

**Title of paper:****Chicago's Green & Garden Roofing Codes & Technology****Author:**

Bill McHugh, Executive Director, Chicago Roofing Contractors Association ~ Hillside, IL USA - Email: [bill@crca.org](mailto:bill@crca.org) ~ Phone - 708-449-3340 ~ FAX - 708-449-0837

**Author Bio:**

Bill McHugh has been Executive Director of the Chicago Roofing Contractors Association since 2004. At CRCA, Bill has been involved in the 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 is on the Event Advisory Board at CONSTRUCT2012. Bill holds a BA from North Central College and an MBA from Western Illinois University.

Rod Petrick is President of Ridgeworth Roofing Co., Inc., a Chicago area roofing contractor. He has been involved in the Roofing Industry for over 30 years, 28 of it as a CRCA Member.

Rod has been very involved with CRCA as President, 1<sup>st</sup> and 2<sup>nd</sup> Vice President, Director, and Chair of the Industry Affairs, Technical Operations plus the Trade Show Committees. Rod is an award recipient at CRCA with a "Special Recognition Award" for his work with the City of Chicago's Energy Code and the CRCA "Award for Safety".

Additionally, Rod is Past President and Secretary/Treasurer, and has been a member of the Technical and Research Committee at the Midwest Roofing Contractors Association (MRCA). He's also on the Labor / Management Committee for the International Union of Roofers, Waterproofers and Allied Workers, and is on the Board of Directors at the National Roofing Contractors Association.

**Keywords:**

Code Requirements for Reflective Green Roofs, Aggregate and Ballast Green Roofs, Vegetative Green Roofs, Photovoltaic, Solar Thermal and Paver Covered Roofs, Insulation, Water Drainage issues, Code Development, Installation.

## **Abstract**

### **Chicago's Green & Garden Roofing Codes & Technology, History, Solutions**

Chicago has had rapid growth in all types of Green Roofing Systems Technologies. Chicago's Urban Heat Island Effect Ordinance which adapted the 2009 Chicago Energy Code, has brought demand for lighter colored green roofs, vegetative green roofing systems, and photovoltaic or solar thermal green roofs.

CRCA and the City of Chicago utilized research from Oak Ridge National Laboratories, and the Roofing Industry Alliance to maximize building owner roofing choices for green roofing 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 gives 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 roofing systems and their components throughout their service life.

## **Paper**

### **Chicago's Green & Garden Roofing Codes & Technology, History**

The Green Movement impetus has been with us for decades in all parts of life. Autos have responded, getting lighter and more fuel efficient. Grocery stores provide reusable shopping bags for a fee.

The construction industry has been responding to the green movement and energy conservation in ways not seen as visibly to the general public. From more efficient HVAC systems to lighting technologies, window films and construction material properties that slow heat and cold transfer, and all kinds of different 'green roofs'.

Green Roofs come in many forms; Vegetative surfacing, reflective cool rooftop surfacings ranging from gravel and ballast, pavers, and light colored roof membranes or coatings, photovoltaics or solar thermal, can all 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 hopefully bring a return on the financial investment, in a very 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 the rooftop as far back as the 1950's, and maybe even earlier.

### **The first 'Cool Roof?'**

In the 1950's, 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 the 'cool roof'. Light colored 'silver' coatings appeared even before then, as a way to provide fire-resistance, extend the rooftop life and cool down the smooth surfaced black built up roofs used on medium sloped, barrel, low sloped, and 'saw tooth' rooftops, common in many cities, such as Chicago.

In the 1970's and 80's, as modified bitumen (MB) systems were gaining acceptance in Europe, similar systems were invented or imported to the US. These Atactic Poly Propylene (APP) or Styrene Butadiene Styrene (SBS) Modified Bitumen Systems were used in Europe with a two ply Built Up Roof (BUR) under the modified. Plus, it was reported to this author, that there was 'always a coating over the top' in Europe.

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

In the US, some MB membrane systems were sold with a UV inhibitor, eliminating the need for a coating, and installed without the 2 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 MB's, polyvinyl chloride, (PVC), chlorinated polyethylene, (CPE), terpolymer olefin, (TPO) single ply systems incorporated either a requirement for a light colored coating, or were light colored as a membrane, using lighter color as a marketing tool. MB's responded, and now require a coating, granules, or other surfacing, and a ply or two under them. However, concern from US regulatory agencies about the dark color rooftops and heat islands they created didn't occur until the late 1990's.

### **Roof Insulation – An Energy Saver – and Green**

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

As a reaction to the 1970's 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, during the 1950's-70's, lower R-Value (R) perlite or woodfiber (R-2.78 per inch) , cellular glass (R 3.4 per inch), and fiberglass (R-4.0) insulations were used widely on roofs. These insulations provided a very stable base for any type of roof membrane, but not much energy savings.

About the same time as the 1970's energy crisis, new insulations were introduced into the low sloped roof market with advertised R's of 4.0 – 9.0/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 energy saving products. Additionally, in the mid 1980's, insulation R-Values began to be published in aged values.(1)

Insulations for the complete building envelope were one of the first items building owners and managers, and regulators looked at 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 are still increasing. Plus, rooftop surfacing colors got lighter, with codes reacting with lighter color requirements.

Increased insulation, lighter roof color, vegetative roof surfacings, gravel and ballast, photovoltaics, solar thermal and other green roof energy conservation schemes, have become components of the solutions to the US 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 real big 'heat island', a band of area away from Lake Michigan, surrounding the city that is a higher temperature than the outlying areas due to 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:

**URBAN HEAT ISLAND EFFECT.-** 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 due to dark surfaces, plus the thermal mass effect, with the city not cooling off until several hours after sunset causing more power demand to cool buildings and also 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, meaning 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 owner and managers choices for

roofing systems. The Roofing Industry Alliance researched and wrote a paper (3) to request a stay of enforcement until 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), and United Union of Roofers, Waterproofers and Allied Workers, Local 11, Asphalt Roofing Manufacturers Association (ARMA), Roof Coatings Manufacturers Association (RCMA), National Roofing Contractors Association (NRCA). Authors Dupuis and Graham's paper 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 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 .65 reflectivity values and .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 .25 required by the city until 2009. The industry then went to work inventing new systems to comply successfully.

From 2001 to 2009, the CRC, CRCA, and NRCA researched and 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, with an Urban Heat Island Effect Ordinance that is in effect today.

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 sloped and sometimes dead flat roofs, the code provides building owners and managers of existing buildings realistic options to meet the code, make the environment better, and meet green demands from customers. By removing black roofs from the building inventory at new buildings and old, a big leap was made to cool the city, reducing the urban heat island effect.

### **2009 Chicago Energy Code Language**

Here's a summary of what's required City of Chicago's Urban Heat Island Ordinance, which caused the 2009 Chicago Energy Code to become adopted. 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 to *'not to require the removal, alteration, or abandonment of, nor prevent the continuous use of an existing building...in existence at the time adoption'*. Further, 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 the building owner and manager 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 the top floor of the building, 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 not 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 gives several options to achieve Urban Heat Island Effect Mitigation in commercial occupancies, through vegetative green roofs, photovoltaics, ballast or aggregate green roofs, or light colored cool green roofs.

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

The City of Chicago is known as a market with a large quantity of smooth surfaced black roofs of many shapes and sizes, and also gravel/ballasted roofs. The intent of the energy code regulation was to remove the black roof from Chicago’s new construction inventory, and eliminate it at tear-off or renovations, all to cool the City in the summer.

The benefits of a cooler rooftop assembly have been debated extensively, with the Roofing Industry Alliance providing data that the cool roof may hurt energy gain on the rooftop in spring and fall. Regardless, the City’s objective was and continues - reduce the temperature of the city in the summer...a noble goal.

### **Exceptions**

Exceptions to the .72 initial OR .50 3 year aged reflectivity include where more than 50% of the low sloped roof is covered with vegetation associated with an extensive or intensive green roof as defined by USEPA, there’s a reduction of reflectivity to minimum .30 for the rest of the roof.

The .30 reflectivity exception recognizes that ballast may be used for many reasons, including fire-breaks on these vegetative green roofs. This .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 due to the nature of the naturally occurring gravel / ballast material. Therefore, the city does not require proof of reflectivity for gravel/ballast.

Another exception to reflectivity is for photovoltaic 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 photovoltaic 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 that '*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 roofing system energy performance. In studies from Oak Ridge National Laboratories (ORNL), it was found that the roof membrane temperature approached that of a white membrane when under 17lbs. of ballast. (4) Additionally, we found from further questions and discussion with Mr. Andre O. Desjarlais at ORNL, that there was not a significant difference in performance if the weight was reduced to 15lbs from 17 lbs.

The requirements apply to partial replacements or retrofits of existing low sloped roofs as well, with 'an initial reflectance value of 0.72 or a three-year installed reflectance value of 0.5 as determined by the Cool Roof Rating Council or Energy Star. The exception for a vegetative green roof is the same as new construction, allowing for ballast with reflectivity of .30.

Insulation must be per section 18-13-101.4, which mandates a minimum R-20 Insulation for typical low sloped 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 those 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.

Through this definition, a built up roof is still 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 the City of Chicago, there are still 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 built up roof (BUR), or others as recommended and warranted by the manufacturer would be a possible solution, as long as the 15lb. 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 the roof was allowed to be black then, it's allowed 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 sloped 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 minimum thermal resistance of the roof insulation.

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

At a CRCA Membership Meeting, March, 2009, the City of Chicago's Javier Ceballos, from the 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 due to 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 AHJ in to confirm prior to 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 ICC's International Building Code (IBC), with Chicago amendments. The CRC and CRCA have participated in these groups at the City, providing input from the International Code Council Code Development Process.

Meanwhile, the ICC Code Development process is currently debating insulation and urban heat island regulations during development of the ICC's International Green Construction Code, (IgCC).

### **Solving the Heat Island Effect Problem**

Several solutions appeared in attempts to reduce the temperature of the city from 2001 – 2009, 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 much literature published to show the reflectivity that membranes, coatings and light colored roof membranes provide. Early in product development, initial reflectivity values ranged from .55-.80+. It was found through aged in-place testing from various sources including Oak Ridge National

Laboratories that actual reflectivity of coatings seemed to be about .50+ after aging and rooftop exposure for 3 years. Plus, 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 did cool the roof, and regulators recognized the innovation. As a result, the State of California, 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 at the International Green Construction Code development process..

### **Vegetative Roof System Types**

According to the NRCA Green Roofing Manual (6) there are three types of Vegetative Roofs; Intensive; (>10" thick), Semi Intensive (>6" and <10" thick), and Extensive (>2" and <6" thick). (6) Each of these rooftop vegetative roof systems provides benefits to building owners and managers, and the City's environment, including water drainage control, and reduction of the Urban Heat Island Effect. Interestingly, the International Building Code 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 1800's. 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 flow downward into aquifers. It was found that water flowed through clay slowly....in about 200 years. (8)

Using the 2009 Chicago Energy Code and Urban Heat Island Ordinance as the mechanism, the City of Chicago Departments of the Environment and Buildings believed they could cool the city and reduce water runoff at the same time, with help from vegetative roof systems.

## **Vegetative Garden Rooftops Hold Water**

Vegetative roof systems slow the water runoff from roofs by using the soil media overburden to absorb and reduce the speed of the water flow through the system. By holding the water on the roof longer, it let's 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 that evaluated the effectiveness of vegetative roofs to retain water on the roof, and detain (slow down) rain flow to the drainage system took place. Of the deposited rain, sleet, snow, and ice,

according to the study, mature vegetative roof systems can retain nearly 50% (during 2003) of the year-round wet deposition. (9) These are average numbers.

Further, storm water that does leave the roof is delayed, depending on the level of roof medium saturation, from anywhere between 10 minutes and 6 hours according to Beattie. When runoff did occur from a vegetative rooftop, peak runoff for all events never exceeded the non-garden roof, and was always less than 50% that of the non-vegetative green roof. It was found that the thin vegetative green roof systems seem to hold less water than the thicker intensive and semi intensive vegetative green 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 an extensive vegetative rooftop covering on 75,000 SF, and the other 75,000 SF retained the exposed white surface. (10)

A study was conducted to measure water runoff from this roof. According to CRCA and CRC research, it seems 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" (9.22cm) of rain on 13 Sept, 2008 where the extensive vegetative green roof retained 58% of the

precipitation. This rain was a part of a multiday storm with a 3 day precipitation total of 5.81" (14.8cm). The three day total retention on the green roof was 3.49" (8.86cm).

Plus, the observed peak delay for the nine events with runoff averaged 1 hour and 53 minutes, with a minimum of 1 hour and 15 minutes and a maximum of 3 hours and 15 minutes. For example, in rain recorded in the morning on 19 June, 2009, there were three sequential precipitation peaks at 10am, 11am and 11:45am. Three corresponding peaks in measured runoff occurred at 11:30am, 12:15pm, and 1pm. In contrast time to peak runoff from the non-green section of the roof was delayed by 15 minutes or less (1 time step in the measurement system). Time to peak was significantly 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, that 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 1 to 3 hours, or even 7 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 do know conceptually that the slower the water runs off the roof, the better it is for Chicago's drainage system. Therefore, CRC and CRCA agrees 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, the City of Chicago Department of Environment's Brad Roback estimated that, "About 2,000,000 SF of Vegetative Rooftops have been installed in Chicago during the 5 year period from 2005 – 2009". (13) Although it seems like a large number, 2,000,000 SF is a very small percentage of the total roofing market in Chicago. It's just less than 500,000 SF/Year, about the size of some 'big box' stores like Target, Wal-Mart, or Jewel.

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 be successful at slowing water into the combined drainage and sewerage system to make a big difference.

## **Implications of a vegetative rooftop covering**

First and foremost, it's important to remember that a vegetative rooftop is about the Roof...not the vegetation.

## **Vegetative Roofs, Reflective Roofs, & Life Cycle Costs**

Vegetative and other light colored roof surfacings are great, but they require much more labor to install than conventional systems, and do need periodic maintenance for a lifetime of service. The plants need watering as totally dry plants can cause a fire risk. Plus, 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 these things cost 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 Photovoltaics. In 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, '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 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 prior to overburden placement to verify water-tightness, damage can occur to the roof membrane if placement of the vegetative topping 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 rooftop and plantings expertise to install the trays or soil medium, supervise the operation on top of the roofing 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, 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 Green 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.
- Photovoltaic Energy Producing Green Products – Harnessing the rooftop real estate for energy production makes the roof an income productive asset. Although we have not seen a large surge of photovoltaics in Chicago, we do 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 reps at Chicago's BUILDEX 2010 Show. (16) Plus, building owners and managers need to understand how much longer the roof under it will last before installing panels. Reroofing with panels either resting on or integrated is a very expensive proposition.

- Ballasted – Aggregate / Graveled Green Roofs – Roofing 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 0.50 after 3 years aging. Innovations in rooftop surfacing and membranes have brought many product options from smooth surfaced roofs, to coatings. Plus, concrete pavers can comply while providing additional heat sink, much like gravel / ballast systems.
- Codes & Standards – For vegetative green 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 all important and required...with standpipes included all the way to the rooftop for vegetative green 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 this all really work, ... a functioning roof ... and specialized knowledge about working at heights, the building owner should choose the workforce 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 photovoltaics – solar thermal system that completes the roof with beauty, functionality, and most important, 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 industry. It's now up to industry to comply, and make the economics work.

Footnotes:

1. Rene M. Dupuis, MRCA Convention Presentation, Phoenix, 1984.
2. “2009 Chicago Energy Code – 2009”, Index Publishing Corp., City of Chicago.
3. “Study on Roof System Reflectivity and Near-Surface Air Temperatures in Chicago, IL”, Rene M. Dupuis and Mark S. Graham.
4. “Evaluating the Energy Performance of Ballasted Roof Systems”, André O. Desjarlais, Thomas W. Petrie and Jerald A. Atchley,, Building Envelopes Program, Oak Ridge National Laboratory, Richard Gillenwater, Carlisle SynTec, Inc., and David Roodvoets, SPRI, April 2008
5. International Code Council, International Energy Conservation Code, 2006.
6. NRCA Green Roofing Manual, National Roofing Contractors Association
7. Construction Specifications Institute, Construction Specifications Canada MasterFormat, 2010.
8. Encyclopedia of Chicago, 2004, 2005, Chicago Historical Society
9. PSU Center for Green Roof Research, David Beattie, Researcher, Penn State University. <http://horticulture.psu.edu/cms/greenroof/?q=node/50>
10. Stormwater Runoff from a Large Commercial Roof in Chicago, Robert Berghage, Charlie Miller, Brad Bass, Don Moseley and Kirstin Weeks. The Pennsylvania State University, Roofscapes, Inc, University of Toronto, WalMart Inc., and ARUP Inc.
11. Journal of the American Water Resources Association, October American Water Resources Association 2006, “Hydrologic Behavior of Vegetated Roofs”. Timothy L. Carter and Todd C. Rasmussen

12. 2011 CRCA Trade Show & Seminars Session question, posed by Rich Ray, CSI, CCS, Specifier, Cannon Design, January 2011.

13. Brad Roback, Rod Petrick, 2010 CRCA Trade Show & Seminars presentation.

14. Additional References:

a. Green Roof Research at Michigan State University.

<http://www.hrt.msu.edu/greenroof/#Green%20Roof%20Research%20at%20Michigan%20State%20University>)

b. International Code Council, International Building Code, 2009

c. International Code Council 2009/2010 Code Cycle Monograph

d. MasterFormat 2010 Edition, Construction Specifications Institute, Construction Specifications Canada

e. Whole Building Design Guide, National Institute of Building Sciences, Roofing Systems, 6/1/2009

f. 2011 CRCA Trade Show & Seminars Education Session, Kami Farahmondpour, Dave Wehrli, January, 2011.

g. 2011 BUILD EX Chicago Show, CRC Program on Green Roof Systems, Codes, May 2011. Rod Petrick & Bill McHugh.