PIMA Technical Bulletin #115

The High R Roof:

Guidelines for Energy-Efficient Roofing and Re-Roofing

About Polyiso Insulation

Polyiso is a rigid foam insulation used in more than 70% of commercial roof construction and offers a continuous insulation solution for commercial and residential wall assemblies. As one of North America's most widely used and readily available building products, Polyiso is a cost-effective insulation option for reducing building energy use and improving the overall service-life of roofs and walls.

The benefits of using Polyiso include:

- High R-value per inch of thickness
- Excellent fire test performance
- Extensive building code approvals
- Cost-effective continuous insulation (ci) solution
- Compatible with most roof and wall systems
- Dimensional stability
- Compressive strength
- Moisture resistance
- Thinner walls and roofs with shorter fasteners
- Long service life
- Preferred insurance ratings
- Virtually no global warming potential
- Zero ozone depletion potential
- Recyclable through reuse
- Recycled content (amount varies by product)
- Regional materials (nationwide production network)
- QualityMark^{CM} certified LTTR-values

POLYISO

Surround yourself with the best.

What is a High R Roof?

A High R Roof saves money, increases the energy efficiency of a building and reduces carbon emissions.

More specifically, a High R Roof is a roof that provides a level of thermal resistance, or R-value, higher than current minimum building code standards and practices.[1] The exact level of insulation needed to achieve superior performance with a High R Roof varies according to the criterion applied, but most high performance building guidelines suggest the level should be up to 50% above minimum required values. A good benchmark is that provided for federal buildings by Executive Order 13423, which sets this high performance target at a minimum 30% improvement in energy efficiency by 2015.[2]

The Role of Roofing in Improving Energy Efficiency of Buildings

The 30%+ improvement in building energy efficiency envisioned by Executive Order 13423 and other high performance building guidelines will require much more than switching off lights and turning down thermostats. Achieving this goal will require investment in energy-efficient technologies and practices. One of the most significant opportunities to increase building energy efficiency lies within the commercial roofing sector, where over 50 billion square feet of flat roofs are currently available for retrofit. If the insulation levels in these commercial roofs are upgraded from their current R-value to the high performance levels embodied in High R Roofs, annual energy savings would exceed $2 billion.[3]

In addition to the long-term potential for energy savings, the commercial roofing market provides a significant multiplier effect to accelerate energy efficiency efforts. For every new roof installed on a new building, approximately three additional roofs are installed on existing buildings to replace older, less energy-efficient systems. As a result, the reach of the roofing industry greatly exceeds new commercial construction by a factor of three, accounting for over 4 billion square feet of total commercial roof installations annually. Consequently, including high performance energy initiatives targeted at the existing commercial roofing market can accelerate energy savings much faster than similar initiatives that only target new construction.

1 Center for Environmental Innovation in Roofing: What is a High R Roof? (http://www.roofknowledge.org/main/energyefficientroofs/highrroofs/whatisahighrroof)

2 Executive Order 13423: Strengthening Federal Environmental, Energy, and Transportation Management (http://www.ofee.gov/eo/EO_13423.pdf)

3 Center for Environmental Innovation in Roofing: Why is Energy Efficiency Important? (http://roofknowledge.org/main/energyefficientroofs/theroleofroofsinenergyefficiency/whyisenergyefficienncyimportant)

What Building Owners and Managers Need to Know about High R Roofs

For rooftops to become vital contributors to the ambitious goal of national energy efficiency and independence, building owners in both the public and private sectors need detailed guidelines for the effective design, installation and ongoing maintenance of High R Roof systems. In particular, they need to understand the specific factors to be considered when making investment decisions about roof insulation, and the levels of roof insulation needed to support the national goal of 30% building energy savings by 2015. In addition, building professionals need to understand the necessary construction and operating practices which will assure the High R Roofs will deliver that anticipated energy savings throughout their entire service lives. Finally, these high performance roofing guidelines and operating practices must be targeted to address the unique conditions of re-roofing, where energy upgrades can contribute the greatest value.

What are High R Roof Insulation Levels?

In 2007, the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) increased insulation levels for commercial low-slope roofing in its Energy Standard for Buildings except Low-Rise Residential Buildings (ASHRAE 90.1-2007). This standard raised the minimum insulation value of commercial roofs insulated above the deck to R-20 for most of the United States and Canada, with the exception of Climate Zone 1, which is the southernmost region of the United States. Today, this standard is incorporated within the 2009 International Energy Conservation Code (IECC), which is being adopted rapidly by state and local code jurisdictions across the United States.

ASHRAE 90.1-2007 is now the current minimum standard for roof insulation levels. Therefore the high-performance values envisioned by the 2008 Executive Order obviously should exceed these minimum levels. In response to the need for a more formalized approach to high performance building energy criteria, ASHRAE is developing a new high performance "Standard for the Design of High-Performance Green Buildings except Low-Rise Residential Buildings" (ASHRAE 189.1-P). This new standard builds on the fundamental science of earlier ASHRAE standards and applies those principles to clearly define the minimum criteria for high-performance buildings. Although the standard is still under development, a consensus regarding roof R-values appears to have been achieved. These new proposed ASHRAE 189.1-P roof R-values are compared to the current ASHRAE 90.1-2007 values for selected locations in the following table:

ASHRAE Climate	Example Location	Standard R- (ASHRAE 90.1-	High R- Proposed R- (ASHRAE 189.1-
Zone	Miami	1	20
Zone	Houston	2	25
Zone	Miami	2	25
Zone	Atlanta	2	25
Zone	Washington	2	25
Zone	Chicago	2	25
Zone	Minneapolis	2	30
Zone 7&	Fargo	2	35

The R-values recommended in proposed ASHRAE 189.1-P should be considered minimum R-values for High R Roofs. In many situations, especially where energy costs exceed national averages or where peak demand charges are added to energy bills, additional levels of roof insulation may be needed.

High R Roofs: Best Practices for Maximum Energy Efficiency

Numerous studies have demonstrated that the energy-savings provided by a well-insulated roofing system may be compromised by thermal breaks in the system, especially at joints and gaps within the insulation layers and at intersections with building walls and penetrations. Important practices to minimize energy losses at these locations in High R Roofs include:

- **Careful Measurement, Cutting and Fitting of Insulation Materials.** Most modern insulating materials can be easily cut in the field, and significant thermal value can be retained through the proper measuring and fitting of there materials around roof penetrations and flashings.

- **Installing Insulation Boards in Two or More Staggered Layers.** PIMA Technical Bulletin 113 identifies the benefits of multi-layering of roof insulation boards to reduce the potential for thermal loss at board joints.

High R Roofs: Protecting Your Long-Term Investment

Roof insulation is a valuable financial resource that needs to be protected against damage and deterioration to maximize return on investment. Two conditions that may compromise the effectiveness of roof insulation are 1) moisture infiltration, and 2) roof traffic. The following strategies may help mitigate the risks that these conditions pose for roof insulation.

Moisture Management. Moisture infiltration into the roof system, either from leaks in the roofing membrane or through vapor drive from within the building, can seriously degrade the insulating characteristics of roof insulation and reduce the overall service life of the entire roofing system. Important practices to minimize the effects of moisture infiltration in High R Roofs include:

- **Effective Moisture Barrier Design.** For buildings in regions with cold winter climates or with high internal levels of moisture or humidity, an analysis should be conducted to determine if the temperature within any portion of the roofing system will fall below the dew point temperature. If the analysis suggests that moisture could condense within the roofing system, the use of a vapor retarder should be considered. Current practice leaves this decision to the project's design professional.

- P**rotection of Job Site Materials Prior to Installation.** Packages of insulation and other roofing materials delivered to the job site should be elevated above the ground or roof with blocking and covered with protective tarps in order to reduce the potential of moisture intrusion. For more details, consult PIMA Technical Bulletin #109 Storage and Handling Recommendations for Polyiso Roof Insulation.

- **Durable Roofing Membrane Selection.** The roofing membrane installed above the insulation should be selected to meet or exceed anticipated weather and operating conditions for the roof. Particular attention should be paid to roof membrane selection and design in regions with high winds or heavy hail storms and for roofs requiring frequent maintenance of roof-mounted equipment.

- **Ongoing Roof Inspection and Maintenance.** In order to assure that minor roof damage or weathering do not lead to major events of water intrusion, roofing systems should be inspected periodically by a qualified roofing professional, especially after storms or other unusual weather events. In addition, periodic preventative maintenance should be conducted as recommended by the roofing system manufacturer or roofing professional.

Roof Traffic Management. Modern roof insulations are designed to resist heat transfer but should not be expected to withstand loads from excessive foot traffic or equipment movement on the

rooftop. Traffic damage can contribute to compromised insulation performance and reduce the overall service life of the roof system itself. Important practices to minimize roof traffic damage in High R Roofs include:

- **Walkway Systems to Protect the Roof Surface and Direct Traffic Flow.** Properly designed and installed roof walkway systems provide a number of benefits to minimize roof traffic damage. The actual materials used to construct the walkway can protect the roof surface and underlying insulation from damage, while a properly designed walkway system helps limit foot traffic in non-protected areas.

- **Use Cover Boards.** A variety of high compressive strength cover boards are available that can protect the underlying insulation by spreading the point loads of roof traffic across a wider area of the roof surface.

High R Roofs: Special Considerations for Re-Roofing

As stated earlier, one of the most significant opportunities to increase building energy efficiency lies within the commercial roofing sector, where over 50 billion square feet of flat roofs are currently available for retrofit. Special considerations are needed when opting to replace the existing roof system by tearing it off to the deck or to recover the existing roof system with another.

The decision to replace an existing roof is frequently driven by the occurrence of roof leaks and the moisture intrusion associated with these leaks which may have significantly degraded the existing roof and perhaps other parts of the building structure. As a consequence, understanding the condition of the existing roof and building are critical determinants of successful High R Roof installation, even if the existing roofing system is removed in its entirety. Important practices to minimize moisture concerns in existing buildings and existing roofs include:

- **Inspection of Critical Building / Roof Interfaces.** Many of the most frequent locations of moisture intrusion into a roofing system are located at the interfaces between the roofing system and other building elements, including parapet walls, roof edges, penetrations, and elevated roof curbs. All such areas should be inspected by a roofing professional and any deficiencies should be corrected prior to re-roofing.

- **Roof Moisture Survey and Testing.** In order to assure that latent moisture will not adversely affect the long-term performance of the re-roofing system when a new roof system is used to cover the existing one, a roof moisture survey should be conducted, especially for any building that has experienced observable water leakage. Moisture surveys can be conducted by roofing professionals using a variety of non-destructive technologies, including infrared and nuclear scanning; these technologies can be combined with selected roof core cuts to validate the results.

Because the insulation levels recommended for High R Roofs require greater total roof system thickness compared to older roofing systems, wall and curb flashings may need to be raised to prevent water intrusion. In addition, the existing drainage pattern of the roof may need to be modified in order to assure effective drainage and prevent ponding. Important practices to minimize flashing and drainage concerns in existing buildings and existing roofs include:

- **Topographical Survey of Existing Roof Surface.** A proper understanding of the topography of the roof surface is very important because building settling and deflection of the roof structure over time may significantly alter the intended roof drainage patterns. The existing elevations and contours of a roof may be easily determined using conventional land survey instruments and methods.

- **Removal of Less Efficient Roof Insulations.** Many roof insulating materials used prior to the development of today's high efficiency polyiso insulations provide a relatively low R-value per inch of thickness. Removing these less efficient materials and replacing them with high R polyiso insulation can effectively "free up" additional roof thickness to help preserve necessary flashing heights.

- **Reconstruction of Parapets and Curbs to Maintain Minimum Flashing Heights.** If the distance between the top of roof flashings on walls and curbs and the top of the new roof surface is inadequate to prevent water intrusion (typically 8" minimum), reconstruction of parapets and raising of curbs may be necessary. Walls and parapets may require additional framing and sheathing and roof curbs may need to be raised by a qualified construction professional.

- **Engineered Drainage Design Using Tapered Roof Insulation.** Building on the results of a roof topographic survey, engineered tapered roof system design can help optimize the desired overall roof R-value with effective drainage design and optimal flashing heights. PIMA Technical Bulletin #108, "Tapered Insulation Systems" provides an excellent explanation of the benefits of a tapered roof insulation system along with some basic design guidelines.

PIMA

For more than 30 years, PIMA (Polyisocyanurate Insulation Manufacturers Association) has served as the unified voice of the rigid polyiso industry proactively advocating for safe, cost-effective, sustainable and energy-efficient construction. PIMA's membership includes manufacturers of polyiso insulation and suppliers to the industry. The products of PIMA's members comprise the majority of the polyiso produced in North America.

PIMA produces technical bulletins to address frequently asked questions about polyiso insulation. These publications update and inform architects, specifiers, and contractors about and build consensus on the performance characteristics of polyiso insulation. Individual companies can provide specific information about their respective polyiso products.

For more information on polyisocyanurate insulation, visit www.polyiso.org

PIMA
POLYISOCYANURATE INSULATION MANUFACTURERS ASSOCIATION

www.polyiso.org • pima@pima.org
1220 North Fillmore Street, Suite 400
Arlington, VA 22201
Phone: 703.258.0093

GAF Firestone Firestone Building Products RMAX CARLISLE CONSTRUCTION MATERIALS
IKO ATLAS SOPREMA CONNECTING FUNCTION WITH FACILITY™ JM Johns Manville