Building Science

Rhino Linings®

HVAC System Sizing Considerations

Typical Practice

A Heating, Ventilation and Air Conditioning (HVAC) contractor is required to use one of the standard methods for determining heating and cooling loads on buildings, such as Air Conditioning Contractors of America's (ACCA) Manual J for residential buildings or Manual N for commercial buildings. However, in many cases, this step is never completed.

These methods take into account specific building characteristics including orientation, dimensions and thermal performance of exterior components (walls, ceilings, basements, windows and doors). Averaged local weather data as well as summer and winter peak design temperatures are also considered. Then, a building is placed into an air leakage category based on construction tightness estimates and a generalized wind shielding description to estimate how the building will perform in breezy or windy conditions.

In the interest of customer satisfaction, to ensure that desired interior design conditions can be met at all times, an HVAC contractor will often add considerable extra heating and cooling capacity equipment. This fairly common desire to oversize is largely due to the unpredictability of performance that is expected from typically constructed "leaky" building. Extra heating and cooling capacity adds significant cost and additional HVAC system space requirements.

This is particularly true on the cooling side. Humid summer conditions coupled with oversized air conditioning units lead to short cycling that cools without dehumidifying adequately. This produces a cold, clammy environment with high relative humidity which is a breeding ground for mold and mildew. Building occupants are faced with poorer indoor air quality and higher energy costs due to ineffective oversized systems.

How To Do it Right

Build tight and ventilate right is the answer to minimizing guesswork involved in HVAC equipment selection. Tight construction drastically reduces the significance of air leakage and its effect on HVAC system sizing. Also, tight construction coupled with mechanical ventilation ensures proper air quality during all weather conditions. Unfortunately, constructing tight buildings that are increasing in complexity with conventional materials and methods has proven to be a difficult and costly challenge.

Dealing with the “Tightness” Challenge

Spray polyurethane foam insulation handles the "tightness" challenge easily. Using a blower door diagnostic air leakage test, spray polyurethane foam insulated residential buildings regularly test at less than 0.15 ACH_n. As we discussed previously, this compares very favorably to conventionally constructed homes that often test at 0.4 to 0.6 ACH_n In addition to air sealing, without convective airflow within the cellular material, the insulating value of spray polyurethane foam remains virtually the same in all conditions of temperature and air pressures.

Duct Location and Duct losses

In many buildings, due to space restrictions or other design considerations, duct work may be located within unconditioned attics or crawlspaces. In these cases, duct losses can account for 5% to 30% reduction in efficiency.

This happens in two ways. First, HVAC duct work is typically constructed of sheet metal tubes which are fitted together. The seams on these ducts are notoriously leaky, especially if high quality mastic sealants are not used. However, the process for sealing ducts is laborious and leaks are often over looked. Even with a significant level of detail in ensuring that ducts are sealed, these ducts often leak upwards of 10% of the air flow through gaps.

Second, ducts located in unconditioned spaces experience drastic changes in the environment they pass through. An unconditioned attic can reach temperatures in excess of 150°F and yet fall to ambient temperatures during the winter months. Most building codes only require that these ducts be insulated to R-6 or R-8, allowing significant amounts of heat loss through the ducts and insulation. A properly functioning HVAC system should have a temperature difference or ΔT of approximately 20°F. However, if this air must then travel through extensive, poorly insulated and sealed duct work in an unconditioned space then the supply registers in the rooms to be heated or cooled will not receive supply air at the proper temperature and volume to efficiently condition the space. This becomes an important design consideration which can be solved with spray polyurethane foam insulation, but it must be accounted for when specifying spray polyurethane foam insulation during the design phase and considered when sizing the HVAC system.

The Bottom Line

Sizing HVAC systems for buildings is not harder than before, but it is more critical than ever. The high performance structures that are now being built allow HVAC professionals greater control over the indoor environment than ever before. It is no longer necessary, nor recommended to guess at air leakage levels or compensate for shortcomings in air barrier and insulation materials. It is recommended that a detailed Manual J, Manual D, and Manual S calculation be used for residential buildings to accurately size the HVAC system. If this process is used, homes of standard construction may see equipment sizing of approximately 500 sqft/ton. With the use of spray polyurethane foam and other responsible building practices, this can stretch to 650-1000 sqft/ton making old rules of thumb inadequate and antiquated.

The net result for the consumer is an average of 30% to 50% reduction in heating and cooling size, lower power requirements, and smaller equipment space requirements, and lower utility costs.

Building Ventilation and Air Quality

History of Construction Issues

For years, changes in North American housing construction requirements have been introduced with the intent to help reduce energy consumption. Many older buildings with hollow exterior walls were not built with dedicated air barrier, vapor barrier or insulation materials and thus experience serious air-leakage. Blower Door depressurization tests on older homes have recorded 1 to 0.6 Air Changes Per Hour at natural air pressures (ACH_n)

During the heating season, large temperature differences between indoor air and ambient air cause leaky buildings to act like chimneys and this "stack" effect alone causes significant air leakage. Wind also creates pressure differentials between exterior surfaces that cause air leakage. Finally, mechanical systems and other fans inside the building lead to air pressure differentials that also cause air leakage. All three pressures cause conditioned air to leak out of (exfiltration) or unconditioned air to leak into (infiltration) the building, depending on the climate and season. This leakage occurs through holes in the building envelope where the air barrier is incomplete, improperly installed or damaged. In northern winters, humidification is needed as excessive air exfiltration causes uncomfortably low indoor relative humidity levels. In humid summer conditions, excess infiltrated moisture must be removed from the interior of the building with air conditioning and/or dehumidifiers.

Other air quality problems are present as ambient air contains mold and mildew spores, bacteria, pollen, dust, etc. In addition, air leakage through structures carries moisture vapor with it, which condenses on colder surfaces. This condensation causes wood decay and contributes to the creation of microenvironments suitable for the development of mold and mildew.

In older buildings, uncontrolled air leakage can be responsible for 50% to 60% of the heating and cooling energy consumption, and large capacity heating and air conditioning equipment is required.

Today's Standards

With the adoption of air barriers and insulation requirements, typical new housing air leakage rates are now 0.4 to 0.6 ACH_n during peak leakage tests. Builders who provide extra attention, labor and effective sealing materials provide structures that test for peak air leakage at 0.25 to 0.4 ACH_n.

Building code changes and extra tightening efforts by custom builders have been implemented to improve energy efficiency and comfort. Savings from reduced heating and air conditioning equipment requirements are realized.

Under Ventilated Buildings

Virtually any building is likely to experience under-ventilated periods unless controlled ventilation is employed. Until recently, little attention has been devoted to varying weather conditions in relation to indoor air quality. Although most residential building codes require point-source exhaust fans for spot use, a few specify make-up air for combustion appliances. With a few exceptions, building codes do not address under-ventilated conditions in residential buildings.

Add to this an indoor environment that is a chemical and biological soup. Many building materials used in new home construction off-gas volatile organic compounds (VOC's). Household cleaners and other vaporized chemicals, smoking and cooking odors also are often present. As we breathe, oxygen is consumed and CO_2 levels rise. Human activities and related processes produce moisture vapor that helps create microenvironments suitable for biological growth. Mold and mildew feed on organic materials like the cellulose in paper and pet or human skin dander. Dust mite life cycles produce dried carcasses and feces that often become airborne (these allergens are known to trigger asthmatic attacks).

During under-ventilated conditions, these and a myriad of other pollutants are introduced to the indoor air, building up to unhealthy levels. The U.S. Environmental Protection Agency has performed studies indicating that average indoor air is 7 to 10 times more polluted than outdoor air.

Ventilation - Doing it Right

The solution is to build buildings as tight as possible and take full control of fresh air requirements with controlled mechanical ventilation. This minimizes unwanted air and moisture movement through the structure, and allows the intake and cleansing of the correct amount of air for the specific building. Buildings are complicated and, when using conventional insulation and air/vapor barrier materials, extremely tight construction is difficult and expensive to achieve.

A Healthy Home with Spray Polyurethane Foam (SPF) Insulation

A typical home with a spray polyurethane foam insulated thermal envelope coupled with minimal caulking typically tests for peak air-leakage at 0.15 ACH_n or less.

Once a tight thermal envelope has been established, a properly designed controlled mechanical ventilation system is recommended. The choice of system (supply side, or balanced) depends on the type of building, and cost. Extra ventilation may be needed to compensate for large point source exhaust fans (i.e. kitchen cook top fans, clothes dryer fans). Ventilation systems installed in buildings with sealed envelopes operate much more efficiently because of greatly reduced random air leakage through the exterior walls, roof and floors. The result is a healthy indoor environment, superior energy efficiency and ultimate comfort.

Building Moisture and Air Quality

Mold and mildew are a major problem in warm, humid climates such as the U.S. southeast where as many as 70% of all homes eventually suffer from mildew problems. Mildew increases the risk of occupant sickness and causes expensive and frequent repairs and redecorating. Mildew is a mold that grows under warm, humid conditions. Optimal growth conditions are from 77° to 86° F, and between 62% and 93% relative humidity.

Moisture Generation in Homes

Relative humidity inside buildings is greatly increased by the addition of moisture to the air in many different ways. Daily human activities such as preparing meals, washing dishes and clothes, bathing, using whirlpool tubs or showers, maintaining aquariums and plants, or even breathing add moisture to the air. A 15-minute shower can add 1.7 pounds (0.75 kg) of moisture to the air.

External Moisture Infiltration

The infiltration of humid air can add significant quantities of water to the air in a typical home. Moisture enters from outside through open doors and windows and by infiltrating the building envelope. Natural ventilation through cracks, crevices and chimneys will cause some air infiltration, but this is accelerated by air entering the building to replace air that has been "exhaled" by exhaust fans. Infiltration can change the air 24 to 48 times a day, and when moisture-laden outside air is brought in to a structure, it adds a tremendous load to air conditioning equipment. With 100% relative humidity, clothing, paper products, wood and some textiles can absorb up to 20% of their weight in water.

Oversized Air Conditioners

Improperly sized air conditioning units can also greatly increase the humidity inside buildings. The role of air conditioning in humid conditions is two-fold: remove moisture from the air, and reduce the temperature. Thus, it is vital that air conditioning units run a significant amount of the time in humid conditions to keep the relative humidity below 60% (the level at which mildew begins to grow).

Unfortunately, in humid climates air conditioning units are often oversized for the load requirement of the building. Even when properly sized to meet peak loads, a correctly installed HVAC system will be “over sized” during significant portions of the year. In these cases, the units only run long enough to reduce the air temperature and do not actually remove much moisture. The result is a lower indoor temperature, but actually a higher relative humidity (colder air cannot hold as much moisture as warmer air). To the occupants, this environment feels clammy or "cave-like" and less comfortable. This causes the occupants to turn down the thermostat further, which can make the problem worse, and wastes energy keeping the building cooler than it needs to be.

Oversized air conditioning units are common in humid climates because of building practices of the past. Older buildings had high rates of random air leakage. Ductwork for systems were typically placed in unconditioned spaces (e.g. attics and crawlspaces), and there was a loss of conditioned air into these spaces due to leaks in the ducts. These practices led to a great uncertainty for the air conditioning contractor who had to design a system to make up for the shortcomings. The result was over-designed, oversized units.

Build an Airtight Structure

The only way to avoid mildew is to control the interior relative humidity. Along with proper practices that reduce generation of moisture by the occupants, such as point source ventilation, reducing air leakage and proper sizing of air conditioning equipment will reduce relative humidity.

Building an airtight structure limits the amount of moisture-laden air that gets inside, and it allows the use of smaller air conditioning systems which run for longer periods, removing more moisture from the air and lowering the relative humidity as a result.

Further reduction in air conditioning sizing can be achieved by sealing ductwork and/or installing ductwork within the conditioned space of the building. (see HVAC System Sizing Considerations)

Vapor Barriers are NOT the Solution

Most air leaks into buildings occur through sill plates and framing members, electrical outlets, duct systems, penetrations through attic floors, and around windows and doors. One attempt to combat the moisture problem has been to apply a vapor barrier against the inside of the interior wall. This is the wrong place for a vapor barrier in a humid climate. The vapor barrier, at this relatively cool location, provides a surface for condensation to occur as outdoor air moves inside. Placing the vapor barrier on the inside of the exterior wall creates another problem in the winter, when interior vapor is trying to move outside.

In fact, modern building codes and building science have eliminated the terminology “Vapor Barrier” from its vocabulary. This term has been replaced with the term “Vapor Retarder” and three different classifications of vapor retarders have been identified with decreasing levels of permeability.

Class	***Permeability Range***
I	Less than 0.1 perm
II	0.1 to 1 perm
III	1 to 10 perm
Vapor Permeable	Greater than 10 perm

Considering that moisture vapor always moves from areas of high concentration to areas of low concentration and that warm air holds more moisture than cold air, building assemblies should be designed with decreasing permeability toward the warm in winter side yet high enough to still promote drying. This can only be accomplished by using materials with the maximum perm rating necessary to avoid moisture accumulation and air impermeable insulation materials like spray polyurethane foam.

The Solution: Monolithic Air Barrier with Spray Foam Insulation

The recommended solution was first proposed by the School of Building Construction at the University of Florida: eliminate the use of a vapor barrier and instead use an air-retarder in the wall to inhibit the passage of airborne moisture. While an air barrier inhibits the entry of air it must be slightly vapor permeable to allow building materials to dry.

Rhino Linings®

Spray polyurethane foam is a site-installed foam material that provides an excellent air barrier throughout the entire building envelope. By expanding into cracks and crevices and adhering to other building materials, this soft flexible foam ties all other building assembly materials together into a monolithic, continuous envelope.

No other sheet-type air barrier material or method can match the performance of spray polyurethane foam. With the air-sealing ability of spray polyurethane foam in place, preventing outdoor moisture from entering the buildings, the air conditioning contractor can select a system that is sized appropriately for the cooling load.

In addition to the air sealing qualities of spray foam insulation, as a specifier, you have some choices in vapor permeability. An open cell, low density product is air impermeable, and when installed at thicknesses greater than 5.5”, it has a perm rating of less than 10 which qualifies as a Class III vapor retarder. Rhino Linings offers products that do not necessarily require the additional vapor retarders that many other types of insulation typically do. For even higher performance, closed cell, medium density products offer improved R-value, and when installed at thicknesses greater than 2” have vapor perm ratings less than 1.0 or a Class II vapor retarder.

Air Quality Tips for Occupants

- With the relative humidity lower, you can set the air conditioner temperature higher and use ceiling fans to stay comfortable during summer months.
- Set the thermostat 5°F higher or lower, depending on the season, than the desired temperature while you are away.
- Keep the interior temperature below 75°F and relative humidity below 60% to avoid mold/mildew growth.
- Wipe dry any thing that gets wet after use - things like shower doors, wet floors and tiles, counter-tops, sinks and spills in general. Hang wet towels, mops and clothing outside to dry. By doing this, the amount of moisture evaporating inside the home will be drastically reduced.
- Close the fireplace damper when not in use.
- Keep doors and windows closed in the morning or after a rainfall, when the humidity is high.

Building Tips

- Build a tight building to prevent warm humid air from infiltrating the envelope.
- Install mechanical ventilation at the source of moisture.
- Ensure that shower stalls and baths drain properly and do not puddle.
- Waterproof and seal exterior block walls.
- Do not install a class I vapor retarder (vapor barrier) on exterior walls unless absolutely necessary.

Insulating for Sound Control

Controlling sound in single and multi-unit dwellings is an important design consideration. Selecting the right materials, including insulation, will determine how effective sound control measures will be. Rhino Linings® offers a spray-in-place two component liquid material that expands into low density polyurethane foam. It provides effective sound deadening properties in buildings.

Reducing Airborne Sound

Sound can travel through a variety of mediums including framing members and, but most commonly through air. Loud stereos, highway and city noise, and human speech are common sources of airborne sound. Sounds propagate through the air at many different frequencies, but it is the mid-range frequency noises that are most noticeable.

Reducing Flanking Sound

Often, reducing airborne sound by providing an air barrier material is not enough. Every possible pathway that sound can travel through to another room must be eliminated. This is called flanking sound. To have a reasonable chance of eliminating it, a site-applied material that fills gaps and crevices must be used. It is a known fact that flanking sound can reduce STC (Sound Transmission Class) ratings by up to 5 or more. This is why STC requirements for sound barrier construction are high, because designers know these values will not be achieved in the field.

Spray polyurethane foam fills gaps in the building cavity while adhering to all adjoining components for a tight seal. This greatly reduces flanking sound, and can produce STC ratings similar to theoretical design values in a smaller cavity thus using less material and saving money.

Reducing Noise Caused by Plumbing

Running water can cause the pipes to vibrate, and transfer that sound into the structure of the house. Once the vibrations get into the structure, the sound can be transmitted to other parts of the building. This can be a big issue in multi-unit apartment buildings. Rhino Linings offers a soft, semi-open-cell material that can be applied around these pipes. The vibrations will then be greatly dampened, and structure borne noise reduced. Properly securing the piping inside the wall or ceiling and good design will minimize the vibration and water hammer sound even more.

Impact and Structural Vibrations

Spray foam is a great insulator to airborne sounds, and can also be combined with other materials to reduce impact and structure borne vibrations. Impact noise is not being transmitted through the air; rather it is causing vibrations within the building assembly itself. Adding insulation will not dampen those sounds effectively; the floor must be isolated from the rest of the structure.

Combined with drywall mounted on resilient channels and/or a staggered stud assembly, spray foam provides an effective break between two parts of a structure, isolating the vibration or impact noise from the people on the other side. Coupling these techniques, with other sound control practices, results in a quite, comfortable living environment.

Insulating Unvented Attics and Cathedral Ceilings

Roof Ventilation History

History shows that the first structures likely used thatched or shake roofs made of natural materials. There was little in the way of heating and cooling. In this design, the main purpose of the roof was to keep the rain and sun out. There was little care to how well insulated the roof was or how moisture vapor moved.

As construction methods improved and buildings were heated and cooled, insulation was added to ceilings and walls to help hold the heat in. Specifically during and after WWII insulation became critical in order to help ration energy use and conserve heating oil. After this transition to more energy efficient designs, paint companies began to have issues with pealing paints that they had never experienced before. Paints began to peal; mold and rot became an issue because moisture generated inside of homes was now coming into contact with cold surfaces that prior to the use of insulation were kept warm by heat escaping from the buildings.

As engineers began to deal with these problems and other building failures, the first building codes were developed to help build better, safer buildings. One building code instituted was the requirement to ventilate the attic space or the underside of the roof in order to remove excess moisture before it could condensate. Various codes, standards and methods were used and through trial and error, it was determined that approximately 1 square foot of ventilated opening per 300 square feet of attic space would prevent condensation from occurring on the underside of roofs.

The ventilation of roofs also solved one additional problem. In winter months, climates with heavy snow load experience a phenomenon called ice damming. This serious problem is caused by warm air contacting the underside of a roof structure, in turn melting snow from the roof. As water runs down the warm portions of the roof, it contacts cold surfaces and re-freezes. As this problem worsens, icicles form, water backs up under shingles and flashing, damaging interior finishes and generating rot and mold. In severe cases, these ice formations can add significant weight to wall and roof surfaces resulting in structural damage. Correctly ventilating the roof fixes the ice damming problem.

These building codes were successful in helping to reduce moisture problems. It was later determined that the amount of ventilation could be cut further if a vapor retarder was placed on the warm in winter side of the insulation. This lowered the total amount of moisture that was allowed to accumulate in the attic and therefore reduced the amount of ventilation that was needed.

Spray foam insulation can be used in traditional attic construction methods as other insulation systems and many of the same benefits that it brings to wall insulation carry over into the attic. Traditional roof ventilation can help solve various building problems; however it does not address the root cause of these problems. A common thread can be found in each problem addressed by roof ventilation. That problem is warm moist air movement from the conditioned space into an unconditioned attic.

New Technologies

Today, buildings are being designed with more complex roof structures. Roof designs such as hip roofs and other designs with numerous hips and valleys are difficult, if not impossible to adequately ventilate. Thankfully with the adoption of new building codes that address conditioned (non-vented) attics, products like spray foam insulation can cure this problem.

Because spray polyurethane foam is “air impermeable”, it can be applied directly to the underside of roof structures. In the absence of insulation on the attic floor, warm air is allowed to enter this “semi-conditioned” space keeping the interior of the foam warm. Since the foam stays above the dew-point, the moisture condensation issues addressed by attic ventilation are no longer a consideration.

In addition, 5.5 inches of ThermalGuard OC.5 foam has a vapor presence of less than 4.2 perms. This allows only small amounts of moisture to pass through the foam allowing the foam and roof assembly to “breath” or dry over time. In extreme cold climates or where indoor relative humidity reaches above 60% during the winter month, closed cell foam, such as ThermalGuard CC2, may be used to achieve perm ratings of less than 1.0.

What about Shingle Temperatures and Shingle Life?

Starting in the mid 1980s, manufactures of attic ventilation devices began to advertise that attic ventilation could potentially increase shingle life by reducing the shingle temperature. This was based on suspicion rather than shingle failures or any firm research. It does not appear to have been a consideration in the adoption of building code regulation for attic ventilation in the 1930’s. It wasn’t until the late 1980’s and early 1990’s that shingle manufactures began including attic ventilation as a key requirement for shingle warranties.

More recent research into the issue of shingle warranties and temperatures has determined that attic ventilation has little effect on shingle temperature and subsequently single life. In direct sunlight when shingles reach temperatures in excess of 150ºF, there is typically less than a 5ºF temperature difference in shingles over a vented vs. non-vented roof assembly with the non-vented shingles being only slightly warmer. It has also been determined that shingles on north vs. south slopes and light vs. dark colors can experience greater temperature swings than vented vs. non-vented. In addition shingles sold in northern, vs. southern climates which experience drastically different environmental conditions carry the same warranties.

Today, some roofing product manufacturers still cling to the requirement for attic ventilation while others fully endorse the application of their products over attics without ventilation.

What’s the Real Benefit

While non-vented attics can be used in almost any climate or roof design, the real energy savings comes in warm humid climates where the traditional ventilation considerations for cold climates don’t apply. In warm humid and mixed climates, it is common practice to install HVAC duct work and equipment in the attic space. As discussed previously, there can be significant cost savings and HVAC sizing savings by locating the duct work in a conditioned space.

One additional benefit is building tightness. One look at the average ceiling before insulation is installed shows just how monumental the task of sealing and insulating the envelope at the ceiling level really is. There are literally hundreds of possible places for air infiltration and for heat to escape across the ceiling.

Recessed lighting is common place in today’s architectural design, however each recessed can light effectively equals 1 square foot of un-insulated space in addition to sources of significant air leakage.

These issues, ceiling height changes and other related problems are virtually eliminated when spray polyurethane foam is used to create a non-vented attic assembly.

In cold climates, the problem of ice damming is controlled as well. By insulating the underside of the roof, warm air is not allowed to contact the roof decking. In turn, snow and ice is not melted off of the roof to cause any ice accumulation at the eve.

Going Costal

One additional thought to consider is the use of non-vented attics in costal regions. These areas have some unique issues that generally don't affect buildings in other areas. Costal areas typically have higher humidity. Venting with relatively higher humid outside air can cause the moisture to be deposited in the attic space. If this warm, moist air contacts cool HVAC equipment, then condensation and subsequently mold and mildew can occur.

During high wind events, air that enters the attic can pressurize the space. This is the most common cause for wind damage to buildings along costal areas. As the wind pressurizes the building, roof sheathing can be loosened and subsequent building failure occurs. Also, wind driven rain can enter the attic through ventilation openings saturating traditional insulation. Wind can also blow loose fill insulation away from the edge of the ceilings leaving large gaps in the thermal envelope.

The solution is to use either open or closed cell spray polyurethane foam in a non-vented attic configuration. Both products offer air sealing properties that can significantly improve building performance as well as energy efficiency in this environment. Specifically, closed cell foam has been shown to significantly improve the strength of the building assembly by "gluing" the framing members together.

Final Note

The air sealing ability of spray foam insulation and its increased thermal performance, make it superior to traditional loose fill and batt insulations when used in the same configuration. One of these advantages is due to the fact that it is not susceptible to "wind washing". Building Science Corporation defines wind washing as:

> "The phenomenon of air movement driven by wind pressures wind passing through the thermal insulation within enclosures, causing significant loss of heat flow control and potentially causing condensation. Typically occurs are exposed building edges, such as at the outside corners and roof eaves because of the large pressure gradients at these locations. This can be thought of as the "wind blowing through the insulating sweater" effect." [sic]

There are many benefits to using spray polyurethane foam to create a non-vented attic assembly. Those discussed here are only a sampling of some of the biggest advantages. However, even though the non-vented attic design offers many advantages that spray polyurethane foam can help achieve, spray foam can also be used in a traditional vented attic. The fact that a non-vented attic design requires the use of air impermeable insulation like spray polyurethane foam; it should not be interpreted as meaning that it is the only use for spray foam in attics.

Rhino Linings®

Steel Building Insulation Practices

Traditional Insulation Practices

Steel buildings are a common choice for buildings of various types and uses. They are used for agricultural buildings and churches, warehouses and offices. How can such a simple building be used for such a wide variation in building types?

Steel buildings are long-lasting structures that are relatively inexpensive and quick to build yet versatile. In addition, these can be fairly energy efficient, due to the reflective nature of the steel and the coatings used on these buildings properties. Yet, they do have some design issues that need to be considered.

Traditionally, steel buildings are designed with steel (or in some cases wood) structural support columns. Additional support beams referred to as “perlins” attach to these support columns and allow fiberglass insulation to be draped over them before steel panels are attached over the top. In order to help control condensation, a vapor retarder is attached to the inside of the fiberglass insulation.

Better condensation control

If a multi-billion dollar space shuttle is only as effective as the $0.25 O-ring used in it, then vapor retarders are the $0.25 O-ring of steel buildings. Building with a poly vapor retarder, which may be easily damaged, and fully relying on it to stop moisture condensation is not good building science.

A better approach is to use building materials which are both air impermeable and offer vapor retarding ability. Spray polyurethane foam offers both of these in one seamless application. When spray foam is used, the foam is applied in direct contact with the structural steel and the exterior panels. This prevents moist air from contacting the cold steel.

ThermalGuard OC.5 Spray Insulation

ThermalGuard OC.5 is a two component, spray-in-place insulation system. It is a semi-open-celled low-density (0.5 lb/ft^3) product. It is installed by spraying the materials in liquid form on the underside of a roof. The liquid immediately expands into foam at a rate of 100:1 in a matter of seconds. ThermalGuard OC.5 forces itself into every corner and crevice and adheres to everything it touches. It provides a continuous air barrier, protecting the steel roof from condensation. ThermalGuard OC.5 is delivered to the site in liquid form in steel drums.

ThermalGuard CC2 Insulation

ThermalGuard CC2 is a two component, spray-in-place insulation system. It is a closed-celled medium-density (2.0 lb/ft^3) product. It is installed by spraying the materials in liquid form directly onto the substrate. The liquid immediately expands into foam at a rate of 25:1 in a matter of seconds. ThermalGuard CC2 is delivered to the site in liquid form in steel drums.

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Installation

Spray polyurethane foam adheres well and permanently to steel. While spray polyurethane foam has been successfully installed over some not so ideal substrate conditions; Rhino Linings® recommends the following surface preparation for metal buildings in order to achieve optimum performance:

A. Primed: If the primed metal surface is free of loose scale, rust, weathered or chalking paint it can be cleaned using pressure washing, steam cleaning, solvent cleaning, vacuum equipment and hand or power tools to remove loose dirt, grease, oil, or other contaminants.
B. Non-Ferrous Metals (including galvanized and stainless steel): When required, clean surfaces as recommended by the primer manufacturer.
C. Unpainted Steel: Clean as recommended by primer manufacturer in order to prepare the steel surface for the primer. When required, the primer shall be applied to the properly prepared substrate and allowed to cure in accordance with the manufacturer's guidelines.

When properly installed, spray polyurethane foam will not shrink or de-laminate with dimensional changes in the surface to which it is adhered. Spray foam is self-supporting, requiring no additional support system. These products do not contain CFC's or HCFC's and do not cause corrosion of metals and fasteners with which it is in contact.

Rhino Linings® insulation products are excellent air barriers and help eliminate the problems resulting from the movement of airborne moisture by preventing moist air from coming in contact with the roof.