold conductive material separating two highly conductive materials.

Thermal bridging - Rapid heat conduction resulting from direct contact between very thermally conductive materials.

Thermo couple - A bi-metal junction electric generator used to keep the safety valve of an automatic gas valve open.

Tempered glass - Glass that has been treated so that when broken it forms many bead like pieces with no jagged edges and meets the U.S. Consumer Product Safety Commission Class 2 rating.

Termination bar - A metal strip that clamps the rubber roof membrane at the edge of the roof and wall in a rubber roof installation.

Thermostat - A device for automatically controlling a heating or cooling system through regulation of interior air temperature.

Thermal conductance - See U-value.

Threshold - A piece of wood, stone, metal, etc, placed on the door sill, or the part stepped over when passing through the door.

Total pressure - Total pressure in the duct equals static pressure plus velocity pressure.

Ton of refrigeration - Equivalent to 12,000 BTUS per hour or the refrigeration equivalent to the melting of one ton of ice per 24 hours or 288,000 BTU per day.

UMC - Uniform Mechanical Code.

Unconditioned space - Space within a building which is not heated or cooled by an active system: or, the outside.

U-value - Measurement of the thermal conductive capacity of a material. It is the reciprocal of the R-value. The amount of heat flow in BTUs per hour per sq ft per degree Fahrenheit temperature difference on either side of a body (BTUH/ft²/°F).

Vapor retarder - A material that retards the passage of water vapor. A film, laminated duplex paper, aluminum foil, paint coating, or other material which restricts the movement of water vapor from an area of high vapor pressure to one of lower pressure. Material with a perm rating of 1.0 or less is normally considered as vapor retarder; commonly referred to as vapor barrier.

Vapor diffusion - The flow of water vapor through a solid material.

Ventilation - The intentional exchange of air, usually for pressure building cavities, spot ventilation of bathrooms and kitchens or whole house ventilation for occupants.

Ventilation shielding - Rigid material installed at ventilation points or recessed fixtures in the attic to keep loose insulating materials from blocking or sloughing into the area.

Vermiculite - An expanded mineral insulation consisting of a mica-like substance which expands when heated. The resulting granules are generally used as loose-fill insulation.

Visible transmittance - The percent of light transmitted by a glass assembly.

Visqueen - Polyethylene film vapor retarder commonly used as a ground cover.

Volume - Vol.

Water pipe heaters - Electric resistance wire encased in plastic which can be wrapped around water pipes in unconditioned spaces to prevent freezing, usually thermostatically controlled.

Wind loads - The pressure exerted on windows and other large areas from the force of the wind.

Weatherstripping - Material such as vinyl, foam, or metal strips installed to prevent air infiltration through cracks around movable portions of windows and doors.

Whole house plenum - An enclosed crawl space used in lieu of return or supply ducts in a forced air heating/cooling system.

Whole house ventilation (system) - A mechanical system to insure sufficient fresh air for occupants. Not to be confused with building cavity ventilation such as attic or crawl spaces. Exhaust whole house systems use an upgraded bath fan, timer and fresh air inlet ports in each room.

Wood decay - A degradation of wood caused by wood destroying fungus. Sometimes called "dry rot".

Zonal pressure - Is the diagnostic test to determine location and effectiveness of a buildings pressure boundary or air barrier.

Appendix NN: Notes