# Appendix A[23] – The "Pen Test"

## PURPOSE

By tracing the continuity of all the materials for each control function, the "pen test" checks the completeness of:

- Rainwater protection.
- The insulation layer.
- The air barrier.

To verify continuity, create sections in which each of these moisture-control elements is traced in a different color to show that the design specifically accounts for them. Contractors can then easily check the sections against their experience with materials, trades and sequencing. The sections will also provide maintenance workers in buildings and grounds with information useful in ordinary maintenance work or in the event of a problem during building use.

## PROCESS

### Rainwater Protection Continuity

To demonstrate complete rainwater protection using the section drawing, place a pen on a material that forms a capillary break between the rain-control materials that get wet and the inner portion of the enclosure that must stay dry. Without lifting the pen off the paper, trace from the center of the roof around the walls, windows, and doors and along the foundation to the center of the foundation floor.

Figure A-1 serves as documentation of rainwater protection continuity. The following describes the traceable capillary break in a sample section. Starting at the center of the roof:

- The roofing membrane is the first line of defense, protecting the water-sensitive inner materials from rain and snowmelt.
- Tracing the roofing membrane from the center of the roof to the edge of the roof, the roofing membrane rises up the parapet wall where it flashes beneath a metal coping, which also forms a metal fascia.
- The fascia forms a drip edge, channeling water away from the cladding.
- An air gap between the drip edge and the brick veneer forms a capillary break, protecting the materials beneath the coping from rainwater.
- Behind the brick veneer, air gap and foam board, a self-adhering water resistant barrier (WRB) applied to the gypsum sheathing forms a capillary break between the damp brick and the inner wall assembly.
- The WRB laps over the vertical leg of a head flashing, protecting the window from rainwater with a drip edge and an air gap. Weep holes allow water to drain from behind the brick cladding.
- The window frame, sash and glazing form a capillary break system that sits in a pan sill flashing at the bottom of the window.
- The pan sill flashing forms a capillary break protecting the wall beneath from seepage through the window system.
- The pan sill flashing shingles over the WRB in the wall beneath, which shingles over a flashing that protects the bottom of the wall system.
- The water-resistant barrier shingles over a flashing that protects the bottom of the wall system where the foam sill seal makes a capillary break between the foundation and the bottom of the framed wall, connecting with:
  - One inch of extruded styrene foam insulation making a capillary break between the top of the foundation wall and the edge of the floor slab.
  - Polyethylene film immediately beneath the slab forms a capillary break between the bottom of the slab and the fill below. NOTE: If the bed of fill beneath the slab consists of pebbles greater than ¼ inch in diameter and contains no fines, then it forms a capillary break between the soil and the slab.

Apply the same procedure to the insulation layer (Figure A-2) and the air barrier (Figure A-3).

[23] Figures A-1, A-2, and A-3 were updated in April, 2014.

**Figure A-1 The Blue Line Traces the Elements of the Capillary Break in the Rainwater Control System for a Section Through a Building**

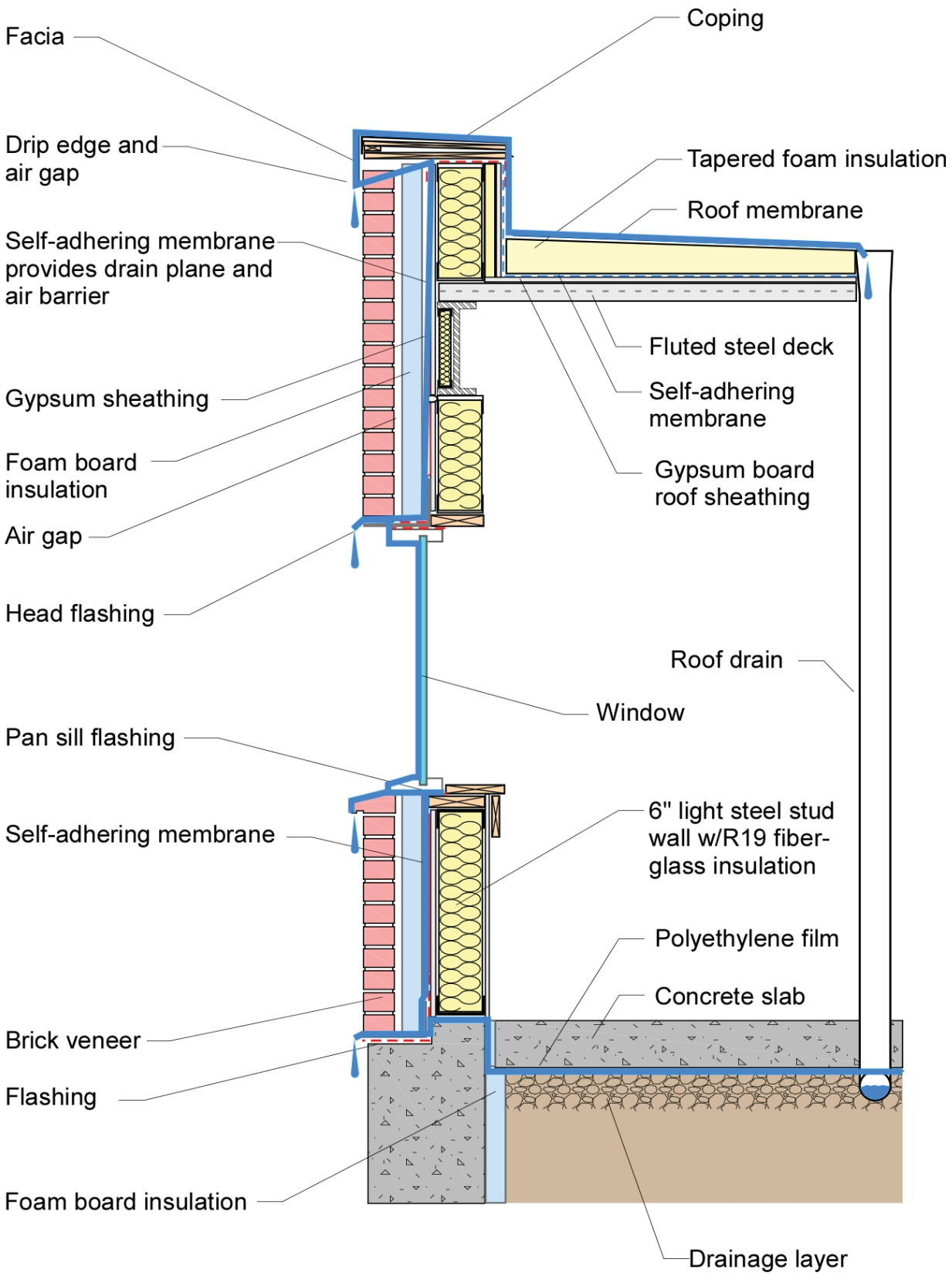


**Figure A-2 The Red Line Traces Continuity of the Insulation Layer**

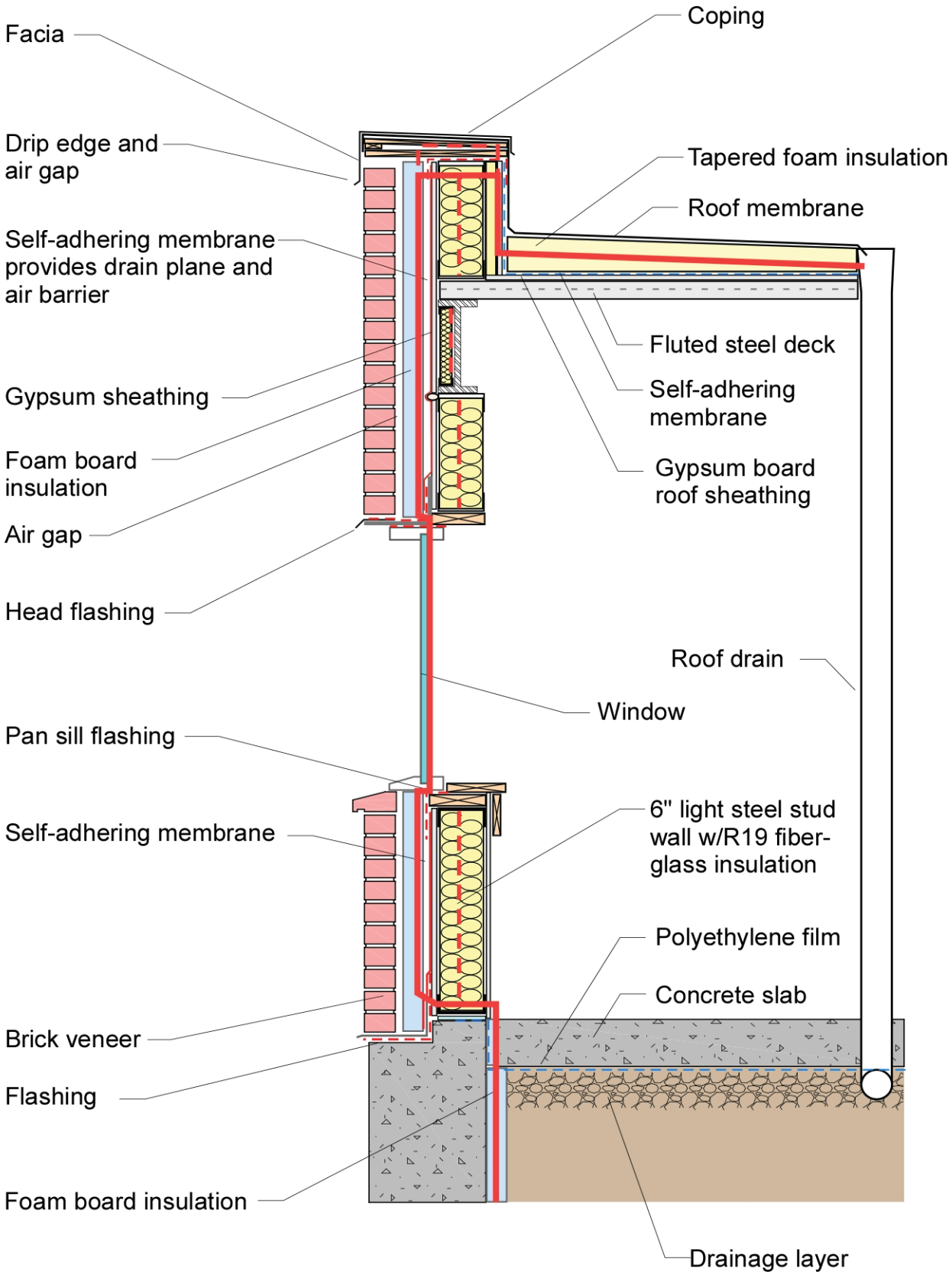
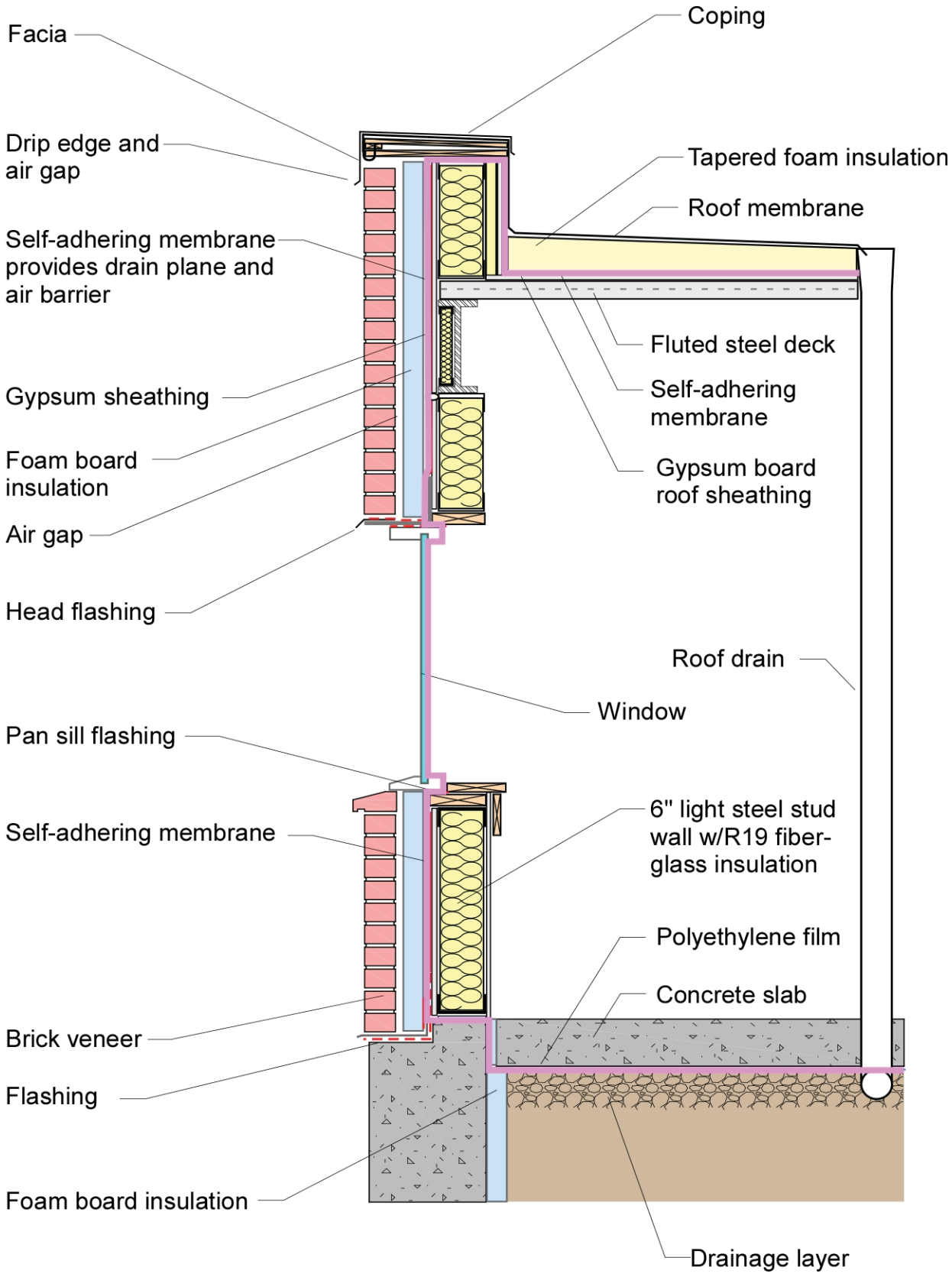


**Figure A-3 The Purple Line Traces the Air Barrier Components**



### Insulation Layer Continuity

To demonstrate a continuous layer of insulating material around a section, place the pen tip on the insulating layer in the center of the roof and trace from one insulating material to the next around to either the bottom of the foundation wall or the center of the foundation floor.

Figure A-2 shows the continuity of thermal insulation in a sample section.

- Beginning at the center of the roof, trace through foam insulation to the edge of the roof.
- Up a layer of foam board insulation to the wooden blocking at the top of the parapet wall.
- The wooden blocking connects to the top of the exterior foam insulation board insulation and the top channel of the light guage steel wall framing.
- The steel wall framing is filled with cavity insulation, and the thermal bridge through the steel is insulated by the exterior foam insulation.
- At the window head the steel lintel is a thermal bridge through the insulation system, the rough opening around the window is sealed using backer rod and sealant.
- The window jamb, sash and glazing system provide insulation continuity to the pan sill flashing at the bottom of the window.
- The exterior insulating foam sheathing and cavity insulation carry the insulation layer to the foundation.
- Foam sill seal provides thermal insulation between the bottom of the wall and the concrete foundation, which carries thermal protection below grade to the bottom of the foundation wall.
- Vertical foam insulation applied to the interior of the foundation wall completes the insulation layer.

### Air Barrier Continuity

Continuity of the air barrier is demonstrated using the same method used for rainwater control and the insulation layer. For this example air barrier materials and the sealants used to connect them are identified from the center of the roof to the center of the foundation floor. Self-adhering membranes are used as examples in this section, but note that wall air barriers may be formed using alternate air barrier materials (e.g., fluid applied membranes, flexible sheets, rigid foam board insulation, and spray polyurethane foam).

- From the center of the roof trace the air along the self-adhering membrane on the gypsum roof sheathing to the edge of the roof.
- The self-adhering membrane continues up the gypsum board sheathing on the parapet wall where it connects to a transition membrane that spans the top of the parapet wall.
- From the transition membrane trace down the self-adhering membrane on the wall sheathing to an intersection with the window head flashing at the steel lintel.
- A transition membrane wraps from the bottom of the steel lintel into the rough opening where it connects to the window by sealant and backer rod.
- The window system forms the air barrier to the pan sill flashing where sealant makes the connection.
- The pan sill flashing carries the air barrier to the self-adhering membrane on the lower wall.
- A transition membrane connects to the concrete foundation.
- Polyethylene film or the concrete slab itself extend the air barrier to the center of the floor.