

MONTANA HOUSE 2

TECHNICAL SPECIFICATIONS

June 28, 2011

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# CHAPTER 1. DESIGN QUALIFICATION AND CERTIFICATION

## 1.1. Design Qualification

Single family homes built to meet Montana House 2 Specifications must meet the thermal envelope, heating system, and lighting and appliance efficiency requirements listed these Specifications, included in Table 1. The Montana House 2 Specification is designed to be the prescriptive standard for the minimum performance criteria for the components of Montana House 2. The Montana House 2 is applicable for homes with heat pump, zonal electric (unducted), or forced air electric heating systems.

“Single family” homes extend to duplexes, triplexes and attached units separated fully from ground-to-roof (i.e., townhouses and condominiums).

## 1.2. Additional Utility Requirements

Utilities may add requirements more stringent than those in this specification.

## 1.3. Utility Quality Control Requirements

Building design and construction must be reviewed and verified by the utility to meet the Montana House 2 Technical Specifications. If the house fails an inspection or test, the contractor and utility will identify the problem area and work to repair it and may retest each home thereafter. The utility will work with the contractor and will be encouraged to improve his construction practices in future houses. If contractor continues to fail inspections or tests, incentive and energy savings levels could be reduced or the builder could be dropped from the program.

### 1.3.1 Building Plan Review

### **A building plan review shall be completed by the utility prior to construction. The plan review will be used as basis for qualifying each Montana House 2. Plans should include all required features for the Montana House 2 (i.e. Slabs, Floors, Walls, Ceilings & Attics). Substantial deviation from the specifications shall be approved by phone followed by written approval from BPA.**

### 1.3.2 Checklist Agreement

### **Once the building plans have met the specifications, the participating utility will provide plan review “checklist agreement”, detailing the required features. The homeowner and the builder must sign the checklist agreement, which states that they agree to build the home to the minimum specifications.**

### 1.3.3 Slab Inspection

The utility shall make an in-progress inspection to verify the under-slab insulation levels prior to the pouring of the slab. The contractor is required to notify the utility at least 48 hours prior to the slab being poured. If the utility cannot be present to inspect under-slab insulation, the contactor shall take pictures that verify insulation levels and submit the pictures to the utility.

**1.3.4 Wall Inspection**

The utility shall make an in-progress inspection to verify proper air-sealing and exterior wall insulation levels prior to installation of the drywall. Contractor is required to notify the utility at least 48 hours prior to installation of the drywall. If the utility cannot be present to inspect the wall assembly, the contractor shall take pictures to verify insulation levels and air-sealing and submit the pictures to the utility.

**1.3.5 Final Inspection**

The utility shall make a final inspection to verify the house was built to the specifications and properly commissioned. The contractor is required to notify the utility when the house is completed.

**1.3.6 Blower Door Test**

If the house is the first one built by the contractor to Montana House 2 specifications the final inspection shall include a blower door test to verify compliance with air tightness specifications. The utility shall perform a random blower door test upon completion of every tenth house thereafter.

## 1.4. Existing Codes and Regulations

These specifications are intended to meet or exceed applicable existing building codes and Federal regulations. In any case where a Federal, State or local code or regulation exceeds these requirements, that code or regulation applies.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Table 1: Montana House 2 New Construction - Prescriptive Component Requirements | | | | |
| Insulation | | | |
| Ceiling | | R- 60 Adv. | Flat or Minimum R-49 vaulted. |
| Wall (above grade) | | R-21 Int. + R-5 foam |  |
| Floors over Unconditioned Space | | R-38 | Insulation in floor joist cavity. |
| Slab Floors | Unheated | R-10 Full Slab +  R-5 Thermal Break | Applies to all concrete slab floors above or below grade. Minimum R-5 thermal break required between slab edge and all walls and footings. |
| Heated Radiant | R-15 Perimeter, 4’  R-10 Remaining Slab  + R-5 Thermal Break | Applies to all concrete slab floors above or below grade. Perimeter insulation shall be installed for a distance of 4 feet vertical, horizontal, or combined distance. Minimum R-5 thermal break required between slab edge and all walls and footings. |
| Basement Wall | | R-21 | Below grade walls can extend up to 24 inches above grade. |
| Sealed Crawlspace Wall | | R-21 | The crawlspace wall shall be sealed and mechanical ventilation shall be provided. Sealed crawlspaces shall be considered conditioned space. |
| Windows & Doors | | | |
| Glazing | Windows | ≤ U-0. .30 | NFRC rated: Up to 1% of heated floor area exempt. |
| Skylights | ≤ U-0.50 | Skylight area shall not exceed 5% of heated floor area. |
| Max. Glazing Area | 15% of Heated Floor Area | Combined window and skylight area. |
| Exterior Doors | | ≤ U-0.16 | One door up to 28 ft2 exempt. |
| Ducts in Unconditioned Space | | | |
| Insulation | Rigid | R-11 |  |
| Flexible | R-8 |  |
| Sealing | | Mastic | Cloth duct tapes not allowed. |
| Max. Leakage | | Not tested |  |
| Ventilation & Air Sealing | | | |
| Ventilation System | | Whole-House | Mechanical ventilation system required. |
| Envelope Tightness | | 4.0 ACH @ 50Pa | Utility to test 10% of homes |
| Heating & Cooling Equipment | | | |
| Heat Pump | | 8.5 HSPF/SEER 13 | Installed according to Montana House 2 New Construction specifications for sizing and controls. |
| Air Conditioner | | SEER 13 |
| Zonal Electric | |  | Electronic thermostat required. |
| Forced Air Electric | |  | Energy Star programmable thermostat required. |
| Water Heating | | | |
| Electric Water Heaters | | ≤ 39 gallons | Energy Factor ≥ 0.96 |
| 40 to 49 gallons | Energy Factor ≥ 0.95 |
| 50 to 64 gallons | Energy Factor ≥ 0.95 |
| ≥ 65 gallons | Energy Factor ≥ 0.91 |
| Appliances & Lighting | | | |
| Appliances | | ENERGY STAR qualified | Applies to built-in appliances and any new purchases. . |
| Lighting | | ENERGY STAR qualified | A minimum of 90% of sockets to be either ENERGY STAR bulbs, fixtures, or both. |

# CHAPTER 2. THERMAL EFFICIENCY

## 2.1. General

All insulation materials shall be installed according to the manufacturer's instructions to achieve proper densities, avoid compression and voids, and maintain uniform R-values. To the maximum extent possible, insulation shall extend over the full component area to the intended R-value. All R-values specified are nominal.

Recessed fixtures (e.g., medicine cabinets, electrical panels, recessed lights, heating equipment, etc.) shall be covered by the full depth of insulation required by the component assembly. EXCEPTION: One percent of the component area (e.g., vaulted ceiling, wall) may have a minimum of R-10 insulation between the fixture and the building exterior if required ventilation clearances are maintained.

Hatches connecting conditioned spaces to attics and crawlspaces shall be insulated to at least the requirement for the appropriate component, except R-38 is allowed for ceiling hatches.

## 2.2. Ceiling

An advanced-frame attic is any combination of heel height, insulation material and baffles that provides the required ventilation space and a minimum of R-49 at the exterior edge of exterior walls. The insulation shall increase to the full R-value at the highest rate allowed by the roof pitch and taper down to reach the outside edge of the exterior wall or to blocking between rafters.

Ventilation baffles in attics shall be permanent, weather‑resistant retainers and allow insulation to be installed to the outer edge of the exterior wall to the fullest depth possible. All vents for attic/roofs and crawlspaces shall be clear of insulation. Attic and roof vents shall not be used as exhaust vents for mechanical ventilation systems.

## 2.3. Above Grade Walls

Insulation shall uniformly fill the entire cavity and to be installed as per manufacturer's directions. When present, insulated sheathing (either interior or exterior) is assumed to cover the entire opaque wall surface. All rim joists in heated basements or crawlspaces, or between floors, shall be insulated to the above-grade wall R-value.

### 2.2.1. Framing Description:

Framing systems shall use 2x6 wood framing. Intermediate framing is defined as follows:

*Intermediate*: Studs framed on 16 or 24-inch centers with single or double top plate(s) and single bottom plate. Corners use 2 studs or other means of fully insulating corners, and 1 stud with trim piece is used to support each header. Headers consist of double 2X material with R-10 insulation between the header and exterior sheathing. Interior partition wall/exterior wall intersections are fully insulated in the exterior wall, typically framed with 2 studs (corners) or drywall backers or ladder blocking (partitions).

## 2.4. Slab Floors

Slab floor insulation shall be installed under the entire slab in heated spaces. Slabs in heated spaces shall have an R-5 thermal break between footings, walls, and slabs in adjacent unconditioned spaces. Slab floors used as part of a radiant heating system shall have R-15 4’ perimeter and R-10 under the rest of the slab.

## 

## 2.5. Sealed Crawlspaces

Where sealed crawlspaces are used, the following requirements apply.

### 

### 2.3.1. Sealing

Crawlspaces shall be sealed at both the rim joist and the mud sill with caulk or gasketing. All penetrations through the building envelope of the foundation wall, including the following, shall be sealed (e.g., caulking, expanding foam, tape, backer rod, gasket material, etc.) to limit air-leakage:

* Over all framing joints where floors intersect exterior walls (e.g., at rim and band joists and at top and bottom wall plates), and
* At the top and bottom of the mudsill on homes with basements or conditioned crawlspaces.

### 2.3.2. Insulation

Perimeter insulation shall extend from the bottom of the subfloor to crawlspace floor covering any exposed foundation. Minimum of R-21 insulation shall be provided at the entire perimeter of the crawlspace. Insulation shall be permanently attached to framing materials in a manner capable of structurally supporting the insulation. Insulation may be either fiberglass batt, “blowin batt,” foam in-place or rigid insulation board or any combination of above.

### 2.3.3. Vapor Barrier

The floor of the crawlspace shall be covered with a vapor (moisture) barrier in accordance with the provisions of the International Building Code. Vapor (moisture) barrier shall be lapped at each seam by a minimum of one foot.

Seams may be taped as an alternative to lap seams.

If a “rat” slab (2” minimum) is poured over the vapor barrier lapped or taped seams may be avoided.

### 2.3.4. Ventilation

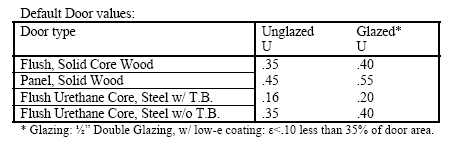
Mechanical ventilation shall be provided by the introduction of forced air from the furnace or heat pump directly into the crawlspace, or by use of a dedicated exhaust ventilation system.

When using forced air from the furnace or heat pump, a minimum of one supply register and a return grill shall be used in the crawl space. A minimum flow of 50 cfm shall be provided by either the supply register.

When using a dedicated exhaust ventilation system, overall ventilation capacity shall be a minimum of 50 CFM or 0.15 ACH calculated based on whole house volume whichever is greater. The exhaust fan shall be rated for continuous duty and use no more than 35 watts or 0.3 amps.

## 2.6. Doors and Glazing

All windows, skylights and sliding glass doors shall be NFRC certified and labeled. Exterior doors that have not been tested shall use the default U-factors found in the following table:



## 2.7. Air Leakage Control

Performance testing, performed as described in Appendix A, is required on at least 10% of houses labeled “Montana House 2” in each utility service territory. Building envelope leakage shall not exceed 4.0 ACH at 50 Pa. The utility shall keep test results records on file and make them available to BPA and/or the RTF on request.

## 2.8. Combustion Appliances

Sealed combustion appliances inside the heated space shall meet the requirements of Local codes or the International Mechanical Code as applicable. Neither unvented nor atmospheric combustion appliances are permitted.

Whenever a combustion appliance used for secondary space heating is present within a building, a Combustion Appliance Zone (CAZ) pressure test is required as outlined in Appendix A; a UL listed carbon monoxide detector should also be installed within the heated space.

Exception: A UL-listed carbon monoxide detector may be installed within the heated space in lieu of the CAZ pressure test requirement.

# CHAPTER 3. HEATING AND COOLING SYSTEMS

## 3.1. General

The primary heating system shall be electric. The heating contractor is responsible for designing and installing the heating system to meet all International Mechanical Code, National Electric Code, applicable local codes and equipment manufacturer's requirements. All equipment shall be located and installed according to manufacturer specifications and guidelines, all applicable codes and standards, and accepted industry practices.

## 3.2. Sizing for Heat Pumps and Central AC

### 3.2.1. Heat Pump System Sizing

The recommended method and form for heating and cooling load calculations is available in the Air Conditioning Contractors of America (ACCA) Manual J. This or an equivalent method shall be performed using Component U-values and F-values in the heat loss and heat gain coefficients that reflect the actual construction of the building. Heating loss and cooling gain calculations shall be made using 70°F indoor design temperature for heating and 75°F for cooling. The recommended ASHRAE winter design temperature and cooling design temperature for the nearest weather station representative of the installation shall be used.

The heat pump system shall be sized using either of the following methods, rounding up to the nearest 6000 Btu/hr capacity at ARI rating conditions:

Heat pumps shall be sized using no higher than a 30°F Balance Point

Heat pumps shall be sized in accordance with the sizing method specified by the utility.

However, in no case shall the Balance Point used for sizing be higher than 35°F. A Balance Point Worksheet shall be kept on file with the utility.

Duct leakage shall be assumed to be CFM50=0.06 x floor area in sq. feet, corresponding to an approximate duct system loss of 10%. Exception: If the air handler and all ductwork are within the thermal envelope of the house, 0% shall be used as the duct system loss in sizing calculations.

Partial tons calculated shall be rounded up to the next half-ton nominal size increment.

Installed auxiliary heating shall not exceed 125% of the heating design load. All supplemental heaters greater than 5 kW shall be staged.

Sizing documentation shall be kept on file at the utility.

### 3.2.2. Central Air Conditioner System Sizing

When sized separately from a heat pump, central air conditioners shall not be sized greater than 140% of design cooling load calculated consistent with methods discussed in Section 3.2.1.

## 3.3. Heat Pump Controls

The utility shall verify heat pump controls meet the following requirements. Results from the installation and functional check-out of system controls shall be held on file at the utility and made available to BPA and/or the RTF on request.

### 3.3.1 Indoor Thermostat

An electronic thermostat shall be installed to control the heating and cooling system. Thermostats used for both heating and cooling shall have a manual changeover feature or heating/cooling lockout to prevent cross-cycling between heating and cooling. All indoor thermostats shall include a manual selector switch to permit all supplemental heaters to be energized under control of the indoor thermostat (with the compressor and outdoor thermostats bypassed) when the compressor is inoperative.

### 3.3.2 Control of Auxiliary Heat

Heat pump systems shall employ control strategies that minimize the unnecessary use of auxiliary heat. In all systems, auxiliary heat shall not operate during a first stage heating call (unless system is switched to emergency heat). Auxiliary heat shall be controlled in the following manner depending on system type:

3.3.2.1. For systems with a single stage of compression and for systems with multiple stages of compression but without supply air temperature sensor control: Auxiliary heat shall be controlled in such a manner that it does not engage when the outdoor air temperature is above 35°F, except when supplemental heating is required during a defrost cycle or when emergency heating is required during a refrigeration cycle failure. Exception: If the minimum setting available for auxiliary cutout on the indoor thermostat is 40°F, 40°F may be used.

3.3.2.2. For systems with a single stage of compression and the option of supply air temperature sensor control, supply air temperature sensor shall not be allowed to bring on auxiliary heat when the outdoor air temperature is above 35°F, except for those special conditions and operating modes specified in the first paragraph of Section 3.3.

3.3.2.3. For systems with multiple stages of compression and supply air temperature sensor control:

Auxiliary heat shall be controlled in such a manner that it engages only after all stages of compression have been engaged and the supply air temperature falls below 85°F. OR

If the staging temperature is set higher than 85°F, the system shall be equipped with an outdoor thermostat or equivalent control that prevents auxiliary heat from operating when outdoor temperatures are above those specified earlier in the first paragraph of Section 3.3.

## 3.4. Zonal Electric Controls

Zonal systems shall have one electronic thermostat per zone.

## 3.5. Forced Air Electric Controls

For central furnace or similar type systems, a programmable ENERGY STAR thermostat shall be installed.

# CHAPTER 4. DUCT WORK

## 4.1. Design Requirements

It is recommended that all ductwork for all system types be designed and installed in accordance with recommended industry practice as outlined in Air Conditioning Contractors of America (ACCA) publications or American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) handbooks.

The air distribution system design and installation shall be such that air flow across the indoor coil is as specified in the manufacturer's literature, or for heat pumps is between 350 and 425 cubic feet per minute (CFM) per 12000 BTU/hr output at ARI rating conditions if the manufacturer’s literature is not specific.

Care should be taken in system design so that the external static pressure acting on the system air handler does not become excessive and affect performance, longevity, and/or energy usage. The system shall be designed and installed such that external static pressure does not exceed 0.8” w.c.

Duct design shall meet the following minimum requirements:

### 4.1.1. Building Cavities and Ducts

Unlined building cavities shall not be used as ducts to convey return or supply air.

### 4.1.2. Branch Ducts

Branch out runs shall be a minimum of 6 inches in diameter except to bathrooms.

### 4.1.3. Zonal Pressure Relief

Return pathways shall be provided between axial zones (e.g. bedrooms) and the main body of the dwelling. Return pathways may include pass-through grilles, pressure-relief ducts, return ducts, door undercuts or similar devices. Return pathways should be sufficiently sized to limit pressurization of axial zones to 3 Pa or less when the system is operating at maximum system airflow.

## 4.2. Duct Installation

### 4.2.1. Duct Connections and Support

All new duct joints, plenum drives, metal joints to include all slips and drives shall be mechanically fastened with screws. Flexible ducts shall be attached using nylon/plastic straps tightened with a manufacturer approved tool (hand tightening is not acceptable) or stainless steel worm drive clamps (Panduit® or equal). Mastic and/or tape of any kind shall not be used as mechanical fasteners. Ducts shall be cut to proper length supported in such a manner to prevent air flow constriction.

### 4.2.2. Insulation

4.2.2.1. All rigid metal ducts and plenums outside the heated space shall be insulated to an installed value of at least R-11. A vapor barrier meeting a flame spread rating of 25 or less and smoke developed rating of 50 or less (in accordance with ASTM E-84-88) shall be installed on the outside surface of the insulation.

4.2.2.2. All ducts and plenums that are internally lined with insulation outside the heated space shall be installed in accordance with SMACNA's Duct Liner Application Standard, Second Edition. The total R-value of this duct work shall be no less than R-8.

4.2.2.3. All flexible HVAC ducts outside the heated space shall have an Air Diffusion Council (ADC) certified minimum R-value of R-8.

4.2.2.4. All HVAC ducts routed within exterior wall cavities shall be insulated to a minimum of R-8 between the duct and the exterior wall sheathing.

4.2.2.5. All duct insulation shall be installed and supported using mechanical fasteners such as permanent plastic straps or nylon twine. Tape is not a mechanical fastener and shall not be used as such. Approved tape may be used at insulation seams to provide a continuous vapor barrier.

### 4.2.3. Air Tightness

All HVAC supply and return ducts, air handlers, and plenums inside and outside the heated space shall be sealed at all joints and corners, including prefabricated joints, with approved mastic. UL181A-M or UL181B-M mastic shall be used on rigid metal ducts. UL 181B-M mastic shall be used on flex ducts. It is unnecessary to seal longitudinal seams unless they are damaged. Tape of any kind is not allowed except for use on operable doors in the system such as on the air handler.

## 4.3. System Air Filter

Air filters shall be installed in the return air system in a location that will be easily accessible to the user for filter servicing and in a position where all return air and outside air will pass through the filters before crossing the indoor coil or heat exchanger. Filters should not be installed in crawl spaces or attics without ready access via a door to conditioned space or a pull-down ladder.

# CHAPTER 5. VENTILATION AND AIR QUALITY

## 5.1. Moisture Vapor Transfer:

The following shall be installed to limit moisture transfer:

### 5.1.1. General

A vapor retarder of not more than 1.0 perm shall be installed in, or applied to, exterior walls, ceilings, and floors. It shall be installed according to the manufacturer's specifications, on the warm side (in winter) of all insulation. The retarder shall be considered to be on the warm side if the R‑value of the materials between it and the heated space is not more than 33 percent of the total R-value of the component section at the insulated cavity.

### 5.1.2. Slab Floors

Slab floors shall have a minimum of 4 inches of sub-slab gravel meeting ONE of the following requirements:

1. ASTM Standard C33, "Standard Specifications for Concrete Aggregates," or any successor standards, and shall be size Number 67 or larger size aggregate as listed in Table 2, Grading Requirements for Coarse Aggregates; or,
2. the 1988 Washington State Department of Transportation specifications 9-0.31(3), "Coarse Aggregate for Portland Cement Concrete," or any successor standards, and aggregate size shall be of Grade 5 or larger size aggregate as listed in 9-03.1(c), "Grading;" or,
3. is screened, washed, free of deleterious substances in a manner consistent with ASTM C33, with 100 percent of the gravel passing a 1‑inch sieve and less than 2 percent passing a #4 sieve. Sieve characteristics shall conform to those acceptable under ASTM C33.

### 5.1.3. Crawlspace Ground Cover

In crawlspaces, a ground moisture barrier of 6‑mil black polyethylene, or equal approved by the utility, shall be installed covering the entire ground surface of the crawlspace.

## 5.2. Attic and Crawlspace Ventilation

Outdoor air ventilation shall be provided in the following places, at the following rates:

### 5.2.1. Attics/Ceilings

Adequate cross ventilation shall be maintained above all ceiling insulation by providing both low and high vents. At least 1 ft2 of net‑free vent area shall be provided for every 300 ft2 of ceiling area with 50‑to-60 percent of the vent area located near the roof ridge and 40-to-50 percent located near the eaves. One-level venting may be used if at least 1 ft2 of net-free vent area is provided for every 150 ft2 of ceiling area and adequate cross ventilation can be maintained.

### 5.2.2. Unconditioned Crawlspaces

Unconditioned crawlspaces shall be ventilated by openings in at least two opposing exterior foundation walls with a net-free vent area of not less than 1 ft2 for each 150 ft2 of underfloor area. Where local code allows, this ventilating area may be reduced to 1 ft2 for every 300 ft2 of underfloor area if the crawlspace soil is dry, well drained and a ground cover meeting the provisions of 4.1.3 has been installed. Where allowed by code, mechanical ventilation of 2 ACH or higher is acceptable.

## 

## 5.3. Mechanical Ventilation

Whole-house ventilation systems, which include exhaust‑air fans and outside-air intakes, are required and shall be designed and controlled to provide adequate ventilation for the occupants while minimizing energy penalties.

Whole-house ventilation systems shall use remotely-mounted exhaust fans (i.e. more than 4-feet from the pick-up grille) or surface-mounted fans (i.e. exhaust fan motors within 4-feet of the pick-up grille). Surface-mounted fans shall have a sone rating of 1.5 or less for intermittently-operating systems and 1.0 or less for continuously-operating systems. Both remotely and surface-mounted fans shall be installed to limit the transmission of fan vibrations to the building structure. Intermittently-operating whole-house ventilation fans shall be controlled by 24-hour timers, with a minimum of 2 on‑periods per day, and shall be set to operate for a minimum of 8 hours per day.

The four general system designs are:

1. Integrated Spot and Whole-House Design: This system uses one or more exhaust fans to provide spot and whole-house ventilation. The fan(s) is controlled by both a manual switch, crank timer, or dehumidistat in the bathroom for spot ventilation AND a 24-hour timer to provide whole-house ventilation.
2. Continuous Ventilation: This system uses a continuously-operating fan to exhaust air at a minimum rate of 25 cfm for the kitchen and 20 cfm per bathroom, with a maximum rate of 0.5 ACH.

A fan exhausting air from the kitchen and from each bathroom also provides spot ventilation. An integrated spot and whole-house fan is acceptable if spot ventilation is also provided for the kitchen and for all bathrooms.

1. Discrete Spot and Whole-House Design: This system uses separate exhaust fans and control systems to provide spot and whole-house ventilation.

*Spot Ventilation* is provided by standard bath fans controlled by a manual switch, crank timer or dehumidistat, and a kitchen range hood.

*Whole‑house ventilation* is provided by a fan, controlled by a 24-hour timer that exhausts air from a central hallway near the bedrooms.

1. Forced-Air Heating/Cooling System Integrated Design: In this system, the forced-air heating/cooling system is used to bring outside air into the return-air plenum and distribute it through the supply ducts. Spot ventilation is provided by bathroom and kitchen exhaust fans

A 24-hour timer, controls the heating/cooling system air handler, a motorized damper in the outside-air supply duct, and an exhaust fan to provide ventilation and to reduce building pressurization.

An outside-air supply duct meeting the diameter and length requirements in section 5.3.7.2, is connected to the return-air plenum within 36 inches of the air handler. The outside-airflow is controlled by a balancing damper or constant airflow regulator in the outside-air supply duct to meet the airflow specified in section 5.3.1.

### 5.3.1. Exhaust Air Flow Rates

Exhaust air flow rates shall meet either the following Performance or Prescriptive requirements.

Performance Path: The minimum combined measured airflow capacity for whole-house exhaust systems shall be 0.35 ACH, but not less than 15 cfm per bedroom and 15 cfm for the main living area. The maximum ventilation rate for non-heat recovery ventilation systems shall not exceed 0.5 ACH for houses of 1400 ft2 or larger or 0.65 ACH for houses smaller than 1400 ft2.

Prescriptive Path: Whole-house ventilation systems that do not meet the performance path shall meet the HVI certified fan flow requirements, minimum duct diameters, and maximum duct lengths listed in this section.

TABLE D: Single Family Intermittent Ventilation

|  |  |  |
| --- | --- | --- |
| Number of Bedrooms | Minimum Certified  Fan Flow  at 0.25 in W.G. | Maximum Certified  Fan Flow  at 0.25 in W.G. |
| 2 or less | 50 cfm | 75 cfm |
| 3 | 80 cfm | 120 cfm |
| 4 | 100 cfm | 150 cfm |
| 5 | 120 cfm | 180 cfm |

Fans shall be certified by HVI at 0.25 inches water gauge as determined by HVI 916.

The following table gives the minimum duct diameter, maximum duct length and maximum number of elbows for smooth ducts or 90 degree bends in flexible ducts based upon fan size.

TABLE E: Exhaust-Fan Duct Length vs. Diameter

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | FLEX DUCT | | SMOOTH DUCT | |  |
| FAN TEST  Max CFM  @ .25 W.G. | Flex  Duct  Diameter | Maximum  Length  Feet | Smooth  Duct  Diameter | Maximum  Length  Feet | MAXIMUM  # 90°  Elbows\* |
| 50 | 4" | 25 | 4" | 70 | 3 |
| 50 | 5" | 90 | 5" | 100 | 3 |
| 50 | 6" | No limit | 6" | No limit | 3 |
| 80 | 4" | Not allowed | 4" | 20 | 3 |
| 80 | 5" | 15 | 5" | 100 | 3 |
| 80 | 6" | 90 | 6" | No limit | 3 |
| 100 | 5" | Not allowed | 5" | 50 | 3 |
| 100 | 6" | 45 | 6" | No limit | 3 |
| 125 | 6" | 15 | 6" | No limit | 3 |
| 125 | 7" | 70 | 7" | No limit | 3 |

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**\***Subtract 10-feet from the maximum duct length for each additional elbow

### 5.3.2. Exhaust-Duct Insulation

All exhaust ducts in unheated spaces shall be insulated to at least R-4.

### 5.3.3. Exhaust Duct Termination

Exhaust ducts shall terminate outside the residence in a fitting with an area not less than the area of the duct.

### 5.3.4. Spot Ventilation

Spot ventilation fans, ducted to the outside of the envelope and meet the minimum capacities listed in the following table. The fan shall be certified at 0.25 inches of water gauge as determined by HVI 916 (July 1993). Kitchen range hoods or down-draft range exhaust fans may be rated at 0.1 inches of water gauge.

TABLE F: Spot-Ventilation Fan Capacity

|  |  |
| --- | --- |
| Location | Certified Fan Capacity |
|  |  |
| Each bathroom | 50 cfm |
| Kitchen | 100 cfm |

Exception: Separate spot ventilation is not required for a continuously‑operating system which exhausts 25 cfm from the kitchen and 20 cfm from each bathroom.

### 5.3.5. Backdraft Dampers

A tight-fitting backdraft damper, capable of closing when intermittently-operating fans are not in use, shall be provided in each exhaust duct.

### 5.3.6. Controls

Intermittently-operating, whole-house exhaust fans shall have both automatic and manual controls. Automatic controls shall include a time clock or cycle timers with a minimum of two on-periods per day and be set to provide at least 8 hours of mechanical ventilation per day.

A manual override switch accessible to, and controllable by, occupants allows occupants to run the fan continuously or disable it if desired.

The spot and whole-house ventilation controls may be wired in parallel, allowing the same fan to perform both functions. A whole‑house exhaust fan, for example, may be wired to both the manual spot-ventilation switch in the bathroom and to a time clock.

### 5.3.7. Outside-Air Supply

The outside-air may be supplied by either of the following the requirements:

1. Fresh-Air Inlets: Individual outside-air inlets shall:

be located to avoid drafts,

have a controllable and secure opening,

be sleeved or otherwise designed to prevent compromising the thermal integrity of the wall or window into which it is placed, and

provide a total opening area of at least 4 in2 of net-free area or be HVI certified to provide 10 cfm at 10 Pascals for each bedroom and for each 300 ft2 of combined living area.

2. Central Outside-Air Duct: A central duct providing outside-air directly to the return plenum of a forced-air heating/cooling system which circulates fresh air to the required rooms (used with Forced Air Heating/Cooling System Integrated Design). This duct shall have a motorized damper and a flow-control device to provide a supply airflow equal to the exhaust airflow rates specified in section 4.3.1. Duct diameter and length shall meet the following requirements:

TABLE G: Option 4 Air-Inlet Duct Length vs. Diameter

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Number  Of  Bedrooms | Minimum  Smooth  Duct  Diameter | Minimum  Flex Duct  Diameter | Maximum  Duct  Length 1/ | Maximum  Number  of Elbows 2/ |
| 2 or less | 6" | 7" | 20 ft | 3 |
| 3 | 7" | 8" | 20 ft | 3 |
| 4 or more | 8" | 9" | 20 ft | 3 |

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1/ For lengths over 20-feet, increase the duct diameter by 1-inch.

2/ For more than 3 elbows, increase the duct diameter by 1-inch.

### 5.3.8. Outside-Air Source

The outside-air shall come from outside the building envelope and shall not be taken from the following locations:

within 10-feet of an exhaust vent or combustion appliance flue outlet unless the vent/outlet is at least 3-feet above the air inlet

where it will pick up objectionable odors, fumes, or flammable vapors

a hazardous or unsanitary location

a room or space containing any fuel-burning appliance

within 10-feet of a plumbing vent unless the vent is at least 3-feet above the air inlet

attics, crawlspaces, or garages

The outside-air source shall have adequate protection from entry by rain, insects, leaves, and other objects.

The outside-air source shall limit excessive airflows under normal operation.

### 5.3.9. Outside-Air Distribution

Adequate outside-air distribution shall be provided by individual room inlets, separate duct systems, or a forced-air system.

Where outside-air supplies are separated from the exhaust points, undercut doors, door or wall grilles, transoms grilles, or other approved means shall be provided to allow air circulation between spaces.

## 5.4. Formaldehyde Reduction Measures

All structural panel components of the house such as softwood plywood, particle board, wafer board, and oriented strand board shall be identified as "EXPOSURE 1," "EXTERIOR," or "HUD-Approved."

# CHAPTER 6. LIGHTING AND APPLIANCES

## 6.1. Lighting

All qualified homes shall have a minimum of 90% of all internal and external lighting sockets employing ENERGY STAR compact fluorescent lamps, or ENERGY STAR fixtures, or some combination of ENERGY STAR lamps and ENERGY STAR fixtures.

### 6.1.1. Qualified Products

All energy efficient lighting products installed for the purpose of meeting the requirements of 7.1 shall be listed as ENERGY STAR qualified and labeled. Visit the ENERGY STAR Web site at www.energystar.gov to determine qualified bulbs, lamps, fixtures and ceiling fans.

## 6.2. Appliances

All “built-in” appliances in qualified homes must be listed as ENERGY STAR qualified and labeled. Dishwashers are the only typical built-in appliance within an ENERGY STAR product category. It is recommended that ENERGY STAR labeled products also be considered for any non-built-in appliances provided as part of the new construction process.

### 6.2.1. Qualified Products

All energy efficient appliance products installed for the purpose of meeting the requirements of 7.2 shall be listed as ENERGY STAR qualified and labeled. Visit the ENERGY STAR Web site at www.energystar.gov to determine qualified and labeled appliances.

# APPENDIX

PERFORMANCE TESTING PROTOCOLS

## SECTION 1. BLOWER DOOR AIR LEAKAGE TESTING

**Scope:**

This Appendix describes the blower door test protocol for testing the air-leakage of a single family house.

**When to Test:**

Testing in new construction shall occur after everything is roughed-in/ installed that will penetrate the building envelope (e.g., plumbing, electrical, HVAC, ventilation, combustion appliances, etc.) and the air barrier has been installed.

**House/Residence Preparation:**

Homes shall be checked before testing to assure that following preparation measures have been completed:

* All windows and doors shall be properly closed, including pass-through wood-box doors and pet doors.
* All interior doors shall be left open.
* Water plumbing drains with p-traps that may be empty shall be sealed or filled.
* All exhaust fan openings, vent openings, and intake-air vents with backdraft dampers (e.g., dryer vents and kitchen, bathroom, utility room, whole-house, range vents, etc.) shall NOT be sealed.
* Open dryer exhaust ducts with no dryer installed shall be left un-sealed.
* Exterior vent openings without backdraft dampers that are part of a continuous ventilation system shall be temporarily sealed for the test.
* Heat recovery ventilator supply openings shall be sealed.
* Heat recovery ventilator exhaust openings without backdraft dampers shall not be sealed.
* Supply and return registers shall NOT be sealed and the heating system shall be turned off.
* HVAC ducts shall be tested with the envelope.
* Dampers in the outside-air supply duct into the return plenum shall be left “as-is.”
* All flue dampers, fireplace doors, and wood burning stove doors shall be closed, but NOT sealed.
* Leave any combustion air ducts or louvers to the exterior open. (If a homeowner or builder has sealed them off, open them for the test.).
* Operable crawl-space vents, where present, are to be left in the open position.

**Equipment Set-up:**

Blower door equipment shall be set-up using the procedure described by the instrument manufacturer. It is assumed that most tests will be performed with a digital pressure gauge. If magnahelic gauges are used, special attention must be paid to ensuring gauges are at room temperature and that gauge hysterisis has been reduced or eliminated through proper procedures (described in product literature).

When setting up the reference (outside) pressure measurement location and input (inside) location, make sure the end of each hose is not in the air stream of the blower door. Use of a static pressure tap is recommended.

**Performing the Test:**

Measure the pressure in the house with respect to outside before testing is begun to get the baseline offset. If using the newest digital pressure gauges, this correction may be done automatically. If not using the newest gauge, record the baseline offset before proceeding.

Run the test in depressurization mode. (Make sure the house is at a lower pressure WRT outside when running the test.)

Perform the test using the following procedures:

1. Depressurize the house to about 50 Pascals WRT outside.
2. Look at the blower door fan pressure. If fan pressure is less than 30 Pa, switch to a more restrictive ring.
3. Record fan pressure and flow.
4. Repeat test at 25 Pa.

NOTE: If wind is a problem, use 5 or 10 second gauge averages or even long term averages.

**Error Checking:**

It is highly recommended that the technician check the validity of the test. The quick method to do this, assuming that the higher test pressure (around 50 Pa) is very close to twice the lower test pressure (around 25 Pa), is to confirm that the lower test flow is about 0.6 x the higher test flow. That is, if the CFM50 is about 2000 CFM, the CFM25 is about 1200 CFM. If this relationship does not hold to within 10%, the test should be repeated.

## SECTION 2. COMBUSTION APPLIANCE ZONE PRESSURE TESTING

**Scope:**

This test is required whenever a vented combustion appliance used for primary space or water heating is present within a building. (Decorative wood or gas fireplaces or stoves are not subject to this test.) A **Combustion Appliance Zone (CAZ)** is any zone in the house that contains a combustion appliance. CAZs need not be heated. The test measures the magnitude of any air handler- induced pressure effects within the combustion appliance zone. A zone with a **sealed combustion appliance** that has an isolated combustion path preventing mixing of room air and combustion air **is not** considered a CAZ. Depressurization of a combustion appliance zone by more than 3 Pascals with reference to outside is considered a potential hazard and mitigation should be performed (by adding pressure relief paths or other means). Depressurization of a CAZ by more than 15 Pa is the hazard threshold for induced-draft (power vented) appliances.

A micro manometer is required to perform this test.

**Set Up:**

* Set up the house for normal heating season operation with all exterior doors and windows closed.
* Turn off all exhaust devices including clothes dryer, bathroom fans, kitchen fan, central vacuum, and whole house ventilation systems.
* Open all return and supply registers.
* Turn off combustion devices so that they will not operate during the test (except furnace if air handler will not operate at high speed without the furnace firing).
* Remove furnace filters.
* Shut off any outside ventilation air to the duct system if it can normally be shut off during air handler operation.
* Close manual flue dampers

Step 1:

Identify zone(s) with the combustion appliance(s). These are referred to as combustion appliance zones (CAZs). If furnace and/or water heater are in the garage, the garage is the CAZ. You may need to do a separate test on each zone if you suspect problems.

**Note CAZ tested (usually main body of house or garage).** There may be more than one: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Step 2:

Measure the baseline pressure. Place one end of the measuring tube outside the house, and attach the other end to the reference tap on the pressure gauge. An extra long hose is very handy for this test. Leave the input port open to read pressure inside the CAZ.

**Record the gauge pressure \_\_\_\_\_\_ Pa.** If there is wind, switch to longer-term average reading.

Step 3:

Turn on the air handler at the highest speed setting (either with fan switch or by turning on the heat).

Step 4:

Door set-up. Moving through the home, check the door position for each interior door. Close the door, and measure the pressure of the room with reference to the main body of the house. If the pressure is positive or zero, leave the door closed. If the pressure is negative, leave the door open. Note that this allows observation of the effectiveness of zonal pressure relief (section 5.1.3 of the Standard). When all doors have been set up properly, **record the gauge pressure in the CAZ: \_\_\_\_\_ Pa. This is the air-handler induced pressure.** If the CAZ is in the garage, go on to step 9.

If the reading is equal to or more negative than 3 Pa, there is a potential problem with atmospherically-vented appliances in the CAZ. If appliances are induced draft, a reading of -15 Pa or more negative indicates a potential problem.

Next, do the worst case test (this is optional). This assumes that the CAZ is inside the house. Leave the air handler on. If CAZ is the garage, go to step 10.

Step 5:

Turn on exhaust fans that are in the CAZ.

Step 6:

Turn on fans located behind interior doors that were shut for step # 4.

Step 7:

**Record the gauge pressure in the CAZ: \_\_\_\_ Pa**. This is the WORST CASE DEPRESSURIZATION number.

Step 8:

If worst case reading is equal to or more negative than 5 Pa, there is a potential problem if atmospherically-vented appliances are in the CAZ. If appliances are induced draft, a reading of -15 Pa or more negative indicates a potential problem.

Step 9:

**If the CAZ is the garage, make sure air handler is off before beginning tests.** Take pressure gauge to the garage. Measure garage pressure with respect to outside and **record the pressure\_\_\_\_\_\_ Pa**. Use long-term averaging if needed (windy).

Step 10:

Turn on the air handler and **record the gauge pressure \_\_\_\_\_\_ Pa**.

Step 11:

Any amount of depressurization (more negative number in Step 10 than in Step 9) indicates the potential for drawing garage air into the heating system. Look for return leaks.

Step 12:

Record any mitigation measures considered and/or undertaken.