Chicago's Green and Garden Roofing Codes and Technology

Bill McHugh
Chicago Roofing Contractors Association
Hillside, Illinois, U.S.A.

Rod Petrick
Ridgeworth Roofing Co. Inc.
Chicago, Illinois, U.S.A.

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Abstract

Chicago has experienced rapid growth for all types of green roof system technologies. Chicago's Urban Heat Island Effect, which adapted the 2009 Chicago Energy Code, has brought demand for lighter-colored green roofs, vegetative green roofs, and photovoltaic or solar thermal green roofs.

The Chicago Roofing Contractors Association (CRCA) and the city of Chicago used research from Oak Ridge National Laboratories, Oak Ridge, Tenn., and The Roofing Industry Alliance for Progress to maximize building owner roofing choices for green roof systems —from vegetative, light-colored coatings to even gravel and ballast green roof systems as surfacing to make roofs green. The code was intended to reduce heat islands by eliminating black roofs over time in Chicago. For roofs on older buildings, the Chicago Energy Code provides options for building owners and managers to comply. It also offers an opportunity for building owners and managers to use the “green on the

top” to market buildings. All these actions continue to foster “cooler topped” roof systems in Chicago and beyond.

This paper and presentation focuses on the code requirements in Chicago, history and the resulting issues that come with these types of roof systems and their components throughout their service lives.

Authors

Bill McHugh has been executive director of the Chicago Roofing Contractors Association (CRCA) since 2004. At CRCA, Bill has been involved in all aspects of CRCA’s outreach to the local and national roofing code, standards, architectural, specifier, roof consultant, building owner and managers, and legislative sectors. He has had articles published and spoken to national and international audiences.

He volunteers at the Construction Specifications Institute (CSI), is past president of the Northern Illinois Chapter, North Central Region past president, and past institute director on the CSI national board of directors. He also is on the Event Advisory Board at CONSTRUCT2012. McHugh holds a bachelor’s degree from North Central College, Naperville, Ill., and master’s degree in business administration from Western Illinois University, Macomb, Ill.

Rod Petrick is president of Ridgeworth Roofing Co. Inc., Chicago. He has been involved in the roofing industry for more than 30 years—28 of those years as a CRCA member.

Petrick has been involved with CRCA as president, first and second vice president, director, and chair of the Industry Affairs, Technical Operations and Trade Show committees. He is received CRCA's Special Recognition Award for his work with the City of Chicago's Energy Code, as well as CRCA's Award for Safety.

Additionally, Petrick is past president and secretary/treasurer of the Midwest Roofing Contractors Association (MRCA) and has been a member of its Technical and Research Committee. He also serves on the Labor/Management Committee for the International Union of Roofers, Waterproofers and Allied Workers, as well as the board of directors at the National Roofing Contractors Association.

Chicago's Green and Garden Roofing Codes and Technology

The green movement impetus has been with us for decades in various parts of life. The auto industry has responded, manufacturing lighter and more fuel-efficient vehicles. Grocery stores provide reusable shopping bags for a fee.

The construction industry has been responding to the green movement and energy conservation in ways that aren't as visible to the general public–more efficient HVAC systems; lighting technologies; window films and construction material properties that slow heat and cold transfer; and different types of green roofs.

Green roofs come in many forms: vegetative surfacing; reflective cool surfacings ranging from gravel and ballast, pavers, and light-colored roof membranes or coatings; and photovoltaic (PV) or solar thermal systems all can be construed as green. But first, there has to be a functioning roof and an optimum code-mandated minimum (or more) amount of insulation added to create an energy-efficient green rooftop.

All these roof components help building owners and managers comply with energy codes, save resources and, it is hoped, bring a return on the financial investment in a competitive real estate market by being green.

Energy Efficiency in Buildings—A Rooftop Perspective

Believe it or not, there were some innovative solutions to energy efficiency on rooftops as far back as the 1950s and maybe even earlier.

The First "Cool Roof?"

In the 1950s, sprinkler pipes were installed on pedestals onto bitumen and aggregate built-up roofs. The idea was to pond water on the roof to keep the rooftop surface cool. This might be the first real version of a "cool roof." Light colored "silver" coatings appeared even before the 1950s as a way to provide fire resistance, extend the rooftop's life and cool down the smooth-surfaced black built-up roofs used on medium-slope, barrel, low-slope and "saw tooth" rooftops, which were common in many cities, such as Chicago.

In the 1970s and '80s, as polymer-modified bitumen systems were gaining acceptance in Europe, similar systems were invented or imported to the U.S. These atactic poly propylene- (APP-) or styrene butadiene styrene- (SBS-) polymer-modified bitumen systems were used in Europe with a two-ply built-up roof (BUR) under the polymer-modified bitumen, and there was "always a coating over the top" in Europe.

The light-colored coatings primarily were used for ultraviolet (UV) light protection, with a secondary benefit of a cooler rooftop, while the two plies underneath provided additional moisture protection.

In the U.S., some polymer-modified bitumen membrane systems were sold with a UV inhibitor, eliminating the need for a coating, and installed without the two plies of BUR under the membrane. EPDM single-ply roofs also gained acceptance during this time period. With both roofs, it was black again. Other polyethylene topped polymer-modified bitumen's PVC, chlorinated polyethylene (CPE), TPO single-ply systems incorporated a requirement for a light-colored coating or were light colored as a membrane, using lighter color as a marketing tool. The polymer-modified bitumen sector responded and such roof systems now require a coating, granules or other surfacing, and a ply or two under them. However, concern from U.S. regulatory agencies about the dark-colored rooftops and heat islands they created didn't occur until the late 1990s.

Roof Insulation–An Energy Saver–and Green

For about a century, low-slope decks and insulation had little function except to keep water out and provide a base for the built-up or other type of roof system above it.

As a reaction to the 1970s energy crisis, roof system insulation usage grew and thicknesses increased exponentially as a way to save energy in buildings. The increased demand for building energy efficiency also caused innovations and change in insulations and roofs.

As an example, from the 1950s through the 1970s, lower R-value perlite or woodfiber (R-value of 2.78 per inch), cellular glass (R-value of 3.4 per inch) and fiberglass (R-value of 4 insulations were used widely on roofs. These insulations provided a stable base for any type of roof membrane but not much energy savings.

About the same time as the 1970s energy crisis, new insulations were introduced into the low-slope roof market with advertised R-values of 4 – 9 per inch. They were used under and over roof membranes, improving the rooftop's energy-saving potential. Newer extruded and expanded polystyrene, polyurethane, isocyanurate and phenolic foams were introduced with some staying and some leaving the market based on how roof systems performed over and under these products. Additionally, in the mid-1980s, insulation R-values began to be published in aged values (1).

Insulation for the complete building envelope was one of the first items building owners, building managers and regulators considered to help make buildings more energy-efficient. With renovation of the top of the building occurring more frequently (every 10-20 years) than the exterior skin or below-grade, the roof seemed like a logical place to target for energy savings. As a result, design R-value requirements increased and still are increasing. Plus, rooftop surfacing colors got lighter, with codes reacting with lighter-colored requirements.

Increased insulation, lighter roof color, vegetative roof surfacings, gravel and ballast, PV, solar thermal and other green roof energy conservation schemes have become components of the solutions to the U.S. energy consumption problem.

Reduce energy consumption and be green on the roof?

In many large cities, it is apparent in summer that there's heat added to urban areas from heat held by structures and pavements. In Chicago, there is a big heat island, a band of area surrounding the city away from Lake Michigan that is a higher temperature than the outlying areas because of the buildup and retention of heat in surfaces such as blacktop, concrete, masonry, dark glass and roof surfaces, and more. These urban heat islands cause increased energy usage. The 2009 Chicago Energy Code defines the urban heat island effect (2) as:

> A microclimatic condition wherein large amounts of dark absorbing surfaces (such as asphalt paving and dark roofs) trap energy from sunlight and release it back into the atmosphere, causing higher ambient temperatures and higher pollution levels.

Structures hold heat as a result of dark surfaces, as well as the thermal mass effect, which involves the city not cooling off until several hours after sunset, causing more power demand to cool buildings and pushing the power demand later into the day. The end result of power demand is more energy usage for air conditioning and more emissions from power plants, which means a hotter city with more pollution.

Chicago's Code Story – Green Options to Meet Urban Heat Island Requirements

In Chicago, a new Chicago Energy Code was adopted in 2001, with high reflectivity and emissivity requirements that limited severely building owners' and managers' roof system choices. The Roofing Industry Alliance for Progress researched and wrote a paper (3) to request a stay of enforcement until the industry had time to catch up to the lofty requirements. The industry alliance consisted of companies and associations such as Koppers Co., Honeywell/Allied Signal, the Chicagoland Roofing Council (CRC), Chicago Roofing Contractors Association (CRCA), United Union of Roofers, Waterproofers and Allied Workers, Local 11, Asphalt Roofing Manufacturers Association, Roof Coatings Manufacturers Association and National Roofing Contractors Association (NRCA). A paper written by Rene Dupuis, president of Structural Research Inc., Middleton, Wis., and Mark Graham, NRCA's associate executive director of technical services, was used as one tool to debate urban heat island effect and other issues. Research from Andre O. Desjarlais, Thomas W. Petrie and Jeralde A. Atchley, Oak Ridge National Laboratory (ORNL) also was a key source of information. (4)

The group worked closely with the city's Department of Buildings and Department of Environment in 2001 to request a reprieve to the proposed 0.65 reflectivity values and 0.90 emissivity required, to allow time for the marketplace to deliver new products that would meet the new green reflectivity requirements. A reprieve was granted with reflectivity of 0.25 required by the city until 2009. The industry then began inventing new systems to comply successfully.

From 2001 to 2009, the CRC, CRCA and NRCA researched and the industry responded to develop rooftop solutions for a workable Urban Heat Island Effect Ordinance at the request of the city's Department of Buildings and Environment. The result was the 2009 Chicago Energy Code whose Urban Heat Island Effect Ordinance currently is in effect.

Working with the City of Chicago, we were able to develop an Energy Conservation Code and Urban Heat Island Ordinance that recognized the existing building stock in Chicago and planned ahead for future new construction. With many low-slope roofs, the code provides building owners and managers of existing buildings with realistic options to meet the code, make the environment better and meet green demands from customers. By removing black roofs from new buildings and old buildings, a big leap was made to cool the city, reducing the urban heat island effect.

2009 Chicago Energy Code Language

Following is a summary of what is required by Chicago's Urban Heat Island Ordinance, which caused the adoption of the 2009 Chicago Energy Code. Key points are extracted from the code below (2):

Urban Heat Island Provisions – 18-13-101.5

The stated intent of the 2009 Chicago Energy Code is to "regulate the design and construction of buildings for the effective use of energy." The code "applies to new, existing, historic buildings, alterations, renovations, or repairs."

Of note is an area of the code that states the intent is "not to require the removal, alteration, or abandonment of, nor prevent the continuous use of an existing building…in existence at the time adoption". Furthermore, the code exempts historic structures from building envelope requirements. Then, "additions, alterations, renovations, repairs for the portions being altered must comply, except where the existing roof cavity is not exposed."

These statements provide the basis for building owners and facility managers to seek a reasonable variance to code requirements. The code is not intended to put buildings out of business economically by high-cost renovations. For instance, if adding insulation means having to rebuild a building's top floor, a variance can be applied for during the permit process. Huge costs—such as raising HVAC units, skylights, raising or moving windows and doors at wall intersections—can make the economics of going green **un**attainable. Not all variances are approved, and only the authority having jurisdiction can approve variances to code requirements.

The code also states that where a change in occupancy "increases energy consumption, the building must comply with the chapter" on energy.

The code offers several options to achieve urban heat island effect mitigation in commercial occupancies through vegetative roofs, PV, ballast or aggregate green roofs, or light-colored cool green roofs.

The code's stated reflectance requirement currently is ".72 initial, OR .50 aged reflectivity as determined by the Cool Roof Rating Council or Energy Star" with no emissivity values mentioned.

Chicago is known as a market with a large quantity of smooth-surfaced black roofs of many shapes and sizes, as well as gravel/ballasted roofs. The intent of the energy code regulation was to remove black roofs from Chicago's new construction inventory and eliminate them during tear-off or renovations to cool the city the summer.

The benefits of a cooler rooftop assembly have been debated extensively with The Roofing Industry Alliance providing data that a cool roof negatively may affect energy gain on a rooftop in spring and fall. Regardless, the city's objective to reduce the temperature of the city during the summer continues to be a noble goal.

Exceptions

Exceptions to the 0.72 initial or 0.50 three-year aged reflectivity include where more than 50 percent of the low-slope roof is covered with vegetation associated with an extensive or intensive green roof as defined by the Environmental Protection Agency, there's a reduction of reflectivity to a minimum of 0.30 for the rest of the roof.

The 0.30 reflectivity exception recognizes that ballast may be used for many reasons, including fire-breaks on these vegetative roofs. This 0.30 reflectivity value is an average of the Chicagoland Gravel Quarries as found in 2001 studies by the Roofing Industry Alliance. Quarries do not guarantee a reflectivity value because each shovel of gravel will be different as a result of the nature of the naturally occurring gravel and/or ballast material. Therefore, the city does not require proof of reflectivity for gravel and/or ballast.

Another exception to reflectivity is for PV panels. It states: "The portion of the roof acting as a substructure for and covered by a rooftop deck, or vegetation associated with an extensive or intensive green roof as defined by the U.S. Environmental Protection Agency ("USEPA"), or by photovoltaic and solar thermal equipment".

This allows the use of PV or solar thermal equipment even though the color may be black. The power generated on-site offsets the black panel color that heats the environment.

The second exception allows "a rooftop deck covering a maximum of 1/3 of the rooftop total gross area. The remainder of the roof area must meet the reflectance requirements."

A third exception states:“Ballasted roofs with a minimum of 15 lbs/sq. ft. of ballast over the entire roof surface may have a reflectance value of a minimum of 0.30. For purposes of this section, ‘ballast’ shall mean river rock aggregate or larger, pavers or other means of weighing down a roofing membrane over a substrate to resist wind uplift.”

In this section, the code recognizes the effect that mass plays in roof system energy performance. Studies from ORNL found that the roof membrane temperature approached that of a white membrane when under 17 pounds of ballast. (4) Additionally, after further discussion with Desjarlais at ORNL, we found there was not a significant difference in performance if the weight was reduced from 17 pounds to 15 pounds.

The requirements apply to partial replacements or retrofits of existing low-slope roofs, as well, with initial reflectance values of 0.72 or three-year installed reflectance values of 0.5 as determined by the Cool Roof Rating Council or ENERGY STAR.® The exception for a vegetative roof is the same as new construction, allowing for ballast with reflectivity of 0.3.

Insulation must be per section 18-13-101.4, which mandates insulation with a minimum R-value of 20 for typical low-slope roofs.

Additional Reroofing Exceptions

In reroofing applications, “where an existing ballasted roof is replaced with a ballasted roof, one of the following two sets of requirements must be met: (i) the reflectance value for the entire roof shall be a minimum of 0.30 and a minimum of 15 lbs/sq. ft. of ballast coverage over the entire roof shall be provided, or (ii) the reflectance value shall be a minimum of 0.72 or a three-year installed reflectance value of 0.5 as determined by the Cool Roof Rating Council or Energy Star." For situations where the roof slope is such that a smooth-surfaced roof is not feasible, this exception allows a ballasted roof assembly. In this code, ballast (2) means the roof membrane, including interply moppings and felts, flood coats and aggregates.

Using this definition, a built-up roof still is allowed in Chicago. An additional exception allows for "dead level" roofs to be replaced with a gravel, ballast roof, or built up-roof with ballast, where the "maximum exposure of the underlying water-repellent layer is no more than 5% of the total area of the roof."

In Chicago, there still are buildings that were built when a "dead flat" roof was still acceptable. As a result, there are many dead-level roofs in Chicago with coal tar pitch or dead-level asphalt as the bitumen. To allow building owners and managers to continue compliance on these buildings without huge costs for adding slope (for a variety of reasons, ranging from raising equipment, perimeter nailers, windows, etc.), the code allows membranes that service a "dead flat" slope roof. Roof membranes such as coal tar pitch and dead-level asphalt BUR membranes or others as recommended and warranted by the manufacturer would be a possible solution, as long as the 15-pound minimum weight is attained.

The final exception mentions that "where an existing low-sloped roof is repaired to mend, fix, patch, cure, refurbish or otherwise salvage a portion of an existing roof in order to maintain or extend the lifespan of such roof, the portion of the roof that is repaired shall meet or exceed the reflectance value in effect when the roof was originally permitted." This "originally permitted" language means that if a roof was allowed to be black then, it's allowed to be black now, and that the Urban Heat Island Ordinance is not mandatorily retroactive for minor repairs.

Additionally, the 2009 Chicago Energy Code refers to the ICC's 2006 International Energy Conservation Code (IECC) insulation requirements (5). Again, for most traditional low-slope assemblies, R-20 continuous insulation (ci) is required. Insulation installed on a suspended ceiling with removable ceiling tiles shall not be considered part of the roof insulation's minimum thermal resistance.

Tapered insulation is an issue that brought questions to the R-20ci requirement. The CRC/CRCA had worked with Chicago to provide for allowing tapered insulation to provide an "average" R-value of 20. However, the code does not address tapered systems.

At a CRCA Membership Meeting in March 2009, Javier Ceballos, from Chicago's Department of Environment, stated that the intent of the code was not to require a minimum of R-20 for tapered systems but an average of R-20. This shows the city's willingness to accommodate existing buildings where there may be major cost implications because of raised perimeter wood nailers, raised mechanical and other rooftop units, skylights, rebuilding curtainwalls where a roof meets a higher structure and much more to accommodate the new insulation depth and flashing heights. Contractors are advised to consult the authority having jurisdiction to confirm before permitting.

Future of the 2009 Chicago Energy Code–Start Anew?

Currently, there are task groups working collaboratively discussing a new Chicago Building Code based on the International Code Council's (ICC's) International Building Code (IBC) with Chicago amendments. CRC and CRCA have participated in these groups, providing input from the ICC code development process.

Meanwhile, the ICC code development process currently is debating insulation and urban heat island regulations during development of the ICC's IGCC.

Solving the Heat Island Effect Problem

Several solutions appeared in attempts to reduce the city's temperature from 2001-09, and introduction of the 2009 Chicago Energy Code. Solutions such as 'cool roofs' from light colored coatings or roof membranes, to vegetative rooftop gardens, light colored pavers, gravel/ballast and more.

In the rooftop marketplace, there has been literature published to show the reflectivity that membranes, coatings and light-colored roof membranes provide. Early in product development, initial reflectivity values ranged from 0.55-0.8+. It was found through aged in-place testing from various sources, including ORNL, that actual reflectivity of coatings seemed to be about 0.50+ after aging and rooftop exposure for three years. Additionally, in areas where the roof ponded water or had dirty exhausts or debris, reflectivity dropped. (4)

Regardless of the actual numbers, these coatings and light-colored roof membranes cooled the roof, and regulators recognized the innovation. As a result, California, as well as Chicago and other large cities, passed urban heat island effect regulations in codes to cool cities using rooftop surface as a tool to get it done. They also demanded lighter-colored pavements for which discussion and debate continues during the IGCC development process.

Vegetative Roof System Types

According to the NRCA Green Roofing Manual (6) there are three types of vegetative roofs: intensive; (more than 10 inches thick); semi-intensive (more than 6 inches and less than 10 inches thick); and extensive (more than 2 inches and less than6 inches thick). (6) Each of these vegetative roof systems provides benefits to building owners and managers, as well as the city's environment, by controlling water drainage and reducing the urban heat island effect. Interestingly, the IBC scopes these roofs in Chapter 15, Roof Assemblies and Rooftop Structures, (6) and the Construction Specifications Institute - Construction Specifications Canada place them in MasterFormat Division 7, specifically 07-55-63, Vegetated Protected Membrane Roofs (7).

Chicago's Water Drainage Problems

Chicago's water drainage problems and sanitary issues have been apparent since the mid-1800s. Why? Chicago is built largely over a marsh. Under the great black farm soil layer and marshes, a heavy clay underbase from the glacial Lake Chicago acts as a barrier to water flowing down into aquifers. It was found that water flowed through clay slowly, taking about 200 years. (8)

Using the 2009 Chicago Energy Code and Urban Heat Island Ordinance as the mechanism, Chicago**'s** Departments of the Environment and Buildings believed they could cool the city and reduce water runoff at the same time by employing vegetative roof systems.

Vegetative Garden Rooftops Hold Water

Vegetative roof systems slow water runoff from roofs by using the soil media overburden to absorb and reduce the speed of water flowing through the system. By holding the water on the roof longer, it lets the surface drains at the street level drain ground-level water while letting the rooftop water enter the drainage system later and, hopefully, slower than the groundwater.

According to David Beattie, Penn State researcher, a 2003 study evaluated the effectiveness of vegetative roofs to retain water on the roof and detain (slow down) rain flow to the drainage system. Of the deposited rain, sleet, snow and ice, according to the study, mature vegetative roof systems can retain nearly 50 percent (during 2003) of the year-round wet deposition. (9) These are average numbers.

Furthermore, storm water that leaves the roof is delayed, depending on the level of roof medium saturation, from anywhere between10 minutes and six hours, according to Beattie. When runoff did occur from a vegetative rooftop, peak runoff for all events never exceeded the non-vegetative roof and was always less than 50 percent that of the non-vegetative roof. It was found that the thin vegetative roof systems seem to hold less water than the thicker intensive and semi-intensive vegetative roofs. This retention also depends on the drainage/retention mat used in the design.

In Chicago, a Wal-Mart was built in 2008 with a white PVC roof and extensive vegetative rooftop covering on 75,000 square feet; the other 75,000 square feet retained the exposed white surface. (10)

A study was conducted to measure water runoff from this roof. According to CRCA and CRC research, this roof was the first full-scale test conducted on a roof of this size to understand many aspects of performance, from temperature transfer to water retention.

It was reported that the largest daily total rainfall recorded was 3.63 inches (9.22 cm) of rain on Sept. 13, 2008, where the extensive vegetative roof retained 58 percent of the precipitation. This rain was a part of a multiday storm with a three-day precipitation total of 5.81 inches (14.8 cm). The three-day total retention on the green roof was 3.49 inches (8.86 cm).

In addition, the observed peak delay for the nine events with runoff averaged one hour and 53 minutes, with a minimum of one hour and 15 minutes and a maximum of three hours and 15 minutes. For example, in rain recorded the morning of June 19, 2009, there were three sequential precipitation peaks at 10 a.m., 11 a.m. and 11:45 a.m. Three corresponding peaks in measured runoff occurred at 11:30 a.m., 12:15 p.m. and 1p.m. In contrast, time to peak runoff from the nongreen section of the roof was delayed by 15 minutes or less (one time step in the measurement system). Time to peak significantly was affected by the storm intensity with longer delays in some of the less intense storms observed. (10)

Additionally, it was found by Carter and Rasmussen that once saturated, the vegetative roof drains similarly to a bare smooth-surfaced roof surface. The time to saturation varies depending on medium type and density, roof slope, plants, length of time from previous rain, humidity, drainage/retention boards in the system and more. It seemed in this research that in lower volume rains, a significant amount of the rainfall was absorbed by the soil medium and released back to the environment. They reported delays in water runoff of anywhere from 10 minutes to two hours. (11)

Great Research, but Questions Remain

Is one to three hours or even seven hours enough time to hold off rain runoff from buildings to give Chicago's deep tunnel drainage and storage system the chance to catch up? Is it enough time to hold water off from the deep tunnel to keep it from filling and reduce the sewage entering Lake Michigan during heavy rainfall periods? (12) And how many and what type of vegetative roofs would it take to alleviate the problem we have in Chicago?

We know conceptually that the slower the water runs off a roof, the better it is for Chicago's drainage system. Therefore, CRC and CRCA agree that water slowdown is worthy to keep Lake Michigan and our drinking water safe. Answers to these questions have not been documented quantitatively at this time.

Vegetative Roofs are Cool, but are They Being Used?

At the CRCA Trade Show and Seminars 2009 Roofing Industry Breakfast, Chicago**'s** Department of Environment's Brad Roback estimated "about 2 million square feet of vegetative rooftops have been installed in Chicago during the five-year period from 2005-09." (13) Although it seems like a large number, 2 million square feet is a small percentage of the total roofing market in Chicago. It's just less than 500,000 square feet per year, about the size of some 'big box' stores like Target or Wal-Mart.

The question remains: Can we do more with vegetative roof systems to slow water drainage by having more of them? With the expense and lack of incentives from municipalities to reduce water drainage from roof systems, we may not be able to make a big difference when trying to slow water into the combined drainage and sewer system.

Vegetative Roofs, Reflective Roofs and Life Cycle Costs

It's important to remember a vegetative rooftop is about the roof—not the vegetation.

Vegetative and other light-colored roof surfacings are great, but they require much more labor to install than conventional systems and need periodic maintenance for a lifetime of service. The plants need to be watered because completely dry plants can cause a fire risk. Additionally, the wind uplift of the trays and built-in-place systems shall be tested and listed or approved by authority having jurisdiction approved methods to comply with code requirements. And the coatings need treatment, cleaning and maintenance to keep reflectivity high for long periods of time. All this costs time and money and must be managed.

The 2012 International Building and Fire Codes, when adapted by a municipality, will have new requirements for all these green roofs and PV. On vegetative rooftops, watering is key for fire resistance. Keeping the plants moist reduces fire risk and keeps the plants thriving. While walking the top of a hotel, a fire service representative noticed garden hoses irrigating plants on a railing on a roof area. His statement was: “See, it does not have to be elaborate, just work and keep the plants dry.”

Without a leak detection system, it can be difficult to locate and fix a leak on a vegetative roof system. Before any roof system repairs can take place, the soil medium and trays must be moved for access to the roof membrane. The topping must be moved to an area that can support the weight. Even if there is a requirement for flood testing before overburden placement to verify watertightness, damage can occur to the roof membrane if placement of the vegetation is not completed by those with experience working over the top of the roof membrane.

That’s why for the vegetative rooftop concept to survive, it needs roofing and plantings expertise to install the trays or soil medium and supervise the operation on top of the roof membrane possibly through a “prime contractor” concept.

Summary

Chicago’s 2009 Energy Code regulated the color of Chicago’s rooftops with many options for compliance and brought a much more energy-efficient R-20 insulation requirement and more to cool the city. Below is a brief summary of the systems used in Chicago to comply:

- Vegetative roofs–These systems are allowed on structures throughout Chicago. Benefits to the city are significant reflectivity, mass effect, water retention for slowed drainage and making the rooftop into a nice place.

- PV energy producing green products–Harnessing the rooftop real estate for energy production makes the roof an income-producing asset. Although we have not seen a large surge of PV in Chicago, we look for solar power to become more widely used. Slowing acceptance of the concept is that the payback without government subsidy approaches 20-30 years according to a survey of solar industry representatives at Chicago's BUILDEX 2010 Show. (16) Additionally, building owners and managers must understand how much longer the roof under it will last before installing panels. Reroofing with panels either resting on or integrated is an expensive proposition.
- Ballasted–aggregate/graveled green roofs–Roof systems can be conventional and green. The weight, or "mass," along with energy-saving insulation, brings value to the rooftop by demonstrated membrane temperatures approaching the performance of lighter-colored smooth surface roofs.
- Reflective green roofs–The Urban Heat Island Ordinance requires a reflectivity of 0.72 initial or 0.5 after three years of aging. Innovations in rooftop surfacing and membranes have brought many product options from smooth-surfaced roofs to coatings. And concrete pavers can comply while providing additional heat sink, much like gravel/ballast systems.
- Codes and standards–For vegetative roofs, the 2012 International Fire Code will have a requirement to keep plants on roofs moist. The new code will mean more irrigation systems, more management of the rooftop to allow or not allow people to use the space, and more and keep the green garden growing as intended. If it is usable space, egress requirements for people using the rooftops as occupied

space, assembly and gathering areas will need to capacity to exit in emergencies. Plus, more fire extinguishing requirements and fire department water access on the roof are important and required with standpipes included all the way to the rooftop for vegetative roofs. And reflective green roofs must meet fire-resistance requirements.

All this affects the proper design, installation, inspection and maintenance of the rooftop.

What's Required to do This Green Roofing Work?

Through an efficient and safe installation process and without ever losing focus on what makes all this work, **…** a functioning roof … and specialized knowledge about working at heights, the building owner should choose the work force that is best-qualified to bring a roof that doesn't leak yet has an overburden or topping system— garden, reflective membrane/coating, gravel or ballast, or PV–solar thermal system--that completes the roof with beauty, functionality, and, most important, is leak-free.

We hope the result of the 2009 Chicago Energy Code and Urban Heat Island Effect Ordinance will be a better Chicago for future generations as the requirements address several issues from a holistic perspective.

The City of Chicago has provided the basis and options for minimum green requirements collaboratively with the industry. It's now up to the industry to comply and make the economics work.

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