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124 park place
grand island, ny 14072
716.775.8035

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Technical Checks: HealthySeal™ Insulation Analysis & Discussion

Executive Summary

A newly constructed residential home is more than a carpentry project completed by laborers of various trades — it is a complex engineering project combining both time-tested construction methods and the most promising new building techniques to enhance the overall home. For absolute success, new home construction also requires the use of only the best components in order to become a quality home for its buyers, your customers. Although many homes are judged based upon cosmetic characteristics, provided through the skillful craftsmanship of the builder's crew, we understand that what is of equal or greater importance is the aesthetic benefit provided a homeowner from the unseen mechanical and technical aspects of the home.

This technical analysis provides a clear understanding why HealthySeal™ may be the single most important contribution to the overall success of a newly constructed home — after all, choice of insulation is one of the few building decisions you can make that can actually reduce the ongoing operating costs of the home. Heating and cooling cost are far and away the largest costs in operating a home. Insulation is the biggest factor in determining those costs that a homeowner can actually control. Most components of a house are cosmetic and can be changed at any time. Insulation of a majority of the home can only be done once!

A home must be healthy and safe for its occupants. Uncontrolled air movement and the presence of moisture have often contributed to the onset of pathogen and allergen growth in homes. Often misunderstood or underestimated in the past, media attention and homeowner education have increased the need to construct a healthier home.

HealthySeal™ solves that problem creating a building envelope that provides an environment free from unmanaged air and/or moisture infiltration.

Foam insulation products providing such a building envelope historically have been developed using chemical products — leaving behind the toxic component, urea formaldehyde. So everything from the application environment to all subsequent situations after its installation — including product breakdown and home fires — created a toxic risk to the homeowners and others.

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In contrast, HealthySeal™, a fully cured polyurethane foam, contains no residual chemical components as verified by various health industry organizations.

In homes and additions, HealthySeal™ provides a virtually airtight seal. This seal prevents damage to the substructure via insect infestation, rodents, and moisture — and prevents the effects of moisture build-up, soil gases seepage, and heat loss in the area constructed.

In considering the roofing structure of a home, HealthySeal™ provides an airtight seal and insulation factor — significantly improving HVAC system efficiency.

Also, by fully sealing the building envelope, HealthySeal™ eliminates the need for air movement in a roofing structure — usually only necessary with fiberglass or loose fill insulation use — while not degrading the performance of code-accepted roofing products.

The thermal seal of a home is greatly enhanced with the application of HealthySeal™. Many common studies have shown than air movement — better stated as “air leakage” — decreases R-value, increasing heat loss by up to 50%. Because HealthySeal™ is an air barrier with almost no vapor or air permeance; there are no air infiltration-related performance concerns with regard to its “real” insulating value.

Using HealthySeal™ in framed walls performs multiple roles. Tested under actual field conditions, HealthySeal™ satisfies the performance criteria required to act as an air infiltration, vapor barrier, and water barrier after one application. HealthySeal™ provides the homeowner with the continuous airtight construction necessary for controlling moisture and airflow — lowering operational costs, allowing for better management of indoor air quality, and enhancing the durability and value of the home.

As an added benefit, HealthySeal™ is an excellent sound barrier — not only reducing noise through the reduction of airflow, but also reducing vibratory noise through its structural integrity.

Applying HealthySeal™ on recessed lighting, flues, and chimneys — by virtue of the product’s expansion and airtight sealing characteristics — provides for even greater energy efficiency. Although building codes generally require spacing between spray foam polyurethane insulation and chimneys, flues, and non-IC rated lighting, HealthySeal™ provides minimal airflow and heat loss from these cavities. Extensive testing of HealthySeal™, as applied directly to recessed lighting, has shown no degradation of the product.

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Significantly, due to overwhelmingly positive corner burns test results, a code change was promulgated to allow HealthySeal™ and other Class 1 polyurethane foams to be left exposed in sill plates and headers.

Our management team encourages your full review of this document. It outlines and provides discussion of the technical analyses performed by the manufacturer of HealthySeal™, independent third party organizations, and Energsmart Insulation, LLC.

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Technical Check #1:
Health & Safety

Uncontrolled air movement within and through the building envelope contributes to poor thermal performance and increased operational costs. A vast majority of energy loss is through ceiling lighting and attic access hatches. The HealthySealTM system eliminates these losses.

But even more insidious than the increased costs or the discomfort of cold floors is the intrusion of moisture — which often accompanies this uncontrolled air movement into the building envelope. This combination of air and moisture entering the building envelope through minor imperfections — often misunderstood or underestimated in the past — can lead to major pathogen and allergen growth and the onset of many asthmatic and allergic conditions.

The degree of "healthiness" of the indoor living space is a growing concern among homeowners and homebuyers. Heightened awareness of the impact of an unhealthy home contributing to respiratory problems in both children and adults has created a new demand in the homebuilding industry — a safe and healthy home.

HealthySealTM is one of the most innovative building techniques designed to address these concerns and provide a living environment conducive to healthy and safe indoor air quality.

HealthySealTM, in combination with a professionally installed mechanical ventilation system, creates a monolithic, air-sealed building envelope. This durable, bonded air infiltration seal ensures an indoor environment free from unmanaged and unwanted air and moisture infiltration, one that is better controlled to provide a safe and healthy living space.

Technical Check #2:
Fire, Toxicity & Out-gassing

Unrelated to HealthySealTM and most modern two-component polyurethane foam, urea formaldehyde foams have left a legacy of inadequate thermal performance, poor durability, and unacceptable health and safety risks.

HealthySealTM does not contain urea formaldehyde.

As a result of this past performance, however, modern formulations of spray polyurethane foam

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— including HealthySealTM — have undergone extensive scientific scrutiny. The conclusions of this research have proven the superior performance and safety of this durable, dependable building product.

A study conducted by the Fire Safety Center of the University of San Francisco, underwritten by NASA, stated that “the unusual toxic effects (of spray polyurethane foam) that have been publicized appear to be encountered only under very specific test conditions” and “raises a degree of doubt as to whether such unusual toxic effects would be encountered in many or any fire situation.”

Natural cellulose materials — such as the wood in the framing members of a home and cotton — were determined to be some of the most toxic, when burned, of all the 300 materials commonly found in a home tested during this University of San Francisco study.

In addition to the scrutiny of spray polyurethane foam under hazardous fire conditions, “out-gassing,” or the presumed leaching of blowing agent into the indoor environment has been a topic of much discussion.

Research conducted at the University of Colorado Health Sciences Center School of Medicine concluded, “A fully cured polyurethane foam contains no residual isocyanate or polyol and, in contrast to the urea formaldehyde foams, present no problems of bleed-off toxic products.”

The findings of this research, as reported in the Journal of the American Medical Association by the physicians who conducted the tests, concluded, “there is no evidence of toxicity in occupants of homes insulated with fully-cured polyurethane.”

Proven, durable, and safe, HealthySealTM is the product of choice for modern home builders and the informed public who wish to have an environmentally conscious, safe, and operationally efficient home that will bring a comfortable, safe living environment for the life of their home.

Technical Check #3:
Below grade, Basements & Crawlspaces

Studies conducted at the Underground Space Research facility in Minnesota have shown that 10 gallons (38 liters) or more of water vapor per day can evaporate into a house through the basement walls and floors.

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Proper treatment of basement walls and crawlspaces are critical to insure the four components of housing excellence — indoor air quality, moisture control, operational cost control, and durability.

HealthySealTM — when used in combination with sound grading, ground cover, and site drainage practices — can significantly impede the intrusion of water vapor and liquid water into the building envelope, as well as reduce or eliminate exposure to Radon and other soil gases.

HealthySealTM applied to the interior surface of crawlspace walls, or to the exterior of a full basement, is a proven one-step application that will seal and protect against damaging water intrusion and heat loss.

The National Research Council of Canada performed Water Vapor Transmission tests, in accordance with ASTM (American Society of Testing and Materials) 1 E-96, on a concrete block wall with spray applied polyurethane — HealthySealTM. The results found that the composite performance of foam and concrete created an almost airtight solid seal, due to the high density "skin" of the foam and the interaction with the concrete block.

In a separate study, spray polyurethane foam — like HealthySealTM — was subjected to prolonged soil exposure tests in accordance with an U.S. military spec MIL-F-1927 and STM D-684. Foam samples were buried along with pine boards, then periodically checked over a ten-year period.

After three years, the pine boards were ravaged by termites, but the SPF remained unblemished — while showing a slight reduction in tensile strength and a slight increase in compressive strength. After ten years, the pine boards were completely rotted — while the foam had only a few pockets made by insects or rodents.

Technical Check #4:
Hot Roofs, Cathedral Ceilings & Cold Attics

For both cathedral and flat ceilings, moisture laden indoor conditioned air is expected to bypass the vapor barrier in small amounts via diffusion (1%) or infiltration (99%) through penetrations and imperfections in the building assembly. Termed "flow through" moisture control, this moisture-laden air entering the building envelope would be passively exhausted to the outside

of the home through openings at the ridge, soffit, or gable end. This practice has been standard for over fifty years and was considered to have universal applications regardless of building environment — heating, cooling, or mixed.

This air movement and the associated migration of moisture through the building envelope is a significant source of R-value degradation, mold growth, “dry rot” of the building assembly, peeling paint, and the buckling of siding materials. Low-density loose fill, large open-celled, and fibrous insulation are particularly susceptible to air movement and moisture-related problems — resulting in significantly reduced thermal performance (up to 50%) and growth of microorganisms.

However, due to the physical nature of HealthySealTM, a thermally superior, airtight construction in these difficult assemblies can be achieved cost effectively.

Sprayed directly to the underside of the roof deck in flat attics or cathedral ceilings — with or without an air space — a solid, seamless water, air, and moisture retarder is achieved. This approach allows greater indoor air quality management and efficient performance of HVAC equipment. In heating and mixed environments, completely sealing the building envelope also eliminates truss uplift and the incidence of ice damming.

In cooling environments with non-vented cathedral ceilings or attic spaces, HealthySealTM eliminates the need to insulate ductwork and piping, creates a conditioned space in which the HVAC equipment will operate more efficiently, and effectively eliminates hot spots. As for roof deck temperatures and shingle life expectations, non-vented roof studies have shown that shingle color is more a determinant of roof deck temperatures than is roof deck ventilation. HealthySealTM will not degrade the performance, or lifespan, of code-accepted roofing products.

Technical Check #5:
Building Envelope, Air Seal & Dynamic Effective Performance

ASTM C-518 is a method used to determine a product’s R-value, or its ability to resist the flow of energy, as quantified in a laboratory setting using exact dimensions at a standard condition — 75° F, no wind load. This methodology is an important measure of uniform characteristics, but hardly describes performance under actual, “real world” conditions.

In reality, convective air currents and air infiltration moving through the building envelope degrade the thermal performance of density, large open cell, and fibrous insulation products — and poorly installed reflective systems.

For example, a 4% void area in an R-11 wall will increase heat loss by 15%. The same 4% void area in an R-19 ceiling insulation causes a 50% increase in heat loss. This increase in heat loss represents a decrease in a material's resistance to the flow of energy. So the bottom line is this — when it comes to some insulation materials, you may not be getting what you are paying for.

A study conducted by researchers at the Oak Ridge National Laboratory, among others, measured the impact of airtight construction and the energy savings generated by reducing air infiltration by 20%. Natural air change rates were calculated from the effective leakage area as determined by blower door tests, assuming a 5 mph wind load and a temperature difference between indoor and outdoor conditions of 10° F. Heating and cooling loads were then calculated for six different heating and cooling environments from Minneapolis, MN to Phoenix, AZ to determine the equivalent R-value of an airtight home, compared to a conventional constructed benchmark with typical air leakage rates. Their findings indicated that to obtain the same heating and cooling loads indicated in an airtight home, a conventionally built home would require whole wall R-values of 2 to 4 times that of the airtight home's whole wall R-value.

Because HealthySealTM is an air barrier, there are no convection currents or air infiltration related performance concerns. HealthySealTM 1700 has an aged, or long-term, design R-value of 6.5 (HS500 has a 3.6 R-value) per inch — nearly double that of any other conventional insulation product. In performance tests under actual field conditions with wind loads and maximum temperature variations, the thermal performance of HealthySealTM remains constant and dependable.

Technical Check #6:
Building Envelope: Moisture, Vapor Barriers & Air Barriers

Because Americans spend 80% of their time indoors, our goal is to provide the four essential construction components that distinguish a safe and energy efficient home from the rest — indoor air quality control, moisture control, operational cost control, and durability.

Control of the building envelope affords the owner the ability to control his or her own

environment, and it begins with a solid, airtight exterior shell of the building. You must build tight, then insulate and ventilate right.

Airflow also carries moisture, which will impact the indoor environment. Movement of moist air into the building envelope driven by temperature and pressure differences will allow growth of pathogens and allergens in the stud cavities. This moisture and air movement will also degrade thermal performance of fibrous or large open-celled insulation by up to 50% and could affect the structural integrity of the building in a relatively short period of time.

Section 5.4 of the Canadian National Building Code has established performance criteria for any material to act as an air flow barrier and contains permeance performance standards under wind loading of 75 Pa of air pressure. Wall details were constructed using various sheathing and interior finishes commonly found in residential construction. These assemblies were sprayed with spray polyurethane foam — like HealthySealTM — and then tested for air infiltration under both positive and negative, static and dynamic air pressures simulating constant and gusting wind loads.

Even when the fiberboard sheathing was pulled off the studs of one of the assemblies under high wind loads, the closed-cell polyurethane continued to meet the air infiltration performance standard.

HealthySealTM in framed walls will significantly simplify the construction process by performing multiple roles in the building envelope with one application. Tested under actual field conditions, HealthySealTM has proven that it satisfies the performance criteria required to act as an air infiltration barrier and vapor and water barrier. HealthySealTM provides the homeowner with the continuous airtight construction essential to controlling moisture and airflow — thereby lowering operational costs, allowing better management of indoor air quality, and enhancing the durability and value of the home.

Technical Check #7:
Building Envelope & Sound Control

In response to the demand for more energy efficient, durable, and healthier homes, builders and designers now have an innovative yet proven system called HealthySealTM to create a superior building envelope to act as the basic building block to meet that demand.

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The definition from the ASHRAE (American Society of Heating, Refrigeration and Air Conditioning Engineers) handbook is that sound from a source is transmitted via a path to a receiver. Airborne and structural-borne transmission paths are the two principal path types.

Strategies to reduce thermal transfer — thereby increasing energy efficiency — and air infiltration are identical to reducing airborne sound. HealthySealTM is by definition — and confirmed through testing with the Canadian National Building Code, Section 5.4 — an air infiltration barrier. As such, HealthySealTM will stop airborne noise.

According to ASHRAE, room-to-room sound transmission occurs when surfaces vibrate, and this is the primary source of sound transmission. Lightweight structures with little damping radiate more sound than a more "massive structure with greater damping." ("Performance Check Between Whole Building Thermal Performance Criteria and Exterior Wall Measured Clear Wall R-Value, Thermal Bridging, Thermal Mass, and Airtightness," ASHRAE bulletin TO-98-25-4.)

The physical properties of HealthySealTM inhibit structural-borne sound transmission. HealthySealTM has the greatest ability to stop the vibration of wall elements, and therefore reduce structural borne transmission of sound.

Technical Check #8:
Recessed Lights, Flues & Chimneys

HealthySealTM will seal recessed lighting from air infiltration, flues from unintended heat gain, and HVAC supply and return lines from energy loss in the attic area.

Sealing flues and HVAC supply and return runs installed outside of the building envelope is an effective way to prevent unnecessary energy use, air flow imbalances, and excessive air infiltration into the building envelope in any environment. HVAC equipment operating outside the building envelope has to work harder to maintain tolerable levels of indoor air quality and comfort. Enclosing these devices within the building envelope or at minimum sealing the ductwork can lead to significant energy savings and increased levels of comfort.

Recessed lighting and other fixtures hung on ceilings in a home are another major source of energy loss. HealthySealTM, since its development, has been successfully sprayed directly on

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top of IC (insulation class) rated recessed lighting with great success. The insulation has a flash point of over 700 degrees Fahrenheit. The internal safety mechanisms in IC rated lights shut the lights down long before the temperature is reached, thus eliminating any concerns about fire. In very few instances, recessed lights have shut off due to the heat buildup that results from HealthySeal'sTM air seal, but this condition has been remedied through the use of lower watt bulbs.

Technical Check #9:
Southwest Research Institute Corner Wall Burn Test

In the Spring of 1999, the Spray Polyurethane Foam Alliance (SPFA) contracted Koffel Associates, Inc. and the independent lab Southwest Research Institute (SRI) to conduct a full scale corner wall burn test to detail the impact of a fire on polyurethane foam in a rim, sill, or header area of the home. The apparatus employed was a modification of the protocols outlined in UBC 26-3 and designed by the leading industry fire expert, Mr. Don Belles.

The results of the testing were so positive, industry representatives from the SPFA promulgated a code change with the International Code Council (ICC) including the International Residential Code (IRC) and International Building Code (IBC) to allow Class 1 spray polyurethane foam to be left exposed in sill plates and headers. Building officials from the three major code bodies — BOCA, ICBO, and SBCCI — as well as the NFPA, reviewed this proposal titled RB-49-00. The proposal passed muster at the three peer review meetings before being "approved as submitted" at the annual business meeting in December, 2000. As a result of this testing, when the IRC and IBC were printed in 2002 and for each state that adopts these changes, the code allows a Class 1 spray polyurethane foam to be left exposed in the rim or band joist area without a requirement for ignition or thermal barrier.

In all cases, code-approved spray polyurethane foam products should be used. Credentialed Class 1 and Class 2 foams are the only classes of foam that are acceptable in residential construction, and it is in the band joist area only that a Class 1 closed-cell foam is allowable to be left exposed.