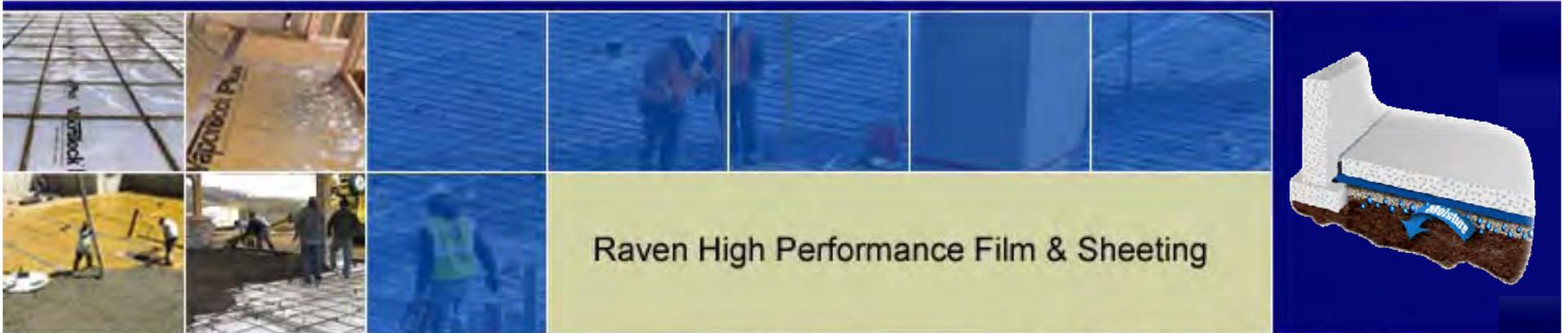


CRITICAL ELEMENTS IN SPECIFYING UNDERSLAB MOISTURE & GAS BARRIERS



www.ravenefd.com

Definitions



- **What is an Underslab Vapor Barrier?**

- A Vapor Barrier is an Impermeable Membrane Designed to Prevent Moisture from Migrating From the Soil up Through Concrete Slabs in Commercial Buildings and Homes
- High Quality Vapor Barriers Must be Very Resilient with High Puncture Resistance and Very Low Moisture Permeance

- **What is an Underslab Gas Barrier?**

- A Gas Barrier is an Impermeable Membrane Designed to Prevent Soil Gases Such as Radon, Methane and Volatile Organic Compounds (VOCs) From Migrating From the Soil Through the Concrete in Commercial Buildings and Homes (Also Blocks Moisture Migration)
- High Quality Gas/Moisture Barriers Need to be Very Resilient. They Contain Multiple Layers that Incorporate Specific Resins Designed to Resist Deadly Soil Gases and Moisture.



Why Specify High Performance Underslab MOISTURE Barriers?

Underslab Moisture Barriers are Designed to Greatly Minimize:

- De-bonding & Blistering of Coatings
- Breakdown of Floor Covering Adhesives
- Moisture Contribution to Microbial Growth, Mildew and Offensive Odors
- Buckling of Wood Flooring and Carpets
- High Humidity Levels in Buildings
- Condensation on Slab Surfaces





How Are Moisture Barriers Classified by ASTM?

- **ASTM E 1745-09** Defines Three Performance Classifications Depending Upon Building Requirements and Installation Demands, **Class A, B & C**
- **Class “A”** Minimums Help to Qualify a Resilient and Effective Underslab Retarder / Barrier For Those “Highly Demanding Installations & Performance Expectations”
- **Class “B” & “C”** Rated Products are Intended for Less Demanding Applications

| Property | Test Method | Class “A” | Class “B” | Class “C” |
|------------------------------|---------------------------|---------------------|-------------------|---------------------|
| Water Vapor Permeance | ASTM E 154 or ASTM F 1249 | 0.1 Perms | 0.1 Perms | 0.1 Perms |
| Tensile Strength | ASTM E 154 | 45.0 lbf/in. | 30 lbf/in. | 13.6 lbf/in. |
| Puncture Resistance | ASTM D 1709 | 2200 g | 1700 g | 475 g |
| Performance Level | | Best | Better | Good |

Cited References:

- ASTM E 154-08 Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover
- ASTM F 1249-06 Standard Test Method for Water Vapor Transmission Rate Through Plastic Film and Sheeting Using a Modulated Infrared Sensor
- ASTM E 96/E 96M-05 Standard Test Method for Water Vapor Transmission of Materials
- ASTM D 1709-04 Standard Test Methods for Impact Resistance of Plastic Film by the Free-Falling Dart Method
- ASTM E 1745-09 Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs



Critical Properties in Specifying Underslab **MOISTURE** Barriers

- **Vapor Barriers Must Conform to Minimum Puncture Resistance Requirements of ASTM E 1745.**

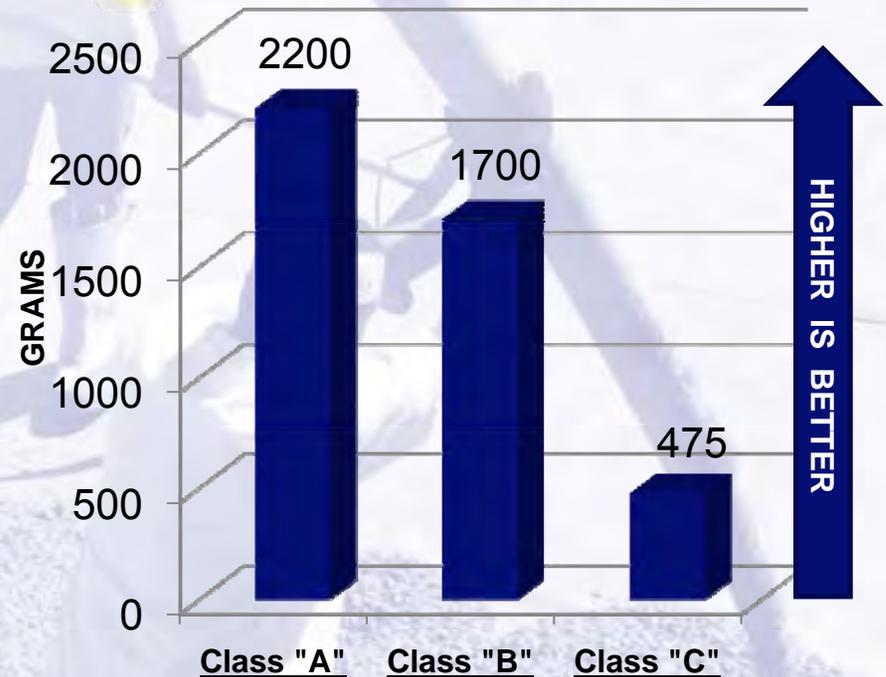
- The Higher the Impact Resistance the Fewer Holes Caused by Installation Stress
- Impact Resistance is More Critical Than the Barrier Thickness
- An 1/8" Diameter Hole in the Barrier Can Transmit 1.3 lbs or 20 oz. of Water Over a 1,000 sq. ft. Area in Just 24 hours!

- **Class "A" Barriers are Available with 4000 Grams of Puncture Resistance for Added Protection**

- Why Risk Installation Damage!



ASTM E 1745 Minimum Puncture Requirements

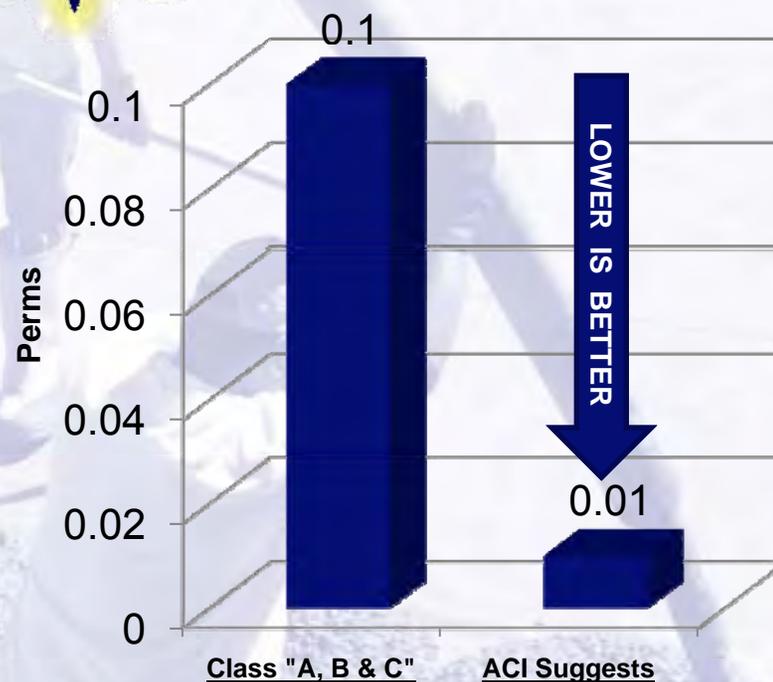


Critical Properties in Specifying Underslab MOISTURE Barriers

- **At a Minimum, Vapor Barriers Must Conform to the Permeance Requirements of ASTM E 1745**
 - ASTM E 1745 Lowered the Accepted Permeance From .3 Perm to .1 Perm
- **When Specifying Vapor Barriers Used in Buildings Requiring Moisture Sensitive Floor Covering Consider:**
 - It Should be Determined if a Vapor Barrier with a Perm Rating of 0.1 will Provide Sufficient Protection.
 - ACI 302.2R-06 Report Claims Low Permeance Flooring Materials Will Benefit From the Use of a Material with a Maximum Perm Rating of 0.01 or less but does NOT REQUIRE IT!

PERMEANCE

ASTM E 1745 Maximum Permeance Requirements



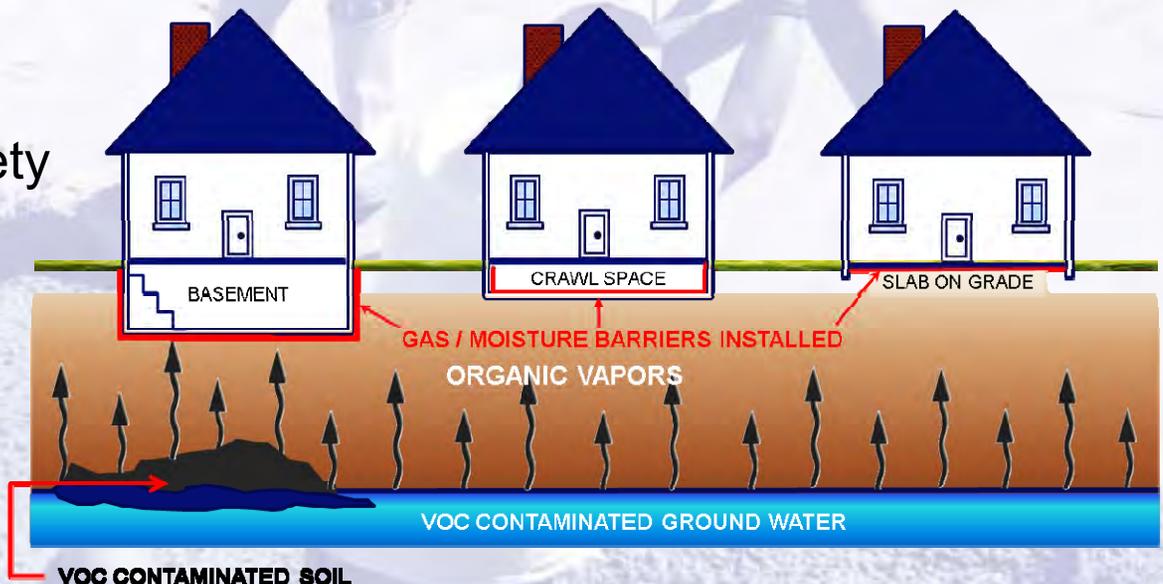
Cited References:

- ASTM E 1745-09 Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs
- ACI 302.2R-06 "Guide for Concrete Slabs that Receive Moisture-Sensitive Flooring Materials"

Why Specify High Performance Underslab **GAS** Barriers?

Underslab Gas Barriers are Designed to:

- Prevent Gas Vapors From Migrating into a Structure as Part of an Active or Passive Ventilation System
- Safely Build on Remediated Brownfield Sites, Methane & Radon Zones
- Minimize Mold Exposure Caused by Chronic Moisture Problems
- Enhance Building Safety
- Maintain Compliance with Standards
- Ensure Human Health
- Limit Future Liability!





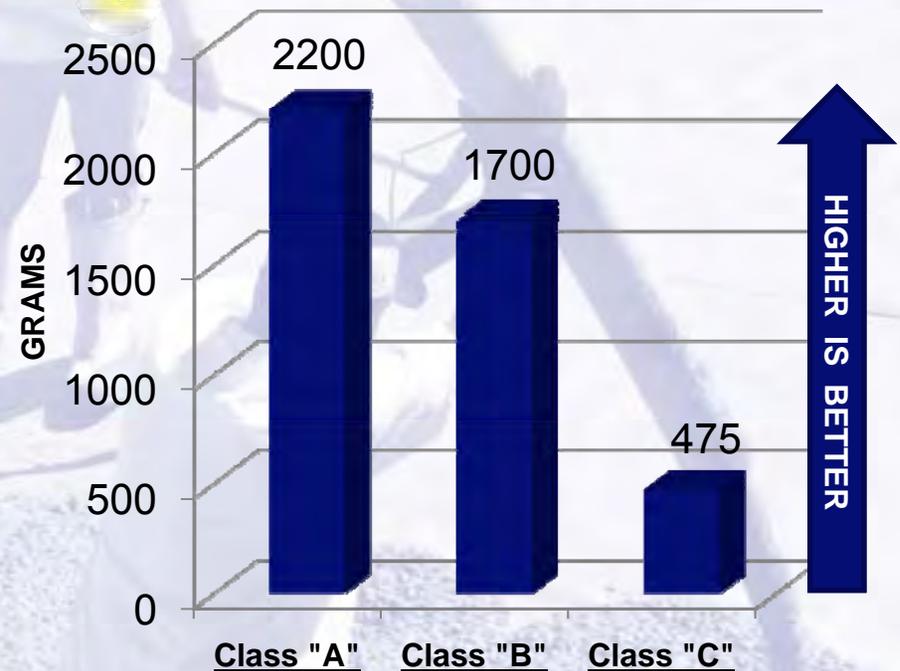
Critical Properties in Specifying Underslab **GAS** Barriers



ASTM E 1745 Minimum Puncture Requirements

- At a Minimum, Underslab Gas Barriers Should Meet or Exceed the Puncture Requirements as Vapor Barrier / Retarders Per ASTM E 1745. (See ASTM E 2121)

- Consider only Class "A" Requirements For Critical Applications
- Minimize Installation Damage by Specifying a Gas Barrier no Thinner Than 20 mils with a Puncture Strength of at Least 2200 grams.



Cited References:

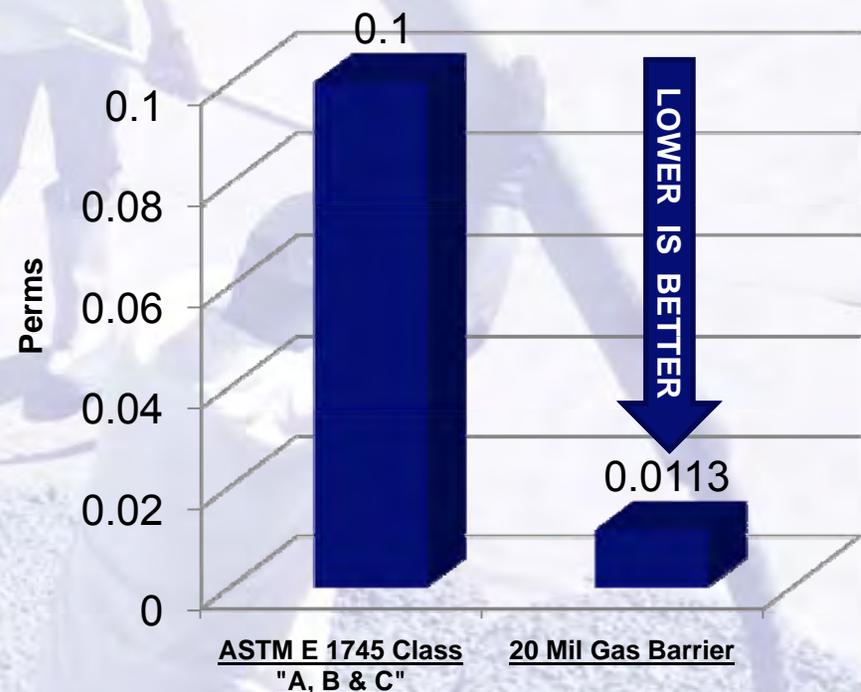
•ASTM E 1745-09 Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs

Critical Properties in Specifying Underslab **GAS** Barriers



ASTM E 1745 Maximum Permeance Requirements

- **ASTM E 2121 Mentions Soil - Gas Barriers Should Conform to the Requirements of Vapor Barriers per ASTM E 1745-09**
 - ASTM E 1745 Lowered the Accepted Permeance From .3 Perm to .1 Perm
- **Gas Barriers Are Available With Very Low Water Vapor Permeance and Low Gas Permeance (Next Slide)**
 - A Water Vapor Perm Rating of .0113 or Lower Provides Excellent Protection for Moisture Sensitive Floor Coverings



Cited References:

- ASTM E 1745-09 Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs
- ASTM E 2121-03 Standard Practice for Installing Radon Mitigation Systems in Existing Low-Rise Residential Buildings

Critical Properties in Specifying Underslab **GAS** Barriers

- Do Not Assume High Quality Moisture Barriers are Effective Gas Barriers!

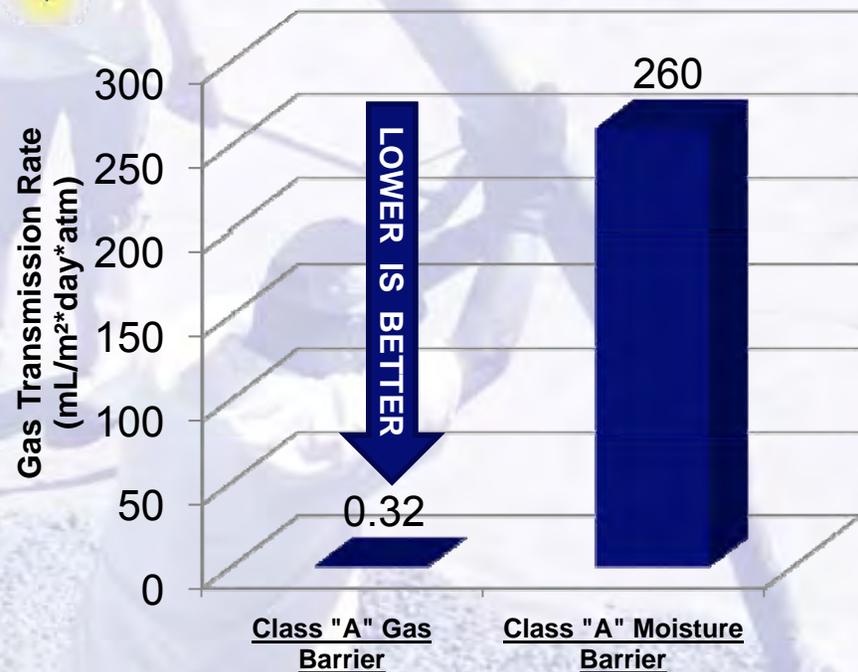
- See Methane Gas Comparison Chart

- Highly Effective Gas Barriers Provide Very Low Permeability to Radon, Methane and VOCs.

- Gas Barriers Are Available with a Methane Transmission Rate as low as .32 (GTR)
- Radon Barriers Are Available with a Radon Diffusion Coefficient as low as $1.1 \times 10^{-13} / \text{m}^2 / \text{s}$ per K124/02/95

GAS PERMEANCE

ASTM D 1434 Procedure "V"
Transmission Rate of Methane Gas



Cited References:

- ASTM D 1434-82 Standard Test Method for Determining Gas Permeability Characteristics of Plastic Film and Sheeting
- Czech Standard ČSN 73 0601 Protection of Buildings Against Radon from the Soil (Measured by Method K124/02/95 Radon Diffusion Coefficient)



Summary of Critical Elements

Proper Barrier Selection Should Include:

- **Determining the Required Perm Rating**

- Is the ASTM E 1745 Minimum Requirement of 0.1 Perms Acceptable as a Moisture Barrier? Or is a .01 Perm Rating Necessary?
- Are Moisture Sensitive Floorings a Design Issue, What are Their Requirements?
- Are Soil Gases a Concern Such as Radon, Methane or VOCs?
- Remember a Moisture Barrier is Not Always a Good Gas Barrier. Select a Gas Barrier Based on Permeability to Radon & Methane in Addition to Water.

- **Determining the Required Puncture Resistance and Thickness Needed to Survive Installation Stress & Long Term Performance**

- Will Concrete be Poured Directly on the Barrier or a Granular Blotter Layer?
- What Does the Sub-base Consist of, Angular Base or Smooth Compacted Surface?
- Will the Barrier be Exposed to Excessive Foot and Equipment Traffic Such as Self-propelled Screeds, Pump Hoses and Reinforcing Bar Placement?
- Select a Class “A” Barrier if Subject to Demanding Installation Stress - If Not Consider a Class “B” or “C” Barrier.

Summary of Critical Elements

A vapor / gas barrier is a one of the most economical yet critical component of a home or commercial building in preventing moisture related problems and assuring healthy indoor air quality!

Selecting the best possible underslab barrier based on puncture resistance will greatly reduce potential damage during the preparation and placement of concrete and provide years of maintenance free service.

Very low permeability will provide long term protection against damaging moisture and dangerous soil gas. As a bonus, reduced moisture levels can significantly reduce HVAC energy costs! Insist on the best performing moisture and gas barriers!





INTRODUCING:

“The Ultimate Gas & Moisture Barriers”
FOR RESIDENTIAL & COMMERCIAL BUILDINGS

VaporBlock[®]
UNDERSLAB VAPOR BARRIER

VaporBlock[®] Plus[™]
UNDERSLAB VAPOR BARRIER / GAS BARRIER



Manufactured By Raven Industries

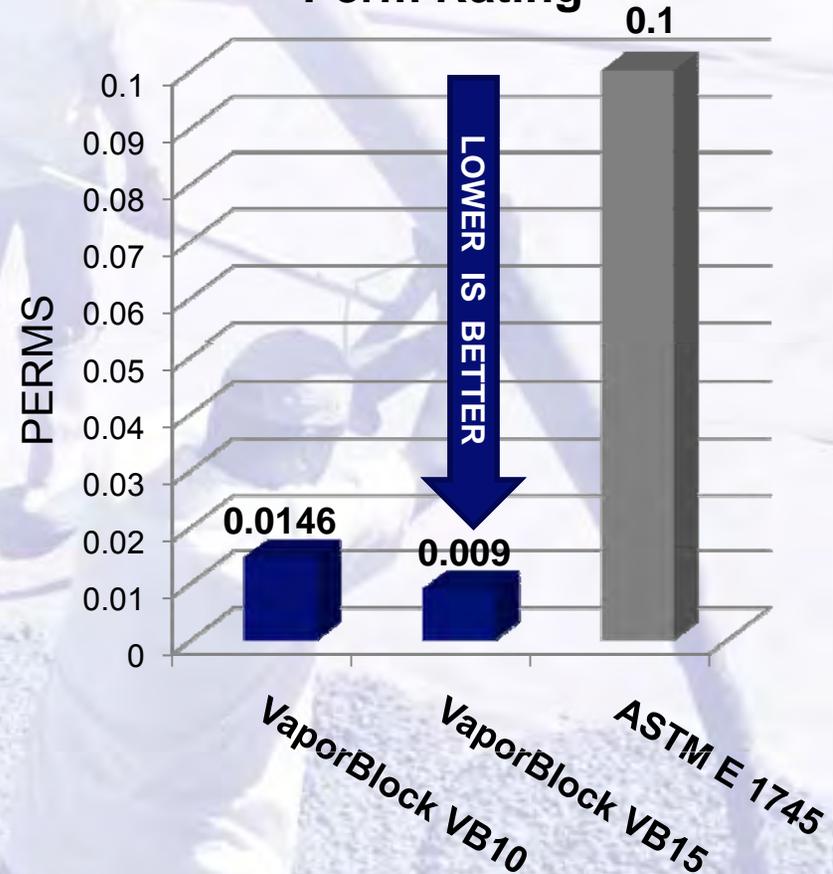
Raven VaporBlock® VB10 & VB15 Moisture Vapor Barriers

- VaporBlock® VB15 is 10 Times Less Permeable Than ASTM E 1745 Maximum Requirements of 0.1 Perms
- This is Critical for Moisture Sensitive Floor Coverings



VaporBlock®
UNDERSLAB VAPOR BARRIER

Perm Rating



Cited References:

- ASTM E 1745-09 Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs

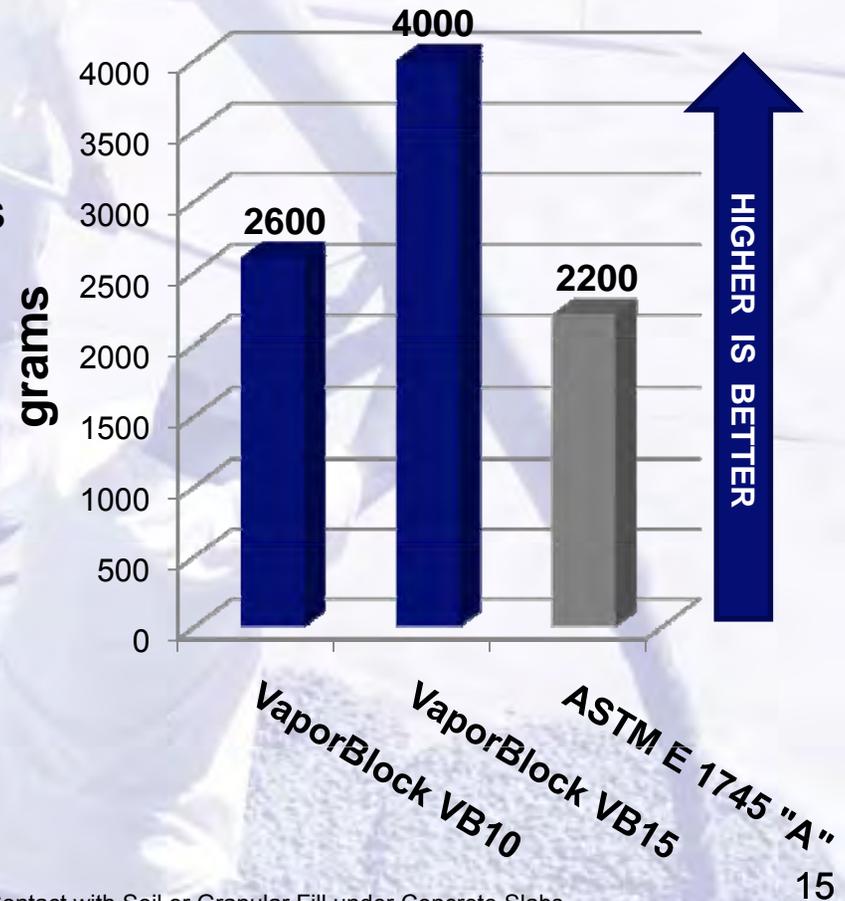
Raven VaporBlock® VB10 & VB15 Moisture Vapor Barriers

- VaporBlock® VB15 Has 80% More Puncture Resistance Than Required by ASTM E 1745, Class "A"
- Critical to Withstand Installation Stress from Foot Traffic, Reinforcing Steel, Screeds, Angular Subbase Particles and Pump Hoses



VaporBlock® UNDERSLAB VAPOR BARRIER

Puncture Resistance



Cited References:

•ASTM E 1745-09 Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs



Raven VaporBlock® Plus VBP20 Gas Barrier

- VaporBlock® Plus™ (VBP20) Gas Barrier is Over 800 Times Less Permeable to Methane Gas Than a High Quality Class “A” Moisture Barrier
- VBP’s Radon Diffusion Coefficient of $1.1 \times 10^{-13} / \text{m}^2 / \text{s}$ Offers Excellent Protection Against Deadly Radon Gas.
- USEPA Recommends an Active or Passive Ventilation System as Part of an Effective Gas Barrier Design (Figure 2)

VaporBlock® Plus™
UNDERSLAB VAPOR BARRIER / GAS BARRIER

Transmission Rate of Methane Gas

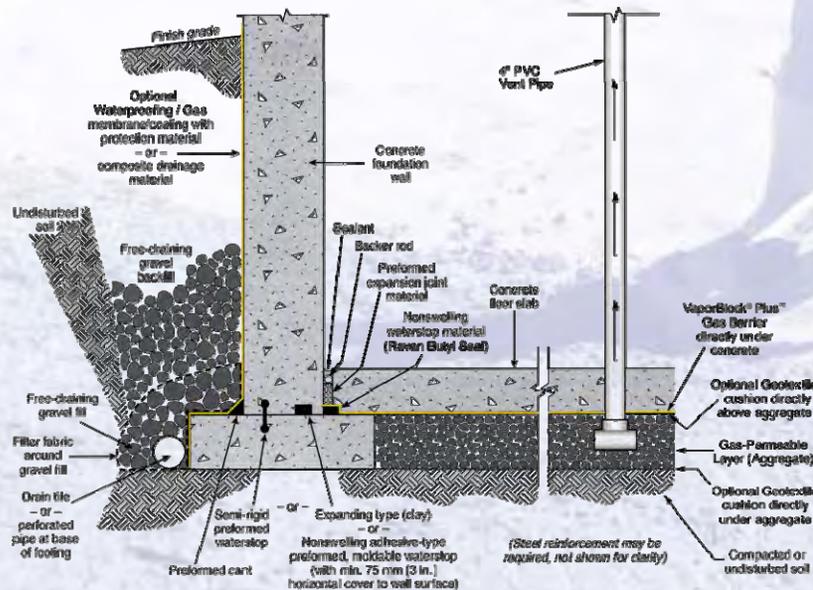
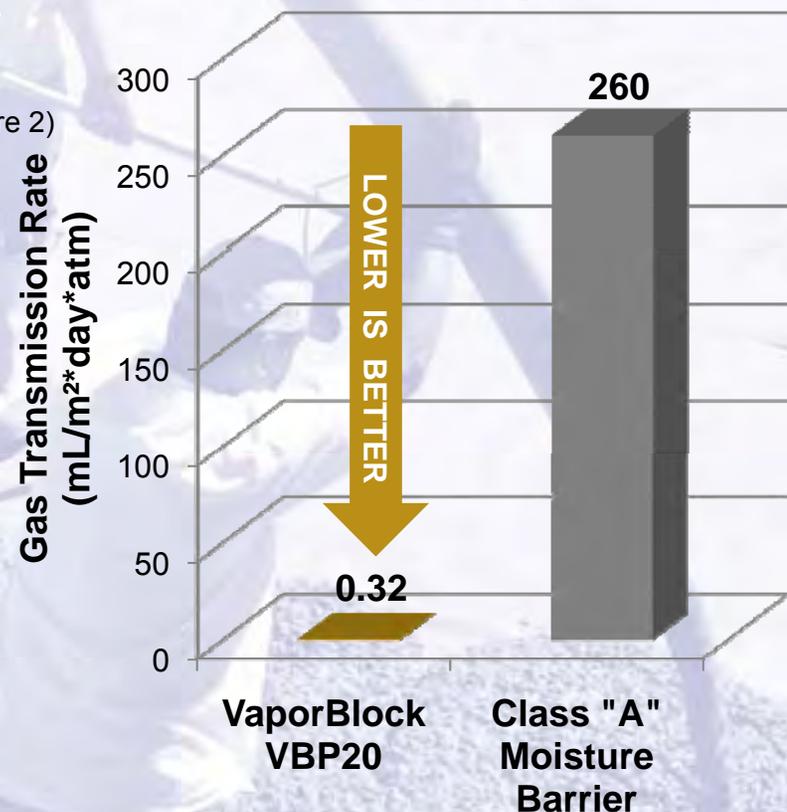


Figure 2. Elements of a moisture/gas-resistant floor system. General illustration only. (Note: this example shows multiple options for waterstop placement.)

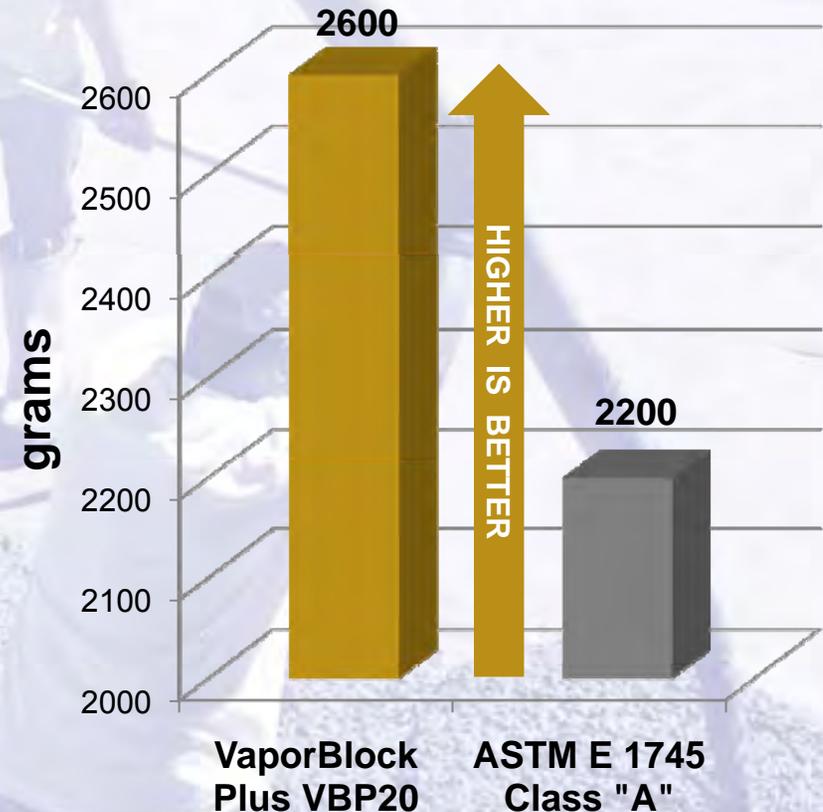
Raven VaporBlock® Plus™ VBP20 Gas Barriers

- Besides Excellent Resistance to Gas Permeation, VaporBlock® Plus™ VBP20 has 18% Greater Puncture Resistance Than Required by ASTM E 1745 (Class "A")



VaporBlock® Plus™
UNDERSLAB VAPOR BARRIER / GAS BARRIER

Puncture Resistance





Other Questions Concerning Underslab Moisture or Gas Barriers?

- Please call Raven Industries, Inc. at 800-635-3456 for more information or:
- Visit our web site at: www.vaporblock.com
 - Drop-in Specifications
 - Installation Instructions
 - Product Data Sheets
 - Brochures
 - Underslab Gas Barriers

Other Excellent Resources:

- ACI 302.2R-06 “Guide for Concrete Slabs that Receive Moisture-Sensitive Flooring Materials”
- ASTM E 1745-09 “Standard for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs”
- ASTM E 154-08a “Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover
- ASTM E 1643 “Standard Practice for Installation of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs



For more than 20 years Raven has designed and manufactured quality engineered materials for construction applications. Our innovative technologies provide products with superior quality and long-lasting durability. You will find a Raven product for everything from commercial buildings to residential homes. Products range from Wet Concrete Curing Blankets to Underslab Vapor & Gas Barriers to Housewraps providing air and weather resistance to name a few, all manufactured in the USA.

RAVEN INDUSTRIES

Recent Announcements

- **Raven Engineered Films Division receives “GAI-LAP” accreditation**
 - June 2009 - Raven Engineered Films Quality Assurance Laboratory has been granted accreditation from the Geosynthetic Institute for designated geosynthetic test methods in accordance with the Geosynthetic Accreditation Institute – Laboratory Accreditation Program (GAI-LAP). Raven is one of only forty-nine laboratories currently granted with the “GAI-LAP” accreditation worldwide.
- **Raven Engineered Films Division – Gains Recertification for Newest ISO 9001:2008 Standard**
 - December 2009 - Raven Engineered Films Division became ISO 9001:2000 certified in early 2007, and has just recently been recertified under the latest ISO 9001:2008 standard. The ISO 9001:2008 certification is for Raven Engineered Films entire quality and management system.
- **Raven Industries, Inc. Named to Forbes Top 200 Best Small Companies**
 - SIOUX FALLS, S.D., Oct. 19 – Raven Industries, Inc. (NASDAQ: RAVN), today announced it was named to the 2009 Forbes' list of the 200 Best Small Companies in America, available at <http://www.forbes.com/200best>. Forbes ranked Raven as the 109th top U.S. small company and 30th based on return on equity. This is the fourth consecutive year Raven has made the list.