The Architect/Specifier Handbook

The Application and Benefits of

Spray Polyurethane Foam Insulation

Tiger Foam® quick curing, disposable, two-component spray polyurethane foam insulation kits are manufactured to ASTM E-84 Specifications and classified as a fire-rated foam insulation.

This product is manufactured using the most environmentally friendly blowing agents and fire-retardant chemicals available today. Tiger Foam® contains no CFCs, VOCs, Formaldehyde or PENTA-BDEs and is one of the safest polyurethane foam insulation formulas on the market today.

Clear hoses and cleanable spray nozzles combined with a state of the art gun and hose assembly make these spray systems especially versatile and dependable. Each disposable kit comes complete with two pressurized tanks (A & B Components) a gun and hose assembly and extra spray nozzles in both cone and fan spray patterns. The resulting foam is closed cell with a perm rating of 2.6 at 1" and 1.2 at 3". R-Value is from 6 to 7 per inch as it varies slightly depending on temperatures and humidity at time of application (this is true of ALL polyurethane insulations). Tanks are recyclable at any steel recycle/reclamation center.

(see MSDS and Tech Data Sheets for full information)

Designer Handbook

Technical information and answers to questions architects and designers who specify
Tiger Foam Brand Spray Polyurethane Foam

What is Tiger Foam®

Spray Polyurethane Foam (spf) systems have been used as a high-performance insulation material in commercial and industrial applications for more than 30 years. This insulation material has been installed in over 300,000 homes in over 20 years of service in stud cavities and ceilings to basements both interior and exterior. Their multi-functional role as air/moisture/vapor retarder in residential applications is only beginning to be appreciated by a larger market. **Tiger Foam®** is a closed-cell, two component, rigid spf product in pre-pressurized tanks that will provide your client with a water, air, and moisture barrier in one application. With an R-value of 6-7 per inch, a perm of less than 1.2 at 3 inches; **Tiger Foam** is the answer to the challenge of creating a durable, efficient building envelope from footing to ridge on straightforward to complicated home designs. Durability, high thermal resistance with air sealing capability, is the preferred product for the home building professional with a specific need on a challenging job or if superior energy efficiency is the demand.

What it Does

Controls Air Infiltration, Convection and Unmanaged Air Flow

One of the country's most critical home comfort and energy efficiency concerns is related to air movement and convective energy loss.

Identified by United States Government Laboratories and nationally known Building Science professionals, air leakage is the main cause of personal discomfort and poor energy efficiency that impacts the long-term durability of buildings. Termed "air infiltration", this phenomenon is really unmanaged, uncontrolled air-flow moving in and out of the structure either through gaps and seams in the building envelope or through convective air movement within the insulation materials and building assemblies. Uncontrolled air disrupts temperature, air pressures and humidity levels in the occupied space in any weather condition leading to heating and cooling systems needing to work harder, cost more money and creates "discomfort zones" commonly associated with too hot second floors and "clammy" basements.

Adds Structural Strength and Durability

Being a closed-cell, rigid polyurethane as opposed to open-celled foams or conventional fibrous insulation materials, Tiger Foam can and does act as a structural element in the design process. NAHB Research Center tests prove that a Tiger Foam application not only makes the building envelope more airtight, but also enhances the strength and racking.

Controls Sound

Tiger Foam has many advantages you can exploit in the building process. **Tiger Foam** is a closed cell foam that acts as an air barrier, has nearly double the conventional "R-value" of more recognizable systems like cellulose or fiberglass and is helpful in eliminating airborne and assembly vibration related noise.

Minimizes Infestation and Mold Growth

Tiger Foam has no nutritional value to any insect that would attract them or other animals to the product

Allows More Accurate Control of the Indoor Living Space by Eliminating Unmanaged Airflow

More accurate take offs of mechanical needs can be obtained and often HVAC equipment can be downsized or eliminated. As with any airtight approach to the building envelope, mechanical ventilation strategies become very important and need to be included in the design. The net result is a more efficient, structurally durable, quieter and more comfortable living space.

A home that is well-insulated and protected from moisture intrusion through effective air infiltration control…

- *Reduces the usage of fossil fuels for energy,*
- *Reduces the CO_2 emissions that are damaging the environment, and*
- *Saves the homeowner money.*

The U.S. Department of Commerce brochure NISTIR 4821, *Envelope Design Guidelines for Federal Office Buildings: Thermal Integrity and Air tightness,* which was prepared as a guideline for the General Services Administration, recognizes and states that' "spray polyurethane foam alone "CAN provide an air-tight and water-tight barrier."

Other Tiger Foam Product Attributes

- Adheres to most surfaces
- Contains no urea formaldehyde
- Uses no fasteners
- High strength-to-weight ratio
- Adds structural strength
- Seamless application
- Insulates hard-to-reach areas
- Resists water
- Eliminates drafts
- Dimensionally stable, does not shrink or settle
- Odorless
- Resists mildew and fungus
- Chemically resistant and Fire Rated
- No food value for rodents or mold
- High R-values

Why the need for a handbook?

Building envelopes are generally successful in meeting a range of structural, aesthetic and thermal requirements. However, poor thermal envelope performance does occur due to the existence of defects in the envelope insulation, air-barrier and vapor-retarder systems. These defects result from designs that do not adequately account for heat, air and moisture transmission, with many being associated with inappropriate or inadequate detailing of the connections of envelope components.

The goal of this handbook is to transfer the knowledge of thermal envelope design and performance from the research, design and construction experts into a form that can and will be used by building design professionals. These guidelines are organized from practical information on Tiger Foam® brand sprayed polyurethane foam insulation for the avoidance of thermal performance problems such as thermal bridging, insulation system defects, moisture migration and envelope air leakage.

Contents

Number 1

Health and Safety

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

Uncontrolled air movement within and through the building envelope contributes to poor thermal performance and increased operational costs. More insidious than the loss of energy dollars 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, 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 identified as a growing concern among homeowners and homebuyers. Heightened awareness of the impact of an unhealthy home contributing to the respiratory problems of children and adults has created a new need in the homebuilding industry; a safe and healthy home. Innovative building techniques designed to address these concerns and provide a living environment conducive to healthy and safe indoor air quality is critical to a growing population of homebuyers.

The Tiger Foam Approach

Tiger Foam® in combination with a professionally installed mechanical ventilation system is the perfect combination of systems that will provide the homeowner a monolithic, air sealed building envelope. This durable, bonded air infiltration seal will insure the homeowner and their loved ones an environment free from unmanaged and unwanted air/moisture infiltration. Because the envelope is sealed, the indoor environment can be better controlled to provide a safe and healthy living space.

Number 2

Fire, Toxicity and Out-gassing

Unrelated to **Tiger Foam®** and most modern two component closed cell polyurethane foam, urea formaldehyde foams have left a legacy of inadequate thermal performance, poor durability and unacceptable health and safety risks. **Commercial Thermal Solutions, Inc.** never has and never will have urea formaldehyde as a component of our spray foam system.

As a result of this past performance, modern formulations of spray polyurethane foam, including **Tiger Foam**, have undergone extensive scientific scrutiny. The conclusions of this research underscore 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 cellulosic materials (such as the wood in the framing members of your 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 finding of this research reported in the Journal of the American Medical Association by the physicians who conducted the tests went on further to state, "There is no evidence of toxicity in occupants of homes insulated with fully-cured polyurethane."

Proven, durable and safe, Tiger Foam® 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.

Number 3

Below Grade; Basements and Crawlspaces

Studies conducted at the Underground Space Research facility in Minnesota have shown that 10 gallons or more of water vapor per day can evaporate into a house through the basement walls and floors. One study in California observed conditions in crawl spaces as having "… foul odors, condensation, mold growth, and wood decay …". 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.

The Tiger Foam Approach

Tiger Foam, when used in combination with sound grading, ground cover and site drainage practices can significantly impeded the intrusion of water vapor and liquid water into the building envelope. The NRCC (National Research Council of Canada) performed Water Vapor Transmission (WVT) tests on a concrete block wall with spray applied polyurethane foam; each component as well as the whole system of foam and block were tested in accordance with ASTM E-96. The results were that the interface of the foam and concrete was significant in that the composite performance of foam and concrete created an almost airtight solid seal.

How well does Tiger Foam do underground? In a separate study Spray Polyurethane Foam (SPF) was subjected to prolonged soil exposure tests in accordance with an American military spec MIL-F-1927 and STM D-684. Foam samples were buried along with pine boards then were periodically checked out over a ten-year period. After three years the pine boards were ravaged by termites, but the SPF remained unblemished, with the exception of a slight reduction in tensile strength and a slight increase in compressive strength. After ten years the boards were rotted and the foam had only a few pockets made by insects or rodents. Tiger Foam will keep the home warm, safe and dry from footing to ridge.

Building Codes and Expectations

In many communities local building codes may dictate other applications or variations on the approach described here. The building code exits to insure that accepted construction practices are followed and certain minimums in performance standards are met. They also exist to benchmark

innovative applications and concepts to make sure buildings are built safely with sound construction technique.

Number 4

Hot Roofs and Cathedral Ceilings

Cold Attics

Whether cathedral or flat ceilings, moisture laden indoor conditioned air, was expected to bypass the vapor barrier in small amounts (1%) via diffusion or via 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, soffitt 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 environments).

Moisture, Air Movement and Thermal Performance of Insulating Materials

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. Loose fill, 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.

The Tiger Foam Approach

Tiger Foam provides thermally superior, airtight construction in difficult assemblies. 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 will better allow pro-actively managed indoor air quality and efficient performance of HVAC equipment. In Heating and Mixed environments, completely sealing the building envelope eliminates truss uplift and significantly reduces the incidence of ice damming. In Cooling Environments, non-vented cathedral or attic spaces insulated with Tiger Foam eliminates the need to insulate duct work 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. Tiger Foam will not degrade the performance of code accepted roofing products.

Number 5

Building Envelope
Air Seal and Dynamic Effective Performance

What is an "R-value"?

ASTM C-518 is a laboratory test method used to determine a products' "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 conditions.

A widely observed condition was that convective air currents and air infiltration moving through the building envelope can degrade the thermal performance of 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. An increase in heat loss represents a decrease in a materials resistance to the flow of energy. The bottom line is this—what you may be paying for with some insulation materials may not be what you are getting.

In a study[1] 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.

The Tiger Foam Approach

Because **Tiger Foam** is a closed cell, high-density insulation material there are no convection currents or air infiltration related performance concerns. Tiger Foam has an aged (long term) design R-value of 6.2 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 Tiger Foam remains constant and dependable.

Number 6

Building Envelope
Moisture, Vapor Retarders and Air Barriers

Can you Build a House Too Tight?

Americans spend 80% of their time indoors. Due to this fact our goal is to provide a home with the four essential construction components that distinguish an energy efficient, safe home from the rest. These four elements are 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. That ability begins with a solid, airtight exterior shell of the building. You must build tight, insulate and ventilate right.

Water, Air, Moisture (WAM) Barriers

[1] "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

Liquid water problems in buildings are due mainly to significant imperfections in the cladding, flashing detail, leaking roofs or poor site drainage. A "drainage plane" or rain screen interior of the cladding can minimize water entry into the wall system caused by wind, capillarity, gravity and air pressure differences. **Tiger Foam** applied to the interior of the drainage plane, cladding or in the façade/block interstitial space in CBS construction acts as a continuous second line of defense against the intrusion of the most dangerous form of moisture: liquid water.

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 time period.

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 foam 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.

Tiger Foam 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, Tiger Foam has proven that in one application, it satisfies the performance criteria required to at as an air infiltration barrier and a vapor and water retarder. Tiger Foam provides the homeowner with the continuous airtight construction that is essential to controlling moisture and airflow, which will lower operational costs, allow better management of indoor air quality and enhance the durability and value of the home.

Number 7

Building Envelope and 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 **Tiger Foam** to create a superior building envelope to act as the basic building block to meet that demand.

Sound Control Definitions and Strategies

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 (increase energy efficiency) and air infiltration are identical to reducing airborne sound. The Tiger Foam formula is by definition and confirmed through testing with the Canadian National Building Code, Section 5.4, an air infiltration barrier and as such, Tiger Foam will stop airborne noise.

The closed-cell rigidity of **Tiger Foam** inhibits structural-borne sound transmission. Again from the ASHRAE Handbook; 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." **Tiger Foam** has the greatest ability to stop the vibration of wall elements and therefore reduce structural borne transmission of sound.

The following chart of the sound absorption coefficients of **Tiger Foam** determined in accordance with ASTM C-423:

Thickness	Frequency	12	250	350	500	1000	2000	4000	NRC
1/4"	S/ab	0.1	0.21	0.21	0.26	0.17	0.63	0.65	0.31
1/2"	S/ab	0.1	0.25	0.29	0.45	0.84	0.97	0.87	0.63
1"	S/ab	0.2	0.49	0.62	0.81	0.91	0.98	0.97	0.80

A rating of an STC (Sound Transmission Coefficient) 59 was recorded on a double plate, double stud wall with 5/8" sheet rock on both sides, an R-11 fiberglass batt with a 1 1/2" dead air space and sealed with closed cell polyurethane foam. Measurements were recorded in accordance with ASTM E-336.

Building Codes and Expectations

In many communities local building codes may dictate other applications or variations on the approach described here. The building code exits to insure that accepted construction practices are followed and certain minimums in performance standards are met. They also exist to benchmark innovative applications and concepts to make sure buildings are built safely with sound construction.

Number 8

Recessed Lights, Flues and Chimneys

Tiger Foam will seal recessed lighting from air infiltration as it will seal flues from unintended heat gain and HVAC supply and return lines from energy loss in the attic area. In a study on non-IC rated and IC rated lights, sealing of the non-IC (Insulation Class) rated lights prevented heat from dissipating and activated the lights internal safety devices turning the light off. IC rated recessed lighting fared only slightly better; within hours though, the build up of heat tripped the internal safety feature at approximately 125° F and the lights temporarily switched off. It is important to note here that cured **Tiger Foam** begins to degrade at 190° F and has an auto-ignition temperature of over 700° F. In this study, it was shown that a fire hazard is not present, but as of yet, no recessed light system has been designed without a tremendous amount of heat loss occurring during its operation. As such, **Tiger Foam** or any other closed cell polyurethane should not be installed directly to recessed lighting fixtures.

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.

Building codes currently mandate a two-inch separation of spray polyurethane foam from recessed lights and a 3 inch separation from masonry fireplaces and hot air flues. Sheetrock or foil faced extruded polystyrene boxes should be installed over rated and non-IC rated lights where possible to prevent energy penalties from excessive air leakage around these lights. In all cases, the use of IC rated recessed lights is preferable and the proper space between lighting, flues and chimneys and foam must be maintained.

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Number 9

Southwest Research Institute
Spray Polyurethane Foam Alliance
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 closed cell polyurethane foam in a Rim, Sill or Header area of the home. SRI conducted the tests; the apparatus employed was a modification of the protocols outlined in UBC 26-3 and was 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 ICC (International Code Council) including the International Residential Code (IRC) and International Building Code (IBC) to allow Class 1 closed cell 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 of 2000. As a result of this testing, when the IRC and IBC are printed in 2002 and for each state that adopts these changes, the code will allow a Class 1 closed cell 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.

Building Codes and Expectations

In many communities local building codes may dictate other applications or variations on the approach described here. The building code exits to insure that accepted construction practices are followed and certain minimums in performance standards are met. They also exist to benchmark innovative applications and concepts to make sure buildings are built safely with sound construction

Number 10

Non-IC Rated Recessed Light Time and Temperature Test

To determine if the temperature generated by a non-IC rated recessed light would impact the physical properties of **Tiger Foam** applied directly to the light housing. Would **Tiger Foam** applied directly to a non-IC rated recessed light create any hazardous conditions? Would the foam decay or would it catch fire? Would it in any way be possible to present an undue risk for fire or degradation of the physical properties of **Tiger Foam** that would lead to unsatisfactory thermal performance?

Two non-IC rated recessed lights were purchased and each were installed in a 2x4-framed box with 1/2 inch drywall on the simulated ceiling side. One light set was left exposed as a control and the other was sprayed with, on average, two inches of **Tiger Foam** from the top of the light to ceiling level. A temperature sensor was positioned at the top of the ceiling light and a second sensor was positioned at the base of the light on both the control and foamed lights.

A 100-watt bulb was installed in each recessed light unit and turned on. Each light unit was designed to use a maximum 60W bulb, so it was decided that a 100W bulb would provide an extreme condition not expected to be exceeded in actual conditions. The testing began at 9 AM with all temperature probes showing a 72° F starting temperature. Temperature readings were taken every 30 minutes for 7 hours.

Essentially, it was observed that the temperatures of both units climbed rapidly to peak at 125° F and 135° F on the top of both light units and between 135° F and 140° F at the base within the first 30 minutes of operation. As the temperature of the foamed unit reached 125°F on the tope position thermal sensing unite safety switch on the recessed light activated and switched the light off. Recessed lighting units have temperature-sensing devices installed to protect the light from overheating. This TSU was continually activated on the foamed unit at around 125° F and shut off every 20 minutes of operation. When the unit had cooled sufficiently to around 105° F, the unit reactivated and the light came on. The non-foamed control unit remained on for the duration of the experiment. The foamed unit was then dismantled to determine if any visible change to the foam had occurred; none was evident.

It appears that the temperatures generated by the recessed light do not affect the foam itself or create a dangerous fire-safety condition when the foam is in direct contact with the non-IC rated recessed light. It does appear that the foam will not allow heat to dissipate out of the light. This heat build-up in turn activates the safety device and turns off the light. The result of this test supports the code requirement of maintaining a two-inch separation of the foam from the recessed light.

Perimeter Insulation and Air Infiltration Seal

Recommended Design Considerations
And Guide Specifications
For Tiger Foam brand
Spray-applied Polyurethane Foam Insulation

Select Spray-applied Tiger Foam Insulation to Control Air Infiltration

Reduce Air Infiltration

Just 3/4-inch Tiger Foam Can Slash Heating/ Cooling Costs Dramatically

It is estimated that FORTY PERCENT (40%) of a home's heating or cooling loss results from air flow through cracks beneath the sill plate, around wall outlets and windows, along duct runs and other leak sources throughout the building envelope. As a result, the United States wastes approximately 40 Billion energy dollars per year through air infiltration loss. Insulation materials that are not self-sealing and monolithic no matter what the "R" Value of the insulation material will not stop this waste of energy and money.

Spray-applied polyurethane foam insulation adheres to most materials. It forms a seal eliminating leaks around studs, window and door framing, and filling in voids where air leaks allow the conditioned air in the home to escape. Failure to stop this air flow through the home's envelope means that "new" air constantly requires reheating or re-cooling. Minimizing areas where air can infiltrate helps to keep energy use and costs down.

Minimize Condensation

Tiger Foam brand spray-applied polyurethane foam insulation helps to seal the home, so energy usage for heating and cooling is kept to a minimum. The result is major cost savings for the homeowner.

Many homes are being built tighter and with more insulation than ever before. However, as a result, this means that moisture from cooking, laundry and showers can be trapped in attic areas where it can lead to wood rot, peeling paint, deteriorating roofing and ceiling materials, and, in turn, can affect the insulation value of commonly-used home insulation materials.

Moisture and condensation have virtually no effect on the properties of sprayed Tiger Foam insulation, if properly ventilated.* Tiger Foam insulation systems

minimize both heat build-up and condensation, resulting in a cooler attic in warmer environments and a dryer attic in cold climates. To the homeowner that means comfort, energy conservation and structural stability.

*If ventilation cannot be assured, refer to local code agency for vapor retarder information.

Inhibits Convection Looping

Temperature differences on outside and inside walls cause cold air to sink and warm air to rise within the stud cavity. This creates a convection current flowing up and down the walls.

The cost of energy to continuously heat/cool air that is moving throughout the stud wall cavity and/or within conventional insulation (if the temperature differential is sufficient to create convection looping) is considerable. Tiger Foam spray-applied against the exterior wall not only helps inhibit air infiltration, but reduces the temperature differences between the outside and inside wall, thereby preventing potential air movement within the cavity.

What you should know about R-values

"R" means resistance to heat flow. The higher the "R" value, the greater the insulation power. Do compare insulation R-values before you buy, however, there are other factors to consider. The "R" Value standard was established in order to compare one products resistance to heat transfer against another under laboratory conditions. The test does not take air flow into consideration. The introduction of air movement into the mix quickly defeats the insulation value of most fiberous materials whose insulative value is based on trapped air. The minute a convective current begins in a wall structure the traditional fiberous materials in the cavity become an air filter not a thermal barrier. **Tiger Foam** prevents air flow by sealing the cavity preventing air infiltration, then its' insulation value prevents the temperatures differential necessary to create the convective current. The amount of insulation you need depends on the climate in which you live, the type and size of your house, your fuel-use patterns, and family size.

It is critical that a contractor calculate specific requirements for each project

How Much Tiger Foam Perimeter Insulation is Necessary?

A nominal 3/4-inch of **Tiger Foam** sprayed-in-place polyurethane foam must be installed to achieve the air-infiltration control necessary to reduce energy costs. Additional thickness may be required to seal voids, cracks and other imperfections in the building envelope. Commercial Thermal Solutions, Inc. recommends a one inch minimum thickness to ensure all points of potential air infiltration are sealed.

The specific thickness of insulation depends on local codes, personal preferences, where the house is located, and the type of construction being utilized. Further, the thickness of the sprayed **Tiger Foam** can vary, if necessary, to complement other insulating materials of choice, i.e., glass fiber, sprayed cellulose or mineral wool, to achieve the required "R" value.

Many "R" value and "U" factor calculations are provided throughout the text of these guidelines. These should provide substantial insight into the results achieved by varying sprayed thickness requirements of Tiger Foam. However, it is critical that a **Tiger Foam** contractor calculates specific requirements for each project, and verifies with local, state and national codes prior to installation.

All hot work, i.e., welding, torches, and open flame work, must have been completed prior to commencing the installation of the spray polyurethane foam insulation. Smoking in the area while the spray polyurethane foam insulation is being applied shall be strictly prohibited.

Safety Precaution!

Air-Infiltration Control Procedures

Cover the openings of all electrical boxes, including electrical-switch and receptacle boxes, telephone boxes, stereo connections, cable TV, etc. Do not mask openings to the exterior of the building envelope as they must be sealed with spray-applied **Tiger Foam** to create the air-infiltration seal that is so important.

Masking is a key preparation step

Cover window openings with polyfilm or other protective materials. This will prevent spray polyurethane foam overspray and waste, as well as saving cleanup time.

As a general rule, if an opening, crack or crevice exists, sprayed **Tiger Foam** insulation will fill and seal it. However, a major loss of heating or cooling takes place between the sill plate and the foundation slab.

Be sure to mark each masked unit

Use polyurethane elastomeric sealant or other approved materials to seal between the wood member and the concrete.

Air-seal window and door framing where major air infiltration occurs. Polyethylene rod stock, followed with caulk, and then single-component polyurethane foam available in kit form, should be used to seal cracks and crevices around windows and door framing to form an integral seal with the thermal envelope.

Do not mask beyond window casing

Installing polyurethane foam insulation around door and window framing will provide a tight energy-efficient, air-infiltration seal.

It is critical that you caulk

Seal holes for plumbing and electrical wiring to eliminate another significant potential energy loss area. Openings in the sheathing for piping, around the top plate and the sill plate should be sealed with **Tiger Foam** to prevent air infiltration.

Electrical wiring applications may require special attention. Refer to Electrical Testing in another section.

Application Tips and Techniques

Controlling thickness is critical to good application technique and to assure full insulation values achieved. Mark a long ordinary needle or pin in half-inch increments. As you work, monitor foam thickness by inserting the pin into the cured **Tiger Foam** and reading the depth as indicated.

Controlling thickness is critical to good application

Spray-applying **Tiger Foam** in a residence can be best done in a "picture framing" motion, in which the applicator surrounds the perimeter of the stud cavity allowing the foam to rise along the stud face. After rise, the middle cavity can be sprayed. This will ensure that the sprayed ***Tiger Foam*** seals cracks and crevices without resulting in fold-over along the stud face where air-pocket voids may occur.

Federal, local and state building codes vary. Most require that spray-applied polyurethane foam insulation be covered with an approved 15-minute fire-rated thermal barrier. One typically approved material is 1/2" gypsum wallboard applied over the spray applied polyurethane foam insulation. However, always check with local officials for recommendations and approvals.

Building codes require an approved thermal barrier

Scrape all stud surfaces clean in order to eliminate any overspray. This task will be easier if the stud face is prepped with a release agent or masked. This will allow any overspray to be quickly and easily pulled loose or scraped away with a trowel, garden hoe or other long-handled tool.

All scrap and unused liquids should be properly discarded. The manufacturer's **Tiger Foam** data sheet and MSDA (material safety data sheet) are an integral part of this guideline and should be read and followed in their entirety.

Safety Precautions!

For homes insulated with spray-applied **Tiger Foam** insulation, electrical work should be undertaken with either baseboard raceway system or shielded cable. Because of code differences, it is important that you refer to regional, state and local electrical codes and check with local code officials if there are any questions. Refer to electrical test in other section.

Do not use aluminum wiring under any conditions in conjunction with spray-applied polyurethane foam insulation.

Recessed lighting, heat lamps, ventilation fans and other recessed fixtures require special installation procedures as detailed elsewhere in this document.

Safety Precautions!

Tiger Foam polyurethane foam is very resistive to water penetration. However, it is not a vapor barrier and is therefore subject to moisture-vapor penetration under certain conditions. The use of a vapor barrier is recommended under some conditions. Check with local authorities for standard procedures in your area.

Wall System Alternatives

Elective additions/ alternatives

Once the house has been framed and enclosed with exterior siding, sprayed **Tiger Foam** may be applied between the studs. As little as 1" inch of sprayed **Tiger Foam** insulation can provide significant "R" value in addition to controlling air and moisture infiltration.

Follow proper electrical and plumbing preparation and clean-up procedures, as outlined in the **Tiger Foam** handbook, before applying an approved 15-minute finish-rating thermal barrier such as 1/2" gypsum drywall, or equivalent.

"R" values are Based on Material Thickness of 1" Examples

1.	Add 1/2" Unfaced Polyiso Foamboard Sheathing	R	3.00
2.	Add 1/2" Exterior Grade Plywood	R	.62
3.	Add 1/2" Fiber Board Sheathing	R	.66
4.	Add 1/2" Molded Expanded Polystyrene Sheathing	R	1.93
5.	Add 3" Sprayed Polyurethane **Tiger Foam**	R	21.0
6.	Add 3" Glass Fiber Batt	R	9.81
7.	Add 3" Blown Fiber Blanket*	R	11.1
8.	Add 3" Sprayed Cellulose Fiber	R	10.5
9.	Add 2 1/2" Sprayed Polyurethane **Tiger Foam**	R	17.5

*Mean value of several products

Un-faced Polyiso Board	R	6.00
Ext. Grade Plywood	R	1.24
Fiber Board Sheathing	R	1.32
Sprayed **Tiger Foam**	R	6.2-7
Glass Fiber Batt	R	3.27
Sprayed Cellulose Fiber	R	3.50
Expanded Polystyrene	R	3.85

Note: Although "R" values presented here have been extrapolated from what were deemed reliable sources, the information provided should be verified from materials manufacturer data sheets.

Figuring "R" Values and "U" Factors for Your Wall System

Using the electives shown on the previous page, you can easily achieve the insulation design that meets the customer's needs. For example:

Basic	R	6.2	3/4" **Tiger Foam** plus inside/outside air
Add #9	R	3.00	1/2" Polyiso Board Foam Sheathing
Add #6	R	9.81	3" Glass Fiber Batt
Total Wall Value		19.01	

Basic	R	6.2
Add #9	R	17.50
Add #3	R	.66
Total Wall Value		24.36

Basic	R	6.2
Add #8	R	10.50
Add #1	R	3.00
Total Wall Value		19.70

Basic	R	6.2
Add #5		21.0
Total Wall Value		27.2

"R" Value: A measure of the resistance of a material to the passages of heat. The less heat that a material will allow to pass through it, the higher the material's "R" Value.

"U" Factor: Measures the amount of heat passing through a composite of materials. To determine "U" divide 1 by the total of "R" values. Example: The "U" of a total "R" value of 23.75 is .042.

Developing Your Own Wall System

Basic	R	6.2
Add #___	R	____
Add #___	R	____
Add #___	R	____

Total System Value R____

1 (one) divided by the total "R" equals "U" ____

In most cases, the habitable area of the structure must be protected by an approved 15-minute thermal barrier

Ceiling and Roof Applications for Sprayed Tiger Foam Insulation

Spray-applied **Tiger Foam** insulation is used to seal off air infiltration and provide high insulation efficiencies in the ceiling area of new homes. The application depends on the roof design. Again, determine the design "R" value for the environment and climate in which the home is located.

Ceilings are among the most important areas to address when controlling the infiltration and providing insulation for the residential environment. If this portion of the building envelope is not properly sealed and insulated, a major portion of your energy costs have been wasted.

Spray-apply the **Tiger Foam** insulation system against the underside of the plywood decking using a window framing technique within the joist area.

For interior residential design with open beam ceiling construction, the **Tiger Foam** insulation system is applied to the underside of the roof decking. An approved 15-minute finish rated material such as 1/2" gypsum drywall is applied between the beams and directly against the foam to leave beam edges exposed.

Sprayed polyurethane foam insulation should, under no circumstances, be applied closer than 3" from chimney, fireplaces, or flue construction and then must be protected by a thermal barrier.

Exterior Roofing Application

For exterior roofing applications, spray-applied **Tiger Foam** may be used to provide a seamless, lightweight high-strength system with unsurpassed water resistance, superior insulation and economical, long-term performance. For specific details, contact **Commercial Thermal Solutions, Inc.** for further information on flat roofs.

Recessed Lighting Fixtures

Recessed lighting, heat lamps, ventilation fans and other recessed fixtures require special insulation of gypsum wallboard box-barrier surrounding at least three inches from the fixture. Sprayed polyurethane foam insulation may be applied up to the box surround. Fixtures designed for high-temperature use (IC Rated) may be used in this application.

Masonry Wall Applications for Sprayed Tiger Foam Insulation

Follow proper electrical and plumbing preparation procedures. To the cement block wall, install 2" furring strips on the interior side of the construction, 24" on center. Spray-apply **Tiger Foam** insulation system into the resulting 2" cavity, making sure the material fills the cavity depth. The insulation system must be covered with an approved 15-minute finish-rated thermal barrier such as 1/2" gypsum drywall or an approved equivalent material.

Exterior Wall Applications

In this construction, spray-applied **Tiger Foam** insulation is applied to the exterior surface of the masonry wall. An exterior finish for the home, such as stucco or face brick, is then applied over the insulation system.

As it is sprayed onto masonry surface, **Tiger Foam** insulation adheres, forming an integral construction with the masonry. Apply insulation to the thickness desired to achieve the design R-value for the construction and inhibit air infiltration through the masonry wall system. Install plasterer's mesh and finish the exterior.

Care should be taken to assure that openings through the exterior wall for plumbing and other services are sealed with the spray-applied **Tiger Foam** insulation to prevent air infiltration and other sources of energy loss

Floors, Foundations and Basements

Spray-applied **Tiger Foam** insulation systems can be used on the exterior surface of a basement wall. In this construction, **Tiger Foam** is spray-applied to the concrete block foundation to design thickness and covered with a moisture barrier to protect its insulation life. The perimeter must be back-filled against the insulation/concrete block construction.

Basement Application

Spray-applied **Tiger Foam** insulation systems may also be used to insulate basements, forming an insulation seal against air infiltration from beneath the housing floor. Install furring strips to concrete block masonry and spray-apply the **Tiger Foam** in the resulting cavities. Be certain to follow precautions and proper preparation for plumbing accesses and electrical installations.

Crawl Spaces

Spray-applied **Tiger Foam** insulation systems may also be used to insulate crawl spaces, forming an insulation seal against air infiltration from beneath the housing floor. Spray-apply the **Tiger Foam** to the foundation wall and into the area formed by the sill plate.

For more information, please contact the manufacturer:

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