

# Differences Between Rigid and Flexible Air Barriers



CE 110 and 112 relate to the air leakage/air barrier section and the list of materials that are deemed to comply as an air barrier. CE 110 & CE 112 propose to remove the words “fully adhered” from item number 11, meaning that ANY single ply membrane would be deemed to comply as an air barrier.

The reason we oppose this change is relatively simple: 1. All of the other materials in the list are rigid. 2. Item #11 (as it is currently written) is rigid. 3. When you remove the words “fully adhered” it means that the deemed to comply single ply roofing system CAN be able to be installed in a way that CHANGES it from rigid to flexible. And a flexible air barrier is very different than a rigid air barrier.

#### 2015 International Energy Conservation Code

##### Revise as follows:

**C402.5.1.2.1 Materials.** Materials with an air permeability not greater than 0.004 cfm/ft<sup>2</sup> (0.02 L/s • m<sup>2</sup>) under a pressure differential of 0.3 inch water gauge (75 Pa) when tested in accordance with ASTM E 2178 shall comply with this section. Materials in Items 1 through 16 shall be deemed to comply with this section, provided joints are sealed and materials are installed as air barriers in accordance with the manufacturer's instructions.

1. Plywood with a thickness of not less than  $\frac{3}{8}$  inch (10 mm).
2. Oriented strand board having a thickness of not less than  $\frac{3}{8}$  inch (10 mm).
3. Extruded polystyrene insulation board having a thickness of not less than  $\frac{1}{2}$  inch (12.7 mm).
4. Foil-back polyisocyanurate insulation board having a thickness of not less than  $\frac{1}{2}$  inch (12.7 mm).
5. Closed-cell spray foam a minimum density of 1.5 pcf (2.4 kg/m<sup>3</sup>) having a thickness of not less than  $1\frac{1}{2}$  inches (38 mm).
6. Open-cell spray foam with a density between 0.4 and 1.5 pcf (0.6 and 2.4 kg/m<sup>3</sup>) and having a thickness of not less than 4.5 inches (113 mm).
7. Exterior or interior gypsum board having a thickness of not less than  $\frac{1}{2}$  inch (12.7 mm).
8. Cement board having a thickness of not less than  $\frac{1}{2}$  inch (12.7 mm).
9. Built-up roofing membrane.
10. Modified bituminous roof membrane.
11. Fully adhered single-ply roof membrane.
12. A Portland cement/sand parge, or gypsum plaster having a thickness of not less than  $\frac{5}{8}$  inch (15.9 mm).
13. Cast-in-place and precast concrete.
14. Fully grouted concrete block masonry.
15. Sheet steel or aluminum.
16. Solid or hollow masonry constructed of clay or shale masonry units.

# Installation Method

Determines

**RIGID**

**Flexible**

When you install a single-ply roofing system, the method of installation determines whether it is rigid or flexible.

Both a flexible and a rigid air barrier prevent air leakage (air infiltrating through the building envelope) but only a rigid air barrier prevents air intrusion (air going through the thermal envelope and into the roofing assembly).

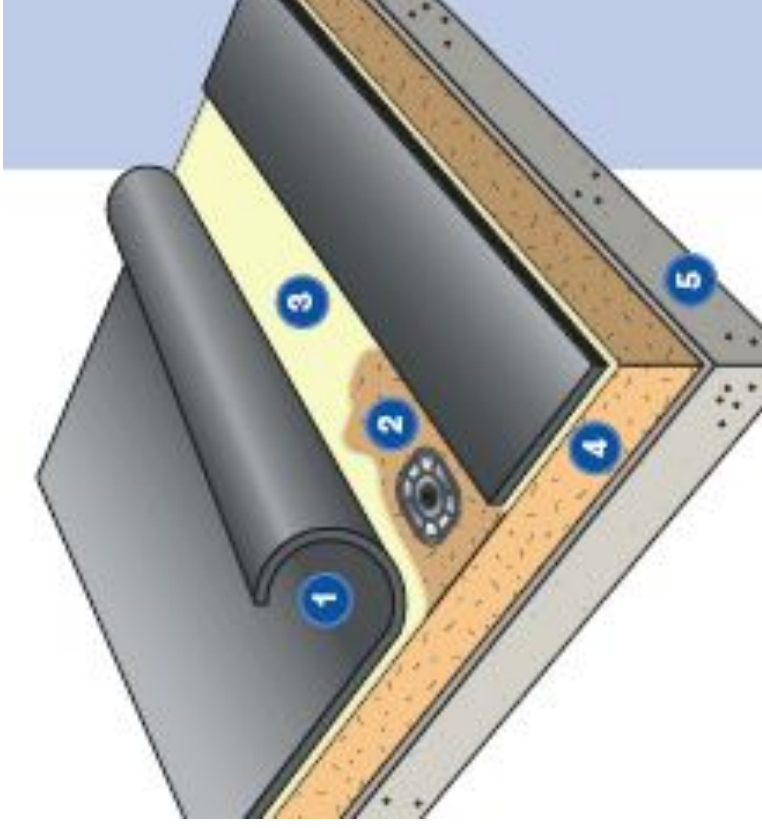
# Fully Adhered Single-Ply

## RIGID

### Typical Installation

#### Components

1. EPDM/Thermoplastic Membrane
2. Insulation Fastener and Plate
3. Bonding Adhesive
4. High "R" Value Insulation
5. Deck

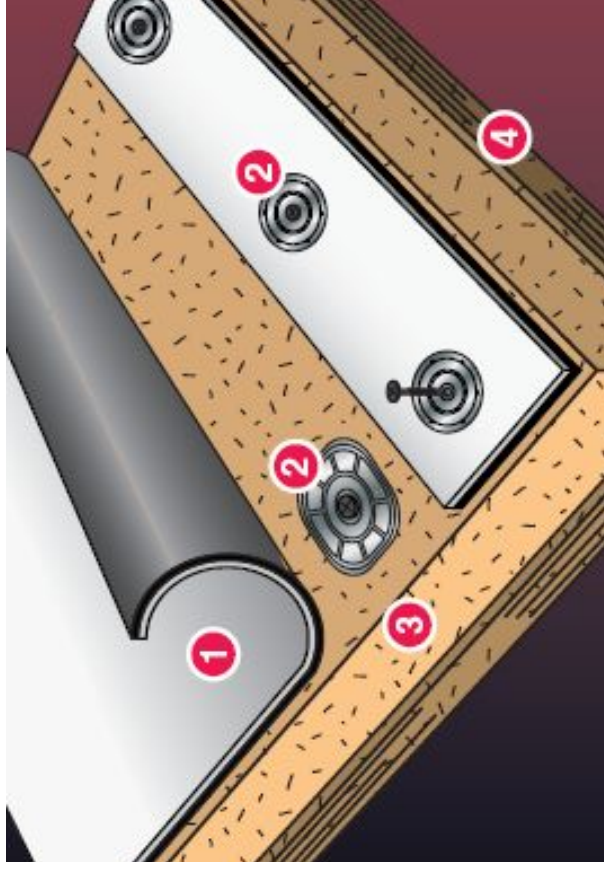


This is a fully adhered single ply roofing system. It functions as a rigid air barrier. Note that there are no gaps in contact between the membrane and the rest of the assembly.

# Mechanically Fastened FLEXIBLE

## Typical Installation Components

1. EPDM/Thermoplastic Membrane
2. Insulation Fastener and Plate
3. High "R" Value Insulation
4. Deck

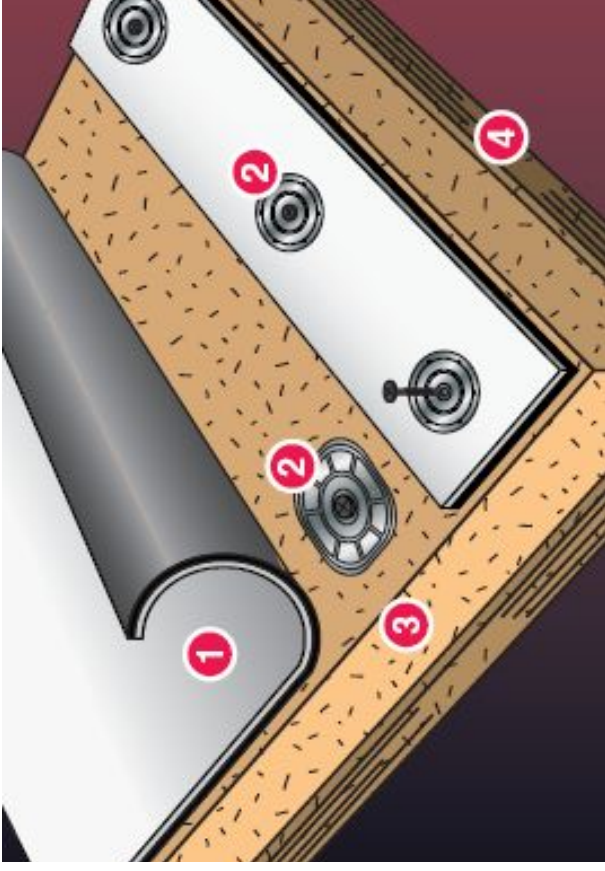


Leaving a space between each seam where the membrane is not secured to the insulation means that it is flexible. In other words, no matter how skillfully those seams are secured, there will always be flexibility of the membrane between the seams because the membrane is not secured at all points of contact.

# Mechanically Fastened FLEXIBLE

## Typical Installation Components

1. EPDM/Thermoplastic Membrane
2. Insulation Fastener and Plate
3. High “R” Value Insulation
4. Deck



This flexible air barrier allows air to intrude ABOVE the deck and into the roofing assembly. It is for this reason, this air intrusion above the deck and the resulting negative impact on the energy efficiency of the building, that we oppose CE 110 and 112.

A flexible air barrier can cause energy loss. By removing the words fully adhered you will permit a flexible air barrier to be installed and give the misimpression that the method of installation is irrelevant to energy efficiency.

# Mechanically Fastened Single-Ply Animation

The animation can be found below this presentation on the ERA website.

This animation demonstrates what fluttering or billowing membrane could look like on a mechanically attached single ply roofing system. Because there is a space between the rows of fasteners where the membrane is not secured, it creates a vacuum of sorts which causes AIR INTRUSTION.

Warm air is pulled into the assembly, cools, and then falls down again.

# Mechanically Fastened Single-Ply In Field Video

The video can be found below this presentation on the ERA website.

This video shows the billowing or fluttering associated with a mechanically attached single ply roofing system which makes the air barrier flexible. You can clearly see the billowing and fluttering of the membrane.

This portion of the video shows a fully adhered single ply roofing system and you see that there is no billowing of the membrane. Once again, the method of installation makes it rigid.



# Research

1. Baskaran & Molletti, National Research Council of Canada, Interface, November 2009
2. Wagdy Anis, AIA, SBRA Boston, RCI 18<sup>th</sup> Int'l. Convention, March 2003
3. Pallin, Kehrer, & Desjarlais, Oak Ridge National Laboratory, Symposium on Building Envelope Technology, October 2014

## Air Intrusion

“In mechanically attached roofing systems, the problem ... is one of air intrusion into the roof assembly.”

- Baskaran & Molletti, National Research Council of Canada, Interface, November 2009

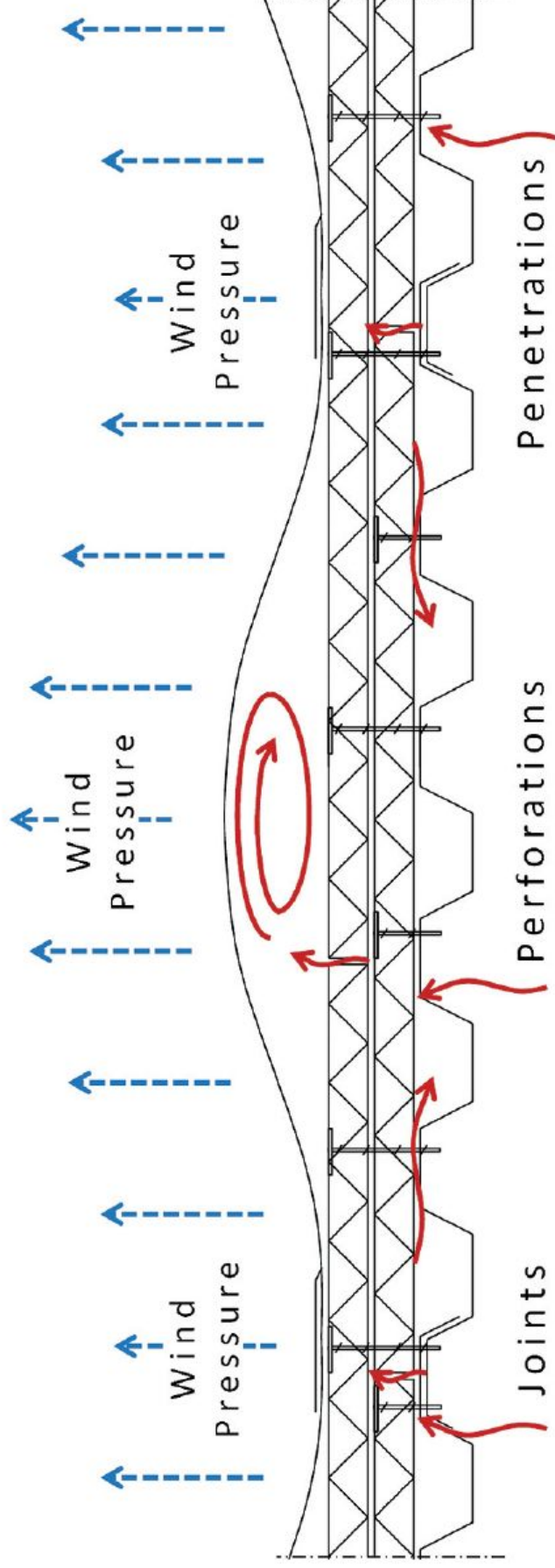
## Does Not Perform

“Mechanically fastened systems ... do not perform the required function of containing air without displacement. In those cases, another air barrier must be selected in the system.”

-Wagdy Anis, AIA, SBRA Boston, RCI 18<sup>th</sup> Int'l. Convention, March 2003

# Energy Penalty Associated with Mechanically Attached Systems

Study done by Oak Ridge National Laboratories



**3% -8% energy penalty for mechanically attached systems**

This is a cross section of what is happening in the video you just saw. Basically wind creates pressure differences on the roof which causes the membrane to flutter or balloon. Air intrusion may occur in overlapping joints of the deck, penetrations, or perforations.

ORNL studied this very issue, and found that there is a 3-8% energy penalty for mechanically fastened systems because of air intrusion – because warm air is pulled into the assembly, cools, and then falls again and has to be re-heated.

## Conclusions

- Fully adhered single-ply and other 12 items in the materials are rigid and meet the intent and ASTM E 2178 test as an air barrier in ASHRAE 5.4.3.1.3.
- Mechanically attached Single-ply membranes are flexible do not meet the intent for an air barrier.
- Air intrusion causes a reduction in the R-value.
- Air intrusion causes condensation.

# Conclusions

- Further study to distinguish between rigid and flexible air barriers is required; and
- Delay further action until further research can be done and ASHRAE can re-write the air leakage section.
- There was a reason that single ply was specified for the type of the assembly; by deleting the words “fully adhered” you are introducing a flexible item into a list of 12 rigid items, and that should give you pause.

The End

