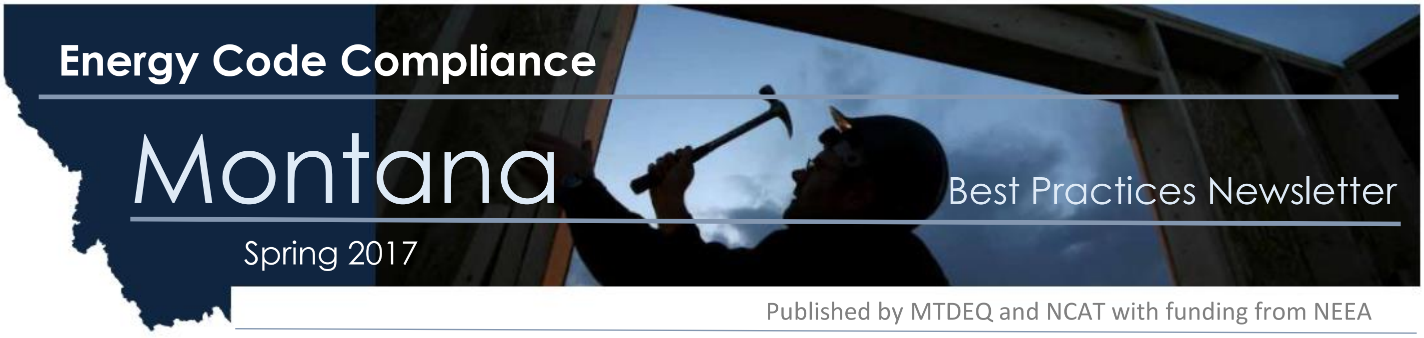

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The Montana Energy Code

The key to realizing the full benefits associated with building energy codes is through compliance. Energy code compliance and verification are performed from different perspectives, but share the same end goal. Architects, designers, engineers, contractors, builders, and other construction-industry stakeholders have a professional responsibility to design and comply with the energy code on behalf of the building owner/developer. Code officials, on the other hand, as well as others who may be involved in compliance verification, must make sure what is built actually complies with the energy code.

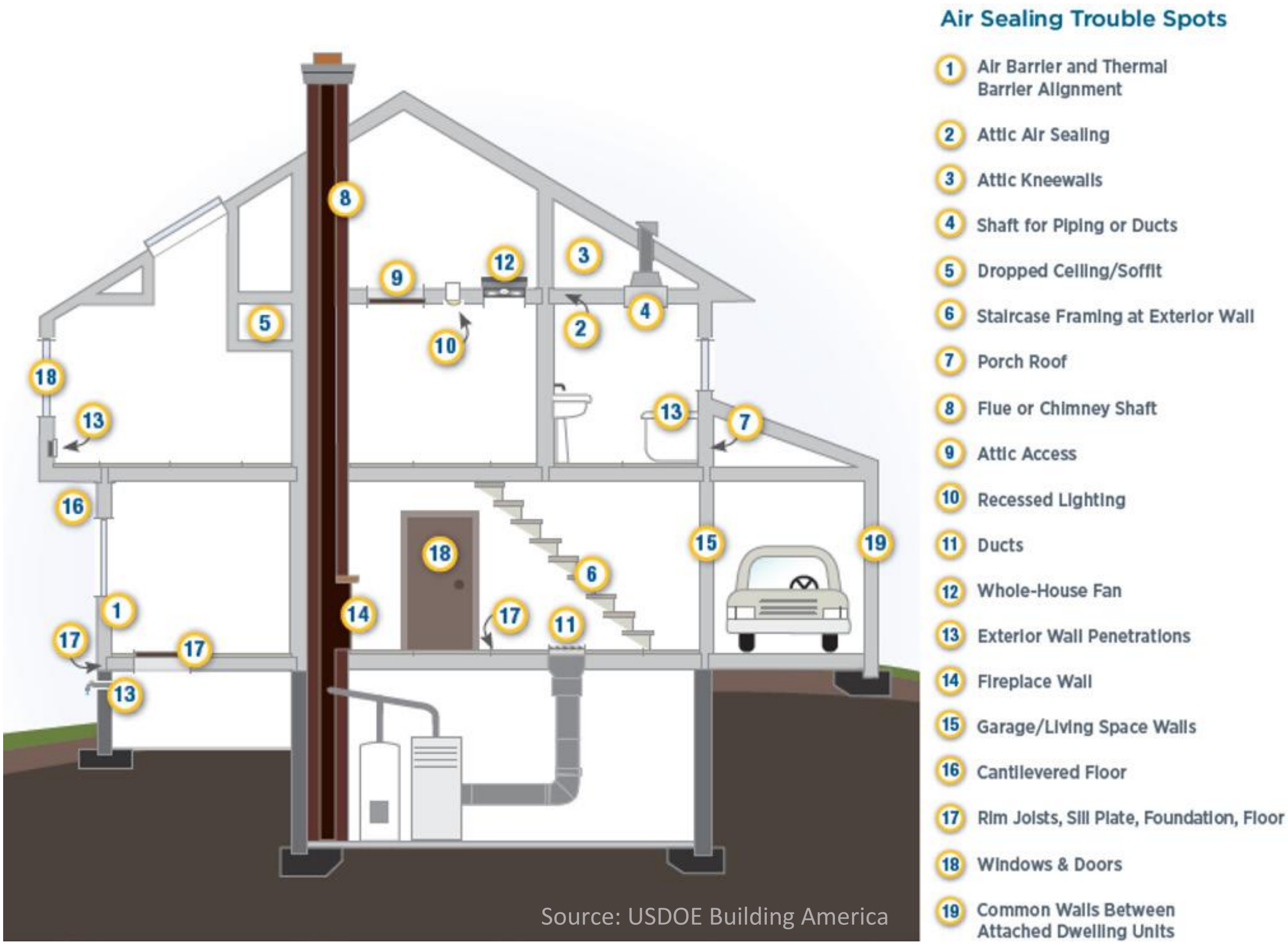
Residential and commercial building owners in the state have a right to expect a minimum level of energy efficiency in the new buildings that they buy. That right is established by Montana law. All commercial and residential buildings built or remodeled are subject to the state energy code. Commercial building energy code compliance is enforced by either a local enforcement jurisdiction or by the state. Residential building compliance is either enforced by local government enforcement jurisdictions or falls under the self-certification program. Montana law requires, as an element of the self-certification program, that the builder provide a signed document to the building owner stating that the house complies with the state energy code.

The energy code also applies to additions, alterations, renovations, and repairs. However, the energy code is not retroactive. Unaltered portions of the original building do not need to comply. A good rule of thumb is that if it is new, then it has to meet the energy code.

This newsletter is intended to assist code officials and the marketplace better understand the energy code and will discuss ways to improve compliance. The newsletter was produced by the National Center for Appropriate Technology (NCAT) and the Montana Department of Environmental Quality with funding from the Northwest Energy Efficiency Alliance.

Building Tightness

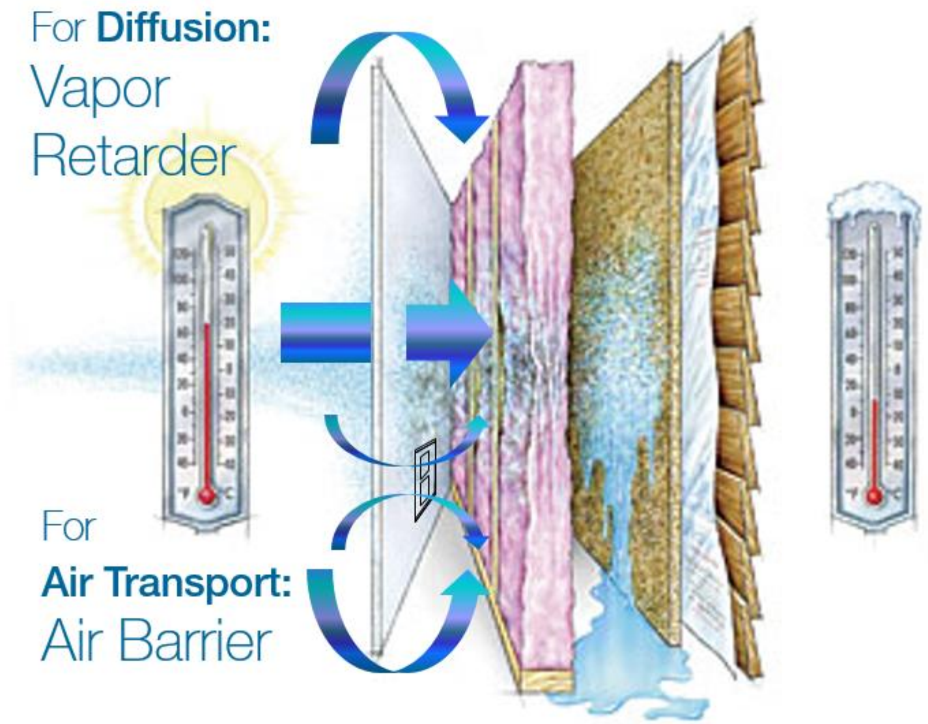
Air-leakage control is an important but commonly misunderstood component of the energy-efficient house. Tightening the structure with caulking and sealants has several positive impacts. A tight house will have lower heating bills due to less heat loss and fewer drafts to decrease comfort. A tight house reduces the chance of mold and rot because moisture is less likely to enter and become trapped in cavities. Tight homes have better-performing ventilation systems and potentially require smaller heating and cooling equipment capacities. Air leakage is sometimes called *infiltration*, which is the unintentional or accidental introduction of outside air into a building. Whenever there is infiltration, there is corresponding exfiltration elsewhere in the building. In the winter, this can result in warm, moist indoor air moving into cold envelope cavities where condensation can occur, resulting in mold or rot. Infiltration is caused by wind, stack effect, and mechanical equipment, such as fans, in the building. The figure below identifies likely points of air infiltration or exfiltration.



Source: USDOE Building America

Air Barriers

The energy code requires that a “continuous air barrier shall be installed in the building envelope.” A Montana amendment to the definition of an air barrier further requires that the air barrier be installed on the warm side of the wall, ceiling, or floor assembly. An air barrier is a material or assembly of materials that reduces air flow through or into the building envelope. While the energy code addresses the installation of air barriers, the International Residential Code (IRC) addresses vapor retarders. A primary purpose of both the air barrier and vapor retarder is to minimize water vapor movement into the building cavities where damage may result. The purpose of a vapor retarder is to minimize the movement of water vapor into building cavities by diffusion through solid materials such as gypsum board. The purpose of an air barrier is to minimize the movement of water vapor into building cavities by air transport. Air transport is many times more significant in the movement of water vapor. Therefore, the air barrier is critical.



A variety of materials make good air barriers. Some of the most common are drywall, plywood, polyethylene sheeting, oriented strand board (OSB) sheathing, and rigid foam insulation. Although air cannot leak through these materials, air can travel through openings and seams. The joints in the air barrier must be sealed with tape, gaskets, foam, or caulk as approved by the manufacturer.

The energy code requires compliance with the air barrier checklist (a so-called *visual inspection*) shown on the following page. The energy code also requires that air barrier effectiveness be tested with a blower door test. Passing a blower door test should help confirm that the air sealing requirements have been met. The energy code requires that the house must pass the test with a result of 4 air changes per hour at 50 Pascal pressure (ACH 50) or less. The blower door test result must be provided to the building code official, who may require that the test be performed by an independent third party. A future newsletter will address building tightness testing in more detail.

It is recommended that builders and designers develop an air-sealing plan. Begin by setting a tightness goal, reviewing the building plans, and identifying potential areas of air leakage. The plan should include the types of materials that will be used to create the air barrier. The code does not identify specific air barrier products but does require that the materials allow for expansion and contraction while also following the manufacturer’s instructions.

To achieve the energy code air tightness requirements, a pre-construction meeting with trades that share responsibility such as the building contractor, framing contractors, insulation contractors, and the person who will conduct the tightness testing. It is also important to perform quality-control inspections, including a blower door test early in the building process. A preliminary blower door test can be performed once windows, doors, and ceiling are installed. The primary purpose of this early test is to identify the location of air leakage sites. A thermal infrared camera can help locate air leaks.

Along with a blower door test, the energy code also requires that a visual inspection(s) be conducted for air barriers and insulation installation. The inspection checklist is shown on the following page.

Mold at the Rim Joist. To the right are two examples of mold behind rim or band joist in a basement and in a crawl space insulated with only fiberglass batts. Water vapor in a house air can travel through the fiberglass batt and, in cold weather, condense on the rim/band joist to cause mold. The purpose of the air barrier and vapor retarder are to prevent this serious problem.


Source: MTDEQ

House Address		City
	Air Barrier and Insulation Installation	
☑ ☒ N/A	**Component**	**Criteria**
☐ ☐ ☐	**Air barrier and thermal barrier**	A continuous air barrier installed in the building envelope. Exterior thermal envelope contains a continuous air barrier. Breaks or joints in the air barrier sealed. Air-permeable insulation not be used as a sealing material.
☐ ☐ ☐	**Ceiling/attic**	The air barrier in any dropped ceiling/soffit aligned with the insulation and any gaps in the air barrier sealed. Access openings, drop-down stair, or knee wall doors to unconditioned attic spaces sealed.
☐ ☐ ☐	**Walls**	Corners and headers insulated and the junction of the foundation and sill plate sealed. The junction of the top plate and top of exterior walls sealed. Exterior thermal envelope insulation for framed walls installed in substantial contact and continuous alignment with the air barrier. Knee walls sealed.
☐ ☐ ☐	**Windows, skylights, and doors**	The space between window/door jambs and framing and skylights and framing sealed.
☐ ☐ ☐	**Rim joists**	Rim joists insulated and include the air barrier.
☐ ☐ ☐	**Floors (above-garage and cantilevered floors)**	Insulation installed to maintain permanent contact with underside of subfloor decking.
☐ ☐ ☐	**Crawl space walls**	Where provided in lieu of floor insulation, insulation permanently attached to the crawlspace walls. Exposed earth in unvented crawl spaces covered with a Class I vapor retarder with overlapping joints taped.
☐ ☐ ☐	**Shafts, penetrations**	Duct shafts, utility penetrations, and flue shafts opening to exterior or unconditioned space sealed.
☐ ☐ ☐	**Narrow cavities**	Batts in narrow cavities shall be cut to fit, or narrow cavities shall be filled by insulation that on installation readily conforms to the available cavity space.
☐ ☐ ☐	**Garage separation**	Air sealing shall be provided between the garage and conditioned spaces.
☐ ☐ ☐	**Recessed lighting**	Recessed light fixtures installed in the building thermal envelope shall be air-tight, IC-rated, and sealed to the drywall.
☐ ☐ ☐	**Plumbing and wiring**	Batt insulation shall be cut neatly to fit around wiring and plumbing in exterior walls, or insulation that on installation readily conforms to available space shall extend behind piping and wiring.
☐ ☐ ☐	**Shower/tub on exterior wall**	Exterior walls adjacent to showers and tubs shall be insulated and the air barrier installed separating them from the showers and tubs.
☐ ☐ ☐	**Electrical/phone box on exterior walls**	The air barrier installed behind electrical or communication boxes or air sealed boxes installed.
☐ ☐ ☐	**HVAC register boots**	HVAC register boots that penetrate building thermal envelope sealed to the subfloor or drywall.
☐ ☐ ☐	**Fireplace**	An air barrier installed on fireplace walls. Fireplaces have gasketed doors.

Mold in Walls. Both photos show mold behind unsealed electrical boxes. The energy code Air Barrier and Insulation Installation Table details code-required air barrier practices that would have prevented this problem from occurring. Because localized air leakage problems can occur, both the Air Barrier and Insulation Installation Table and building tightness testing is required by the energy code.

Source: MTDEQ

Q & A - Air Barriers

Q. What materials make good air barriers?

A. Most air barriers are an assembly or system of several materials. Sheet polyethylene and gypsum board are the most common elements of most air barriers. A gypsum board-based air-barrier system requires no polyethylene. Polyethylene is classified as a Class I vapor retarder and will prevent a wall from drying. A wide variety of materials can make up an air-barrier system, including wood, poured concrete, glass, some rigid foam insulations, some spray foams, plywood, and peel-and-stick rubber membrane. Although air can't leak through these materials, it can leak at penetrations, edges, and seams. When these materials are used to form an air barrier, additional materials such as tape, gaskets, or caulk are required to complete a code-compliant air barrier. To make a good air barrier, a material not only must stop air flow, but it also must be durable.

Q. If house wrap has been installed under the house siding, is that a code-compliant air barrier?

A. No. The primary purpose of house wraps is to provide a water-resistant barrier to protect against moisture that penetrates the siding or cladding. In other words, house wraps protect the wall sheathing from wind-driven rain that gets past the siding. The Montana energy code requires that an air barrier be installed on the warm side of the wall, not under the siding on the wall's exterior. There are certainly benefits from installing a house wrap, but a house wrap does not meet code requirements for an air barrier.

Q. If a house has sheet polyethylene installed under the drywall, is the polyethylene an air barrier?

A. That depends. The sheet polyethylene would have to be sealed at all edges, seams, and penetrations to fulfill the code requirements for a continuous air barrier. To act as an effective air barrier, however, polyethylene needs to be installed with careful attention to a long list of details, including the use of non-hardening sealant at all seams and the use of airtight electrical boxes.

Q. Where are the most common air barrier defects located?

A. Most air leaks occur at the joints between different materials: for example, where floors meet walls and where walls meet ceilings. Although gaps around windows and doors occasionally contribute to air leakage, the most significant air leaks are usually in hidden areas. Here's a list of some of areas that are often poorly sealed, and therefore responsible for significant air leakage:

- Basement rim joist areas
- Cracks between finish flooring and baseboards
- Utility chases that hide pipes or ducts
- Plumbing vent pipe penetrations
- Kitchen soffits above wall cabinets
- Fireplace surrounds
- Recessed can light penetrations
- Cracks between ceiling-mounted duct boots and ceiling drywall
- Poorly weather-stripped attic access hatches
- Cracks between partition top plates and drywall

Q. What's the best way to identify air leaks in the air barrier?

A. Tracking down air leaks can be a challenge, especially for builders not familiar with tight building practices. The best way to test the integrity of a home's air barrier is to perform a blower door test. While the blower door fan is exhausting air from the house, an infrared camera, infrared thermometer, or smoke stick is used to find air leaks. It surprises many builder that significant air leakage paths can occur through interior partitions located far from exterior walls.

Plan Review Pointers - Air Barriers

1. Verify that submitted construction documents identify location (warm side of wall) and details of continuous air barrier installation, including specification of how joints in materials will be sealed. The code required air barrier installation details are included in Table R402.4.1.1 *Air Barrier and Insulation Installation*.
2. Verify that the construction documents specify a tested envelope tightness of 4 ACH50 or tighter.

Field Inspection Pointers - Air Barriers

1. Verify installation of continuous air barrier in accordance with Table R402.4.1.1 *Air Barrier and Insulation Installation*.
2. Verify that all joints and penetrations in the air barrier are sealed.
3. Verify that all air barrier materials are installed per manufacturer's instructions.
4. Verify that the building envelope has been tested by an approved entity to a tightness of 4 ACH50 or tighter.

Vapor Retarders

As noted earlier, both vapor retarders and air barriers are intended to reduce the penetration of water vapor into the walls. Vapor retarders are materials used to slow or reduce the movement of water vapor through a material or building assembly by diffusion. The IRC R702.7 requires that a Class I or II vapor retarder be installed in our climate on the interior side of exterior walls. Exceptions for the vapor retarder requirement include a basement wall or any portion of wall below grade and walls not affected by freezing moisture. The vapor retarder class is based on the manufacturer's certified testing or a tested assembly. The following are some materials that meet the class specified:

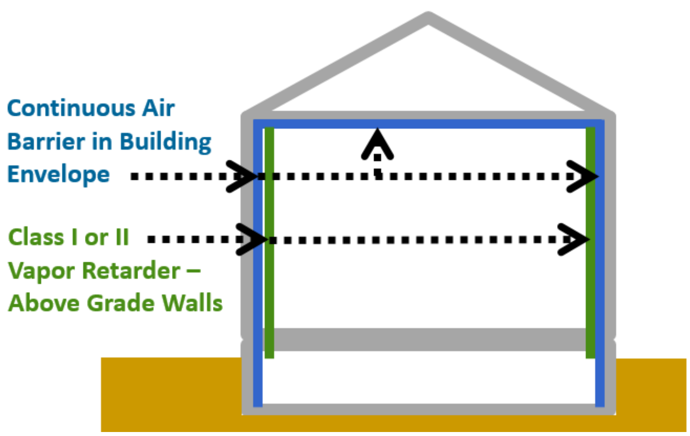
- Class 1: ≤ 0.1 perm. Examples are sheet polyethylene and aluminum foil.
- Class II: > 0.1 perm but ≤ 1.0 perm. Examples are Kraft-faced fiberglass batts and low-perm paint.
- Class III: > 1.0 perm but ≤ 10 perm. Examples are latex or enamel paint.

Class III vapor retarders are allowed with vented cladding (i.e., vinyl siding) over fiberboard or gypsum wall sheathing. A Class III vapor retarder is also allowed on a 2X6 stud wall that is constructed with at least R-11.25 continuous exterior insulation sheathing.

IRC Section R806.5 includes provisions addressing vapor retarders in unvented attic assemblies. In general, it requires that assemblies with air impermeable insulation shall not have a Class 1 vapor retarder and shall have a Class II or Class III vapor retarder in direct contact with the underside of the insulation.

Vapor Retarders and Insulated Basements Below-grade basement walls differ from above-grade walls in that they are vulnerable to ground moisture wicking into the wall or basement floor. Because of this, it is important to maintain the drying potential of the wall, since one never knows if the long-term moisture drive will be from the outside or the inside.

Vapor Retarder and Air Barrier Code Summary



Air sealing and the resulting tighter house can lead to air-quality concerns due to lack of fresh air flow entering the house. Contaminants from household chemicals and elevated moisture levels can build up, creating health concerns. Tighter buildings also increase the risk of backdrafting of unsealed combustion appliances, such as conventional gas furnaces, water heaters, fireplaces, and wood stovse. Montana code requires a minimum level of ventilation, depending on the house size and number of bedrooms. Options range from an upgraded bath fan to heat-recovery ventilation systems. Mechanical ventilation will be discussed in more detail in a future newsletter.

For questions, suggestions, or to be removed from the newsletter distribution list email daleh@ncat.org.