FOAM-LOK™

SPRAY FOAM INSULATION

DESIGN CHARACTERISTICS OF SPRAY POLYURETHANE FOAM INSULATION

LOCK IN ENERGY SAVINGS

Located in Houston, Texas, Lapolla Industries, Inc. is a global supplier and manufacturer of spray foam insulation, reflective roof coatings, and equipment. Our products are designed to reduce energy consumption in the residential, industrial, and commercial markets.

Lapolla provides our customers with professional support from start to finish.

- High Performance Building Materials
- Highly Experienced Technical Staff
- 24/7 Product Support
- Rig Maintenance and Repairs
- On-Site Training
- Parts, Equipment, and Accessories
- Access to Promotional Offers

SPRAY FOAM INSULATION

The following information has been assembled in an effort to explain and clarify the sometimes complicated concepts in Building Science. Residential construction methods have been generally consistent for decades. As new technology develops, the construction industry is typically slow to keep up while design and construction professionals gain experience and confidence in incorporating new products into the complicated composite we know as a "home".

Homes have historically been built to intentionally allow structures to "breathe" for fear of trapping moisture. Uncontrolled moisture presents a clear concern for the longevity of most building materials. The "breathability" alleviates the concern for reasonable amounts of unmanaged moisture, but unfortunately does not control the inflow of airborne pollutants and allergens and the loss of conditioned air. This lack of control compromises the indoor air quality as well as significantly increases consumer costs through energy loss.

Spray foam technology eliminates the aforementioned issues by raising the standards of functionality and design for both residential and commercial construction. Spray polyurethane foam has been commercially available for over half a century and is now being accepted as a mainstream solution in retrofit construction for both residential and commercial construction.

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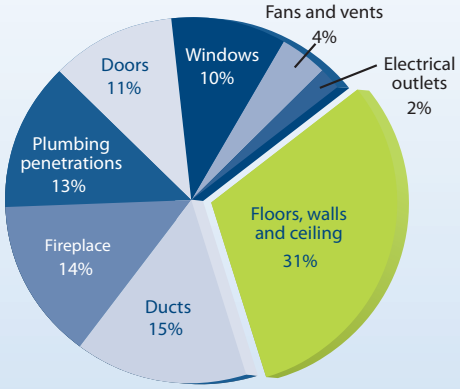
AIR BARRIER MATERIALS

APPROACH

Air barriers created by the use of spray polyurethane foam should be the primary strategy utilized when designing high performance roof or attic assemblies. Spray polyurethane foam provides:

- Reduced infiltration and exfiltration of both moisture and air
- Added rack and shear strength to the assembly
- Superior insulation properties
- Controlled thermal loading of appliances and duct work located in the space

AREAS OF AIR MOVEMENT



Source: Department of Energy: energy.gov/energysaver/detecting-air-leaks

AIR BARRIER MATERIALS SHOULD BE:

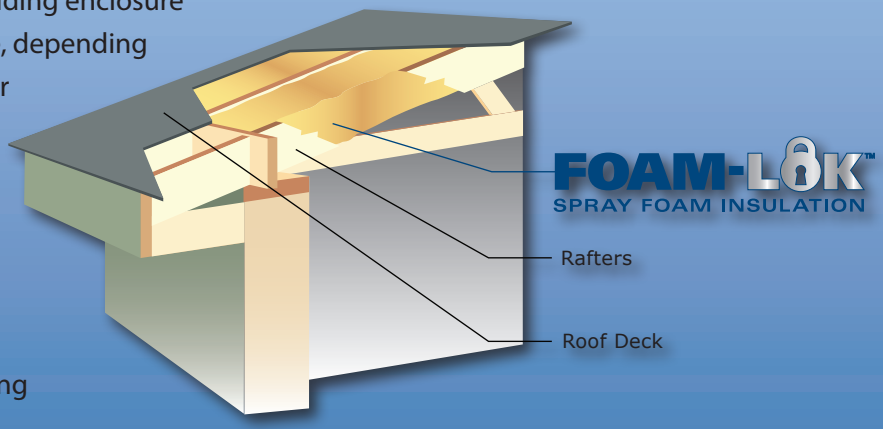
- Impermeable to air flow
- Continuous over the entire building envelope
- Able to withstand the forces that may act on them during and after construction
- Durable over the expected lifetime of the building

Sealing and insulating the "envelope" or "shell" of your home — its outer walls, ceiling, windows, doors, and floors — is often the most cost effective way to improve energy efficiency and comfort.

In order to design and build safe, healthy, durable, comfortable, and economical buildings, airflow must be controlled. Uncontrolled airflow carries moisture that impacts a material's long-term performance (serviceability), structural integrity (durability), indoor air quality (distribution of pollutants and location of microbial reservoirs), and thermal energy performance. One of the key strategies in the control of airflow is the use of air barriers.

Air barriers are intended to resist the air pressure variations that act on them. Spray foam systems can serve as a successful air barrier, either externally applied over structural elements (closed-cell spray foam) or internally applied (closed and/or open-cell spray foam) within cavity systems at the proper thickness.

Air barrier systems keep outside air out of the building enclosure or inside air from escaping the building enclosure, depending on climate or configuration. Sometimes, air barrier systems do both. Air barriers can be located anywhere in the building envelope.



In cold climates, interior air barriers control the exfiltration of interior, often moisture-laden, air whereas exterior air barrier systems control the infiltration of exterior air and prevent wind-washing through cavity insulation systems.

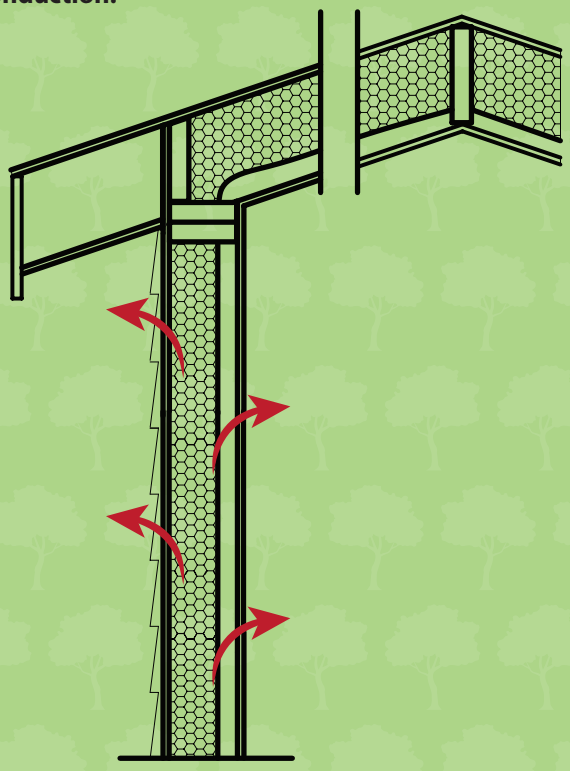
INSULATION MEASURING THE VALUE

Heat loss or gain can occur through a building envelope by three primary mechanisms: conduction, convection, and radiation. Three secondary mechanisms that influence the performance of insulation are air infiltration, air intrusion, and moisture accumulation. Spray polyurethane foam effectively controls the three primary and the three secondary mechanisms of heat transfer, resulting in insulation efficiencies well beyond those suggested by its high R-Value alone.

Conduction

R-Value is a well-publicized "status" to reflect insulation value to consumers. R-Value only measures conduction or the material's ability to resist heat loss or gain. It is derived by taking the "k" value, determined by using an ASTM test method, and dividing it into the number one. The "k" value test is the actual measurement of heat transferred through a specific material. The test favors fiber insulation materials — fiberglass, rock wool, and cellulose fiber as the test does not account for air movement (wind) or moisture (water vapor). Zero wind and zero moisture are not real-world conditions.

Spray Foam Insulation: The predominant heat transfer mechanism for spray foam is conduction. However, because the polymer matrix forming the cells is a poor conductor of heat, spray polyurethane foam has a very high R-Value and effectively blocks heat transfer by conduction.



Convection

Convective heat transfer occurs when a liquid or vapors come in contact with a material of a different temperature. Within a stud wall cavity, "convective loops" will occur when the exterior and interior temperatures are different. For example, if the interior is warm and the exterior cold, air within the cavity in contact with the exterior wall will cool, becoming denser, and flow downward. On the other hand, air in contact with the interior wall will warm, becoming less dense, and rise. Air rising and falling within the wall cavity forms a "loop" which transfers heat from the warm wall to the cold wall. The result is increased heat loss/gain and costly energy bills. By stopping the air movement, convective heat loss will cease.

Spray Foam Insulation: Spray foam eliminates air movement within the insulation material eliminating convection as a heat transfer mechanism within the insulation mass.

Radiation

Radiation is the transfer of heat from one object to another by means of electromagnetic waves. Radiative heat transfer does not require that objects be in contact. Radiative heat transfer occurs in the void of a space.

Spray Foam Insulation: Heat transfer by radiation is effectively blocked by spray foam because of the cell structure. Heat can transfer by radiation across each cell. However, because the cells are at basically the same temperature, heat transfer by radiation is virtually non-existent. Additionally, the building interior walls insulated with spray foam tend to be nearly the same temperature as the room. Therefore radiant heat variances to an occupant is minimal leading to greater indoor comfort.

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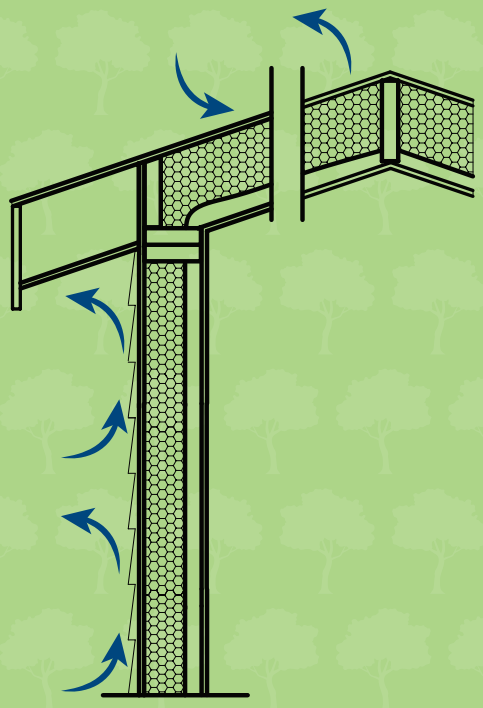

Air Infiltration

Air infiltration transfers heat by the gross flow of air between the exterior and the interior. The primary force behind air infiltration is the air pressure difference between the exterior and the interior. Air pressure differences can be caused by wind or stack effect.

Spray Foam Insulation: The bonding of spray foam plus the expansion of the material in place will create a total seal. Spray foam is one of the only insulation materials that will fill in corners, the cripples, the double studs, bottom plates, top plates, etc.

Air Intrusion

Unlike air infiltration, wherein air moves from the exterior to the interior, air intrusion occurs when air enters the insulation from the exterior and exits back to the exterior. Air intrusion is also called "wind wash." There is no drafting of air to the interior of the building but the thermal gradient of the insulation is disrupted. In effect, air intrusion introduces forced convection into the building envelope (wall, ceiling, etc.). Air intrusion can substantially undermine the effective R-Value of conventional insulations and can occur independently of air infiltration. Like air infiltration, house wraps are traditionally used with conventional insulation systems in an attempt to reduce air intrusion. Vapor retarders installed on the interior side of the building envelope will not affect air intrusion.

Spray Foam Insulation: The adhesion of spray foam insulation to most building materials creates a total seal for the building envelope. Stopping air intrusion is one of spray polyurethane foam's greatest assets.

Moisture Accumulation

Insulation is an important component in a moisture management system. Air infiltration and exfiltration, within a structure, contributes to approximately 99% of moisture intrusion. Moisture accumulation within insulation materials will reduce the insulation's R-Value, contributing to heat loss/gain. Moisture accumulation can be controlled with effective air barriers, vapor retarders or "flow through" designs (which allows moisture transfer without condensation).

Spray Foam Insulation: Spray foam stops moisture accumulation by reducing air infiltration and air intrusion. In addition, closed-cell spray polyurethane foam retards both heat transfer and water vapor transfer, making it an ideal material for use with flow-through designed building assemblies.

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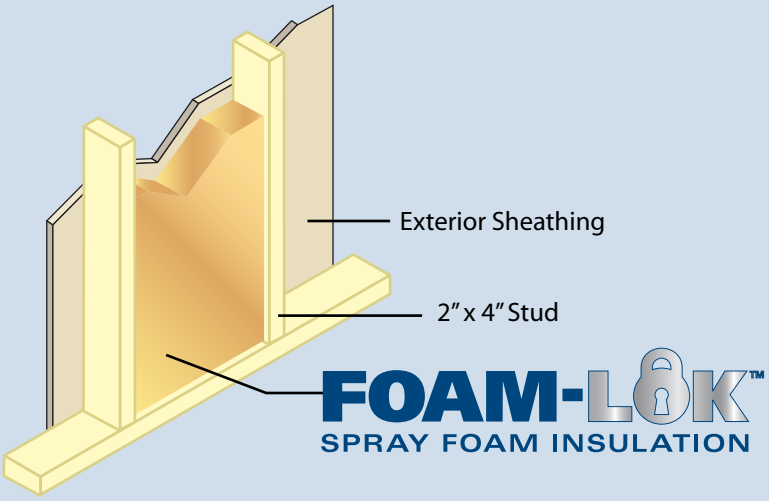
CLOSED-CELL SPRAY FOAM INSULATION

About Closed-Cell Foam Insulation

Closed-cell spray foam insulation is one of the most efficient insulating materials commercially available, with aged R-Values **at almost 7.0 per inch**.

The description "closed-cell" comes from the cell structure of the finished insulation material. One cubic inch of polyurethane foam insulation contains millions of tiny plastic closed cells filled with a non-ozone depleting blowing agent. The blowing agent is captured within the cells which contributes to highly efficient insulating properties. In addition, closed-cell foam provides an inherent air barrier with low moisture vapor permeability, and excellent resistance to water. The density for closed-cell spray foam is approximately two pounds per cubic foot. The medium density foam provides sheer and racking strength to wall assemblies in building applications.

Closed-cell spray foam insulation systems, when properly installed, deliver **energy savings of up to 40%.**



Small imperfections in the building envelope (holes, cracks, gaps) not properly sealed will eventually lead to poor building performance or worse, moisture accumulation, allergen/pathogen growth, and very possibly structural failure. The solid nature and sealing capability of closed-cell spray foam inhibits moisture-driven elements. Two inches of closed-cell spray polyurethane foam insulation will minimize air infiltration, exfiltration, convection and conduction, and control solar driven moisture in the building envelope.

FEMA Technical Bulletin 2-93[2]

- "Closed-cell" is the only type of insulation classified as an "acceptable flood-resistant material" by FEMA.
- "Flood-resistant material" is defined as any building material capable of withstanding direct and prolonged contact with floodwaters without sustaining significant damage.
- Batt or blanket insulation types and all other insulation types are classified as "unacceptable".

[2]FEMA Technical Bulletin 2-93 "Flood-Resistant Materials Requirements for Buildings Located in Special Flood Hazard Areas in accordance with the National Flood Insurance Program.

Cavity Fill Insulation	Water Vapor Permeability[1]
FOAM-LOK™ 2000 & 2000-4G Closed-Cell Spray Foam Insulation	**Class II Vapor Retarder @ 1.5"**
Fiberglass Loose Fill	Permeable
Fiberglass Batt	Permeable
Cellulose Loose Fill	Permeable
Cellulose Dense Pack	Permeable

[1]ASTM E-96, 1 perm or less is required to qualify as a Class II vapor retarder

OPEN-CELL SPRAY FOAM INSULATION

About Open-Cell Foam Insulation

Open-cell spray foam insulation is a spray-applied, half pound density, non-structural, thermal insulation material used in wall cavities, floor assemblies, ceiling assemblies, and attic applications. Open-cell foam insulation is a performance upgrade over conventional insulation that leads to energy efficiency, improved occupant comfort, a cleaner indoor environment, and greater noise reduction for building/home owners.

Building envelopes with increased insulation levels are becoming standard practice. Consumers are increasingly involved in the selection of green building products due to rising energy costs.

Open-cell spray foam technology is a cost-effective solution to improve the energy efficiency of a building. The material expands 120 times its initial volume and fills cavities of any shape providing a continuous, protective air barrier that helps to minimize air leakage and air intrusion.

Open-Cell vs. Closed-Cell Spray Insulation Comparison				
Properties[1]	**FL-400 Open-Cell SPF**	**FL-500 Open-Cell SPF**	**FL-2000 Closed-Cell SPF**	**FL-2000-4G Closed-Cell SPF**
Density (ASTM D-1622)	0.4 pcf	0.4 - 0.6 pcf	1.8 - 2.2 pcf	1.8 - 2.2 pcf
Blowing Agent	Water/CO^2 only	Water/CO^2 only	Water/CO^2 and 245fa	Water/CO^2 and Solstice
Aged R-Value (ASTM C-518)	3.5/inch	3.7/inch	6.3/inch	6.8/inch
Open Cells (ASTM D-2856)	>96%	>94%	-	-
Closed Cells (ASTM D-6226)	-	-	>90%	>90%
Compressive Strength\ (ASTM D-1621)	≥5 lb/in^2	≥5 lb/in^2	≥20 lb/in^2 ✔ Structural[2]	≥20 lb/in^2 ✔ Structural[2]
Air Permeance[2] (ASTM E-2178, E-283)	< 0.02 L/s-m^2 ✔ Air Barrier at 3½"Thickness	< 0.02 L/s-m^2 ✔ Air Barrier at 3½"Thickness	< 0.2 L/s-m^2 ✔ Air Barrier at 2"Thickness	< 0.2 L/s-m^2 ✔ Air Barrier at 1"Thickness
Surface Burn Characteristic[3] (ASTM E-84)	Class 1	Class 1	Class 1	Class 1
Water Vapor Permeance[2] (ASTM E-96)	32 perms at 1 inch	22 perms at 1 inch	<1 perm at 1.5 inches ✔ Vapor Retarder	<1 perm at 1.5 inches ✔ Vapor Retarder
Water Absorption (ASTM D-2841)	No Direct Water Contact Allowed	No Direct Water Contact Allowed	< 2% ✔ Resistant to Flood Damage[4]	< 2.36% ✔ Resistant to Flood Damage[4]

[1]For actual performance data on a specific SPF product consult the manufacturer's technical data sheet.
[2]As designated by the International Code Council in Acceptance Criteria AC377
[3]Flammability ratings do not represent actual performance in a fire situation. Class 2 is required in most residential applications. Class 1 is required in commercial buildings and some residential applications.
[4]Classified as "Acceptable Flood Resistant Material" by FEMA, Tech Bulletin 29-3. Fiberglass batt and blanket insulation are classified "Unacceptable".

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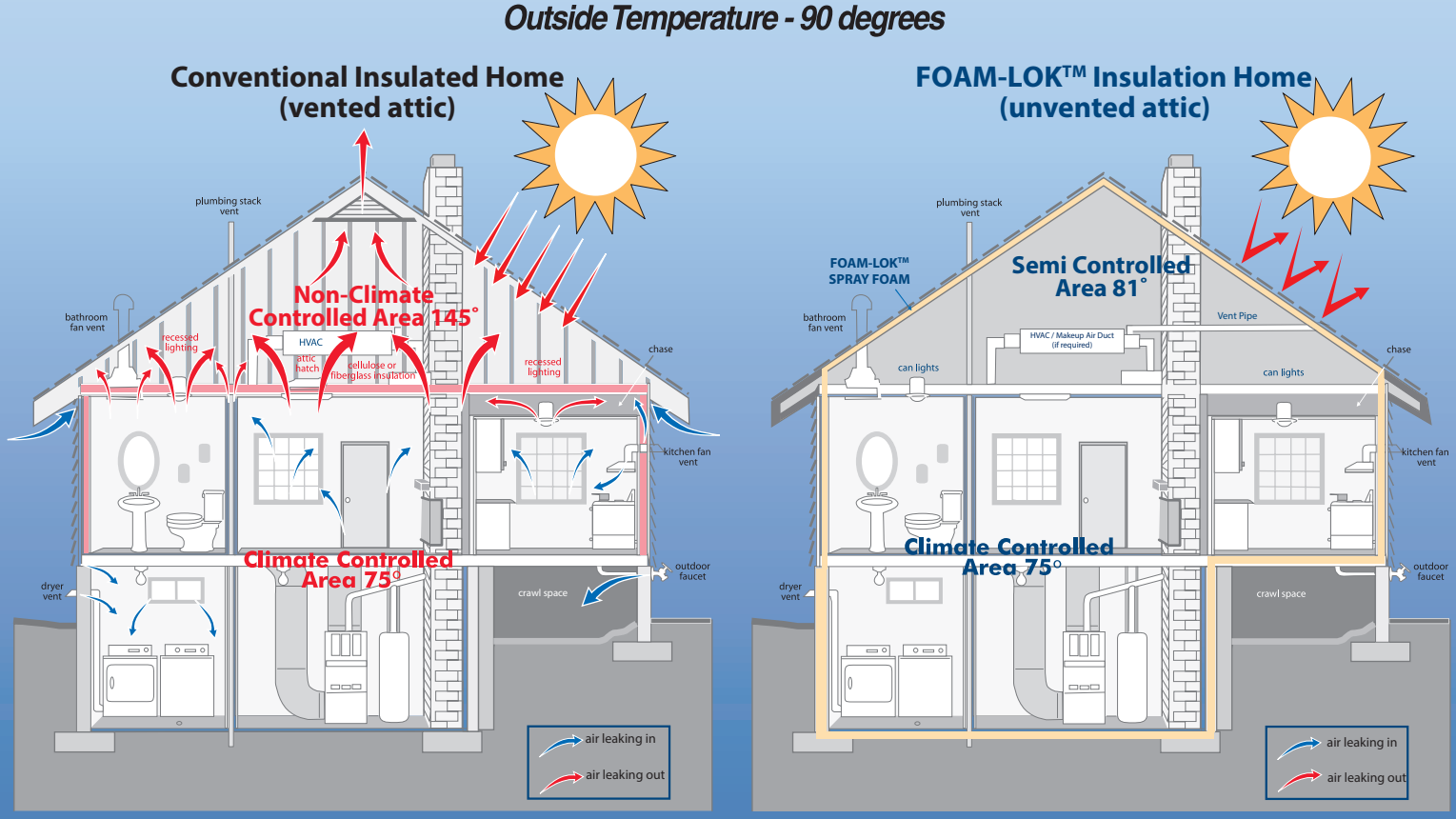
ATTIC INSULATION

Why Two Approaches – Vented and Unvented?

Vented attic and roof construction has a long history of successful performance. Why change a good thing?

As the complexity of attic and roof assemblies increases, the difficulty to construct vented assemblies also increases. The more complex a roof geometry, the easier it is to construct the assembly in an unvented conditioned manner. With complex roof designs, multiple dormers, valleys, hips, skylights combined with cathedral construction with interior soffits, trey ceilings, and multiple service penetrations, it is often not practical to construct a vented roof assembly with a FOAM-LOK™ interior air barrier at the ceiling plane. It is more common to locate mechanical systems and duct work in attic spaces.

When such duct work is leaky, significant problems can occur. In high wind regions, particularly in coastal areas, wind-driven rain is a problem with vented roof assemblies. Additionally, during high wind events, vented soffit collapse may lead to building pressurization, window blowout and/or roof loss due to increased pressure in the structure. Unvented roofs (principally due to the robustness of their construction) generally perform better than vented roofs during hurricanes. In coastal areas, salt spray and corrosion are a major concern with steel frames, metal roof trusses, and truss plate connectors in vented attics. Finally, in wildfire zones, unvented roofs and attics have significant benefits in terms of fire safety over vented roof assemblies.



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RETROFIT INSULATION

FOAM-LOK™ Retrofit Foam is specifically designed for injection and pour applications into existing wall cavities and block wall constructions. FOAM-LOK™ Retrofit Foam provides the same physical properties characteristics of the FOAM-LOK Open Cell spray applied insulation system and allows the applicator to insulate and air seal existing walls without removing the interior face of the existing wall. FOAM-LOK™ Retrofit Foam may also be used to insulate the cavities of existing block wall constructions.

FOAM-LOK™ Retrofit Foam Insulation adds tremendous R-value to exterior walls, achieving up to R-13 in 2 x 4 walls and up to R-21 in 2×6 walls. Additionally, FOAM-LOK™ Retrofit Foam Insulation reduces energy use in buildings beyond its stated R-value because FOAM-LOK™ Retrofit Foam:

- **Reduces moisture infiltration through air leakage**
- **Minimizes dew point problems and condensation**
- **Avoids thermal bridging & resists heat movement in all directions**
- **Provides reliable performance under varying conditions**

There are very few things that homeowners can do in the way of home improvement that will actually yield a return on investment. With energy savings of up to 50%, FOAM-LOK™ Retrofit Foam can not only pay for itself, but can actually save money for the entire life of the home.

Attic Applications Benefits

A significant temperature variance between the living space and the attic creates excessive stress on the HVAC system and compromises energy efficiency and comfort. By applying FOAM-LOK™ spray foam to the underside of the roofline down to the top plate, the attic becomes part of the conditioned space.

- **Eliminates unwanted air infiltration**
- **Maintains interior conditioned temperatures**
- **Protects the home from insects and rodents**
- **Reduces energy consumption**
- **Eliminates wind-driven rain from entering the home**
- **Unparalleled wind uplift protection**

Crawl Space Applications Benefits

Traditional design of crawl spaces allows for air movement and moisture to collect beneath the home, which comes with many unintended consequences. By applying FOAM-LOK™ spray foam between the floor joists, and directly to the subfloor sheathing, an air and moisture barrier is created, protecting the living space above.

- **Keeps floors warm in the winter**
- **Eliminates unwanted air infiltration**
- **Maintains interior conditioned temperature**
- **Protects the home from insects and rodents**
- **Eliminates unwanted collection of moisture**
- **Significantly reduces the risk of mold and mildew**

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HVAC CONSIDERATIONS

Building performance optimization is achieved when products and systems work together to promote an energy-efficient environment. For instance, installing a 20 seer heat pump, FOAM-LOK™ spray foam and single pane windows would create a weak link in the envelope because of the inefficient windows. To achieve a highly efficient building, the insulation, windows and HVAC system have to work together. When calculating the HVAC load, we normally see numbers from 800-1400 square feet per ton with spray foam insulation vs. 400-600 with conventional insulation.

When considering HVAC load calculations for any structure insulated with spray polyurethane foam, it is important to remember that bigger is not better. FOAM-LOK™ spray foam seals the building envelope so tight, very little conditioned air will be lost to air leakage. It is also important to note that when you create an unvented attic, the HVAC system and ductwork are located within the insulated envelope and not subject to the severe environments of a traditionally insulated attic. This allows the unit to perform much more efficiently and eliminates the condensation that normally forms on the duct work and any leaks in the duct work remain inside of the conditioned envelope.

With the increase of energy conserving homes being built and older homes being upgraded, it is even more important to properly ventilate the indoor air. Proper ventilation plays a key role in removing excess humidity, airborne pollutant particles, and odors from homes. Ventilation systems such as a HRV (heating recovery ventilators) or ERV (energy recovery ventilators) should be considered when designing the home's building envelope.

Guidelines to consider when running load calculations for FOAM-LOK™ Spray Foam Insulation:

- Building Science today teaches us that every building/house should have a room-by-room load calculation performed by a professional who has been trained in this field.
- The insulation of the building envelope is the most important item in a building that determines how the heating and cooling system(s) will work, along with the comfort levels experienced by the end user of the building.
- When using FOAM-LOK™ Spray Foam Insulation, the three main items to change in reference to standard insulation loads are: A) show the R-values for what they are, B) Unvented Attic Assemblies should be calculated with a ceiling as cathedral or ceilings on rafters and C) Infiltration is a measure of the air leakage rate of the building. For spray foam applications the infiltration rate should be set for "tight". Typically this results in an infiltration rate between 0.20 and 0.15 Air Changes per Hour (ACH) under natural conditions.

Note: when performing a load calculation, all items should be considered such as the windows (U-Value), type of roof, orientation of building, the area the building is located, foundation information, wall information, siding information, etc.

Spray Polyurethane Foam Insulation

Spray Polyurethane Foam

FEATURES	BENEFITS
Spray Applied	• Seals cracks and crevices • Insulates hard to reach areas • Quick and easy installation by a Qualified Applicator • Self-adhered seamless layer of insulation • Conforms to any architectural design
Minimizes Air Infiltration/ Exfiltration	• Keeps conditioned air where it should be – inside the building • Helps eliminate drafts and provides for comfortable interiors
Excellent Adhesion	• Adheres to most building materials • No fasteners required
Lightweight	• A high degree of strength-to-weight ratio • Adds little weight to ceiling or roof areas
Safe	• Meets Class 1 building requirements • No off-gassing after fully cured

Open-Cell Foam

FEATURES	BENEFITS
High Insulation Value	• Performs in hot as well as cold temperatures
Rigid	• Will not settle or shrink
Moisture Resistant	• Helps protect against mold and mildew

Closed-Cell Foam

FEATURES	BENEFITS
High Insulation Value	• High R-Value allows more insulation in less space (2" x 4"s instead of 2" x 6"s) – cost savings in stud size reduction • Performs in hot as well as cold temperatures
Rigid	• Will not settle or shrink • Adds structural strength
Moisture Resistant	• Inhibits moisture driven elements due to its closed-cell structure • Helps protect against mold and mildew

2000-4G Closed-Cell Foam

FEATURES	BENEFITS
Low GWP	• Global Warming Potential (GWP) of 1 • Equal to CO^2
Low ODP	• Ozone Depletion Potential of ZERO
Improved Performance Characteristics	• Better R-Value of up to 10% • Improved Yield

Contact us today at **1.877.636.2648** or **info@lapolla.com**

www.lapolla.com

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