

Slide 1



In the following slides we will walk through a series of green building systems so that you, as a safety professional, can assess the associated risks and begin to plan for safe practices when you begin to work with these systems onsite.

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As the green building industry continues to expand so does the number of new systems, terms, and practices, most of which few of us have heard of. The following section will walk through a number of these systems to help participants develop a definition and understanding of some of the more commonly used green building systems so that they can identify safety risks/concerns/attributes and begin to think about the practices and tools required to ensure green building projects are safe for all employees.

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As we walk through the following systems try to think whether or not we have to “teach old dogs new tricks” or if we can apply the same safety principles we are currently using to the new green building systems.

More often than not safety concerns on green building systems are the same as a typical construction project. We are still concerned about:

- Personal Protective Equipment
- Health Hazards
- Scaffolds
- Stairs and Ladders
- Falls
- Electrical
- Caught-in or Between
- Struck-by
- Excavations

The difference is that green building systems often introduce new trades to unique situations and experiences that they are not familiar with. Key to ensuring safety on green building systems is educating **ALL** trades about the risks involved with each new system and practice.

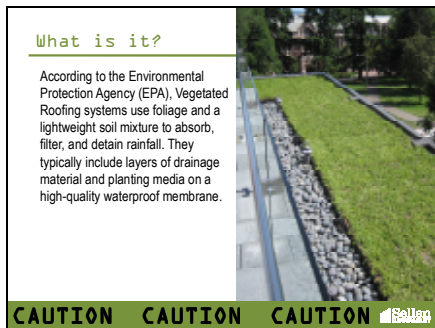
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The first system we will look at is vegetated roofing.

INSTRUCTOR: Ask the audience – How many of you have worked on a vegetated roof? Any lessons learned you can share?

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According to the Environmental Protection Agency (EPA), Vegetated Roofing systems use foliage and a lightweight soil mixture to absorb, filter, and detain rainfall. They typically include layers of drainage material and planting media on a high-quality waterproof membrane.

Vegetated roofing provides a wide range of performance benefits from increased roof life (up to 3x), to better insulation properties, to stormwater management, heat island effect reduction and increased biodiversity.

Source:


<http://www.epa.gov/owow/NPS/roofcover.pdf>

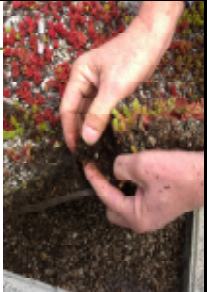
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**Types of systems**

**EXTENSIVE**

- Shallow soil base
- Typically planted with sturdy, short root vegetation like sedums
- Often require less maintenance
- Lighter system means roof does not need to be designed much different in relation to load

**CAUTION CAUTION CAUTION** 



Vegetated roofing systems can be designed to fit a wide range of needs. Vegetated roofing systems are typically either Intensive, Extensive, or tray based systems.

Source:

<http://www.greenroofs.com/content/Variou-Types-of-Green-Roof-Systems-Come-Together-at-NYC's-5-Boro-Complex.htm>


Extensive vegetated roofing systems are very common. Extensive systems have shallow soil depths, typically less than 6" of soil, and are often designed to require minimal maintenance. Extensive systems are limited in the vegetation that can be used but they support sturdy smaller plants like sedums and other perennials. Due to their shallow soil depths, extensive systems are lighter meaning the structural support for the roof does not have to be designed too differently from a typical roof.

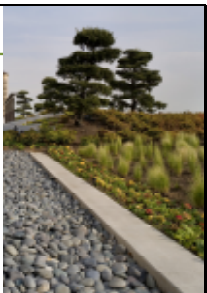
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**Types of systems**

**INTENSIVE**

- Deeper soil base for a wider variety of vegetation including shrubs and small trees
- Typically 6" to 12"+ of soil
- Very similar to a garden bed
- Often requires more maintenance

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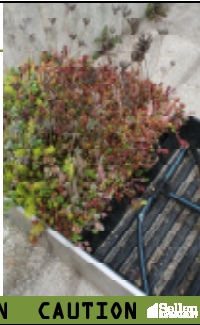
Intensive vegetated roofing systems resemble a true garden bed. They have deep soil depths typically between 6" to 12"+ and can be planted with a wide range of plants from shrubs to ground cover to small trees. Intensive systems can be some of the most aesthetically pleasing, but requires a deeper soil base and additional roof support for larger trees, shrubs and plants to grow. Intensive systems typically take more time to design, install, and require more maintenance than other systems. Because of the range of plants, intensive systems often require more permanent irrigation systems.


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**Types of systems**

**TRAYS**

- Often have extensive soil depths
- Prefabricated system
- Easy to install, replace and maintain
- Irrigation can be integrated into tray system




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Tray based vegetated roofing systems are typically sold as a complete, prefabricated package. Tray systems can integrate irrigation, drainage, and other materials that may be added features when installing other systems. Tray systems are easy to replace and maintain. Trays allow installation and maintenance crews to simply lift small sections of the vegetated roof out of place to irrigate, replant, or redesign the system. Tray systems tend to have shallow soil depths like extensive vegetated roofing systems and thus are light weight.

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**How is it Constructed?**

- Where is it located?
- Which trades may experience a new situation?
- How is it sequenced?
- What equipment & materials are involved?
- How is it installed?
- How is it operated & maintained



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Now that you are familiar with the types of vegetated roofing exist, what are some of the questions that we need to be asking when working with a new green building system like this one?

- Where is it located?
- Which trades may experience a new situation?
- How is it sequenced?
- What equipment & materials are involved?
- How is it installed?
- How is it operated & maintained

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**Installation**



**CAUTION CAUTION CAUTION** 

Let's walk through a sample installation of a vegetated roof. After the waterproofing membrane has been installed a drainage layer or material is installed (see the black product being covered by the aggregate in the photo above). The drainage layer allows any remaining water that isn't absorbed and evaporated by the vegetation to exit the roof.

Bigger aggregate (see the sand colored material covering the drainage mat in the image above) covers the drainage layer to support the drainage of the remaining water.

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Following the drainage layer and aggregate, a silt fabric root barrier is installed to prevent the roots from the vegetation from working into the roof itself and causing any damage.

Soil covers the root barrier and is spread evenly throughout the vegetated roofing system.

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The soil must be spread and compacted enough to support vegetation. Take note of how soil is being delivered via overhead hoisting.

INSTRUCTOR: Ask the audience – Can you see any other safety concerns in this image?

Point loading  
Shovel trip hazards

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After the soil is spread evenly, vegetation is craned to the roof typically in trays like those shown here.

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After the soil is spread evenly, vegetation is craned to the roof typically in trays like those shown here.

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While each installation and system is different, the image above shows an example of plugs that are installed in holes dug out for individual plants. Every installation presents its own unique challenges.

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Depending on the climate and the vegetated roofing system, temporary irrigation will be required for the first few months after installing the plants.

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Depending on the climate and the vegetated roofing system, temporary irrigation will be required for the first few months after installing the plants.

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As with any garden, vegetated roofing systems do require at least some level of maintenance. Plants will need to be replaced, irrigation may be necessary depending on plant selection, climate, and time of year, and the soil itself may need to be tended to. It is very important that either our landscapers or our maintenance crews understand the safety requirements for work on a roof, especially a vegetated roof system where aesthetics may call for minimal to no railing or fencing.

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**Top 9 Most Frequently Cited OSHA Standards**

- ✓ Scaffolding, general requirements, construction
- ✓ Fall Protection, construction
- ✓ Hazard communication standard, general industry
- ✓ Control of hazardous energy (lockout/tagout), general industry
- Electrical, wiring methods, components and equipment, general industry
- Powered industrial trucks, general industry
- ✓ Ladders, construction
- Electrical systems design, general requirements, general industry
- Machine guarding (machines, general requirements, general industry)

**CAUTION CAUTION CAUTION**

Shown here is the list of the Top 9 most frequently cited OSHA standards violated in FY2011.

INSTRUCTOR: Ask the audience – Which of these standards may apply to this green building system?  
Click for predetermined checkmarks.

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**Ensuring Safety**

- Access
- Fall Protection
- Material Delivery
  - Placement
  - Point Loading
  - Overhead Protection
  - Hoisting
  - Equipment Conveyance
- Environmental Factors



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Key takeaways to ensure safety when installing or working on a vegetated roof include:

(INSTRUCTOR please note: The following is the list of takeaways from the slide plus questions that we should be asking on the jobsite to ensure the installation has been assessed for safety)

- **Access** – How will workers get to the vegetated roofing system? Is there stair access? Will scaffolding or a ladder be required?
- **Fall Protection** – All employees working on the roof should be tied off unless additional safety features such as a guardrail have been put into place.
- **Material Delivery**
  - **Placement** – Where will the materials be delivered? How long will they remain in that location? Where will the material be stored? Are there any trip hazards associated with storage/placement?
  - **Point Loading** – Roof structures can only withstand a specific weight load. If we are dropping all of our material onto one location, has that location been designed to bear all of that extra weight?

- **Overhead Protection** – Will work be taking place beneath the vegetated roofing installation? If so, what steps have we taken to prevent materials from falling off the roof and striking workers below? Do workers beneath the installation know that there is overhead work taking place? Do workers on the roof know there is work taking place below?
  - **Hoisting** – How will the materials be delivered? Will a crane drop them off? If so, are there pinch point concerns we have to worry about when rigging the material to the crane? Who will be responsible for landing and removing the materials? Have they been properly trained to direct the crane operator?
  - **Equipment Conveyance** – What equipment will need to be delivered to the roof? How will those materials be delivered to the roof? Have we located a proper location to store equipment that will be required for the install?
- **Environmental Factors** – Are we doing the installation during the winter? If so how are we dealing with rain/slip hazards? Is there a chance there may be ice on the roof? Additional environmental concerns include strong winds, lightning, and excessively hot days where workers on the roof are at a greater risk of heat exhaustion.

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Next we'll examine Skylights and the increase in daylighting that is being driven by green building projects.

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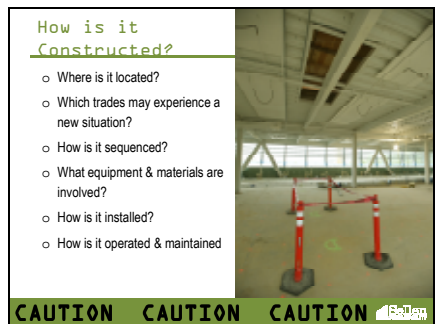


Skylights are openings in the roof that allow daylight to enter a given space. While skylights are not necessarily a new system, green building projects integrate skylights and daylighting more frequently than typical construction projects which means field crews may be at greater risk of falls compared to a typical construction project.

INSTRUCTOR: Ask the audience – How might skylights make construction sites more safe?

Answer: Added daylight reduces trip hazards associated with cords from temporary lighting.

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As we are walking through the installation it is important to be thinking about the following questions:

- Where is it located?
- Which trades may experience a new situation?
- How is it sequenced?
- What equipment & materials are involved?
- How is it installed?
- How is it operated & maintained

Note: This image illustrates safe protocol for a skylight that is about to be installed, ensuring that people on the floor below are kept away from any overhead exposure while the temporary plywood protection is removed and the skylight is installed.

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The biggest concern with skylights are trip and fall hazards. As skylights are being installed it is crucial to ensure any openings are covered and remain covered as work progresses. While covering openings with temporary protection may help, are tie offs and fall protection still required? Should glazers be wearing harnesses? Some of those answers depend on the type of installation, but what do we need to install and pay attention to, to ensure safety?

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Again, skylights are not a new system and many of us are familiar with their installation. That said, green buildings are integrating skylights more frequently than non green projects. Before work begins it is important to plan for any openings that will be created for skylights.

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As skylights are installed it is important to be aware of additional trades that may be working on the roof. Glazers may be aware of the safety hazards that are present when installing skylights, but what about the roofers? Plumbers? Electricians? And what about landscapers who may be installing a vegetated roof while skylights are going in?

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As you can see here, this particular skylight installation requires a unique metal panel to be installed on top where the panes connect. The panel cannot be installed without having to lean over the skylight or even lean on the skylight. Skylights need to be able to hold 800 pounds to count as fall protection. If the skylight system that is being installed cannot withstand 800 pounds, fall protection or catch platforms are critical to the safety of the workers installing the system.

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As green buildings integrate skylights at a higher frequency the types and size of skylight installations are changing quickly. Many projects today are integrating very large skylight installations. The image shown here is of a skylight installation that circles an atrium in a new office building in South Seattle. The atrium itself is more than 30 feet wide so it obviously presents unique challenges for installing the glazing system.

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Working with their site safety manager, the field team developed a ladder and pulley system that allowed workers to tie off and move glass into place without much trouble.

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### Unique Safety Concerns

- Large installations
- Glass of varying sizes
- Bends and curves in roof
- Steep sloped roof
- Additional green building systems integrated into roof design



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While this system helped the teams set the glass it created a new safety hazard in that the sled could become dangerous if it slid back to the roof uncontrolled while someone was working in front of it.

Anytime we introduce a new system, or unique installation, it is important to think through any potential hazards that may be involved.

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### Operation & Maintenance



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Skylights will need to be cleaned and may even need to be replaced if cracked or damaged. How can we design our roofs to support proper safety during maintenance of skylights?

Answer: If we know glazing systems like the one shown here will be hard to access we should ensure that the glass itself can handle the required load for someone to safely stand on the glass to clean/maintain.

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### Top 9 Most Frequently Cited OSHA Standards

- ☒ Scaffolding, general requirements, construction
- ☒ Fall Protection, construction
- ☐ Hazard communication standard, general industry
- ☐ Control of hazardous energy (lockout/tagout), general industry
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- ☐ Machine guarding (machines, general requirements, general industry)

CAUTION CAUTION CAUTION 

Shown here is the list of the Top 9 most frequently cited OSHA standards violated in FY2011.

INSTRUCTOR: Ask the audience – Which of these standards may apply to this green building system?

Click for predetermined checkmarks.



Key takeaways to ensure safety when installing or working on skylights include:

- **Fall Protection** - All employees working on the skylight install should be tied off unless additional safety features such as catch platforms have been put into place.
- **Overhead Protection** - Will work be taking place beneath the skylight installation? If so, what steps have we taken to prevent materials or equipment from falling through the roof openings and striking workers below? Do workers beneath the installation know that there is overhead work taking place? Do workers involved with the skylight installation know there is work taking place below?
- **Access** - How will workers get to the skylight installation? Is there stair access? Will scaffolding or a ladder be required? Will it be accessed from below?
- **Scheduling** – If possible, the skylight installation should be scheduled in a way that minimizes risks associated with additional trades working in the area. If we can schedule the install during a time when there are no other trades working on the roof or below the skylight installation the installation will be safer for everyone.
- **Material Delivery**
  - **Rigging** – It is important to ensure glazing and framing is properly secured during rigging so nothing drops when it is being hoisted to the roof.

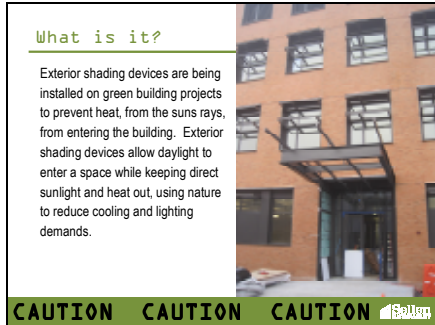
- **Point Loading** - Roof structures can only withstand a specific weight load. If we are hoisting all of our material onto one location, has that location been designed to bear all of that extra weight?
  - **Pinch points / Caught between** – When rigging materials to be hoisted to the roof it is important to be aware of the pinch points (i.e. between glass panels, at anchors, etc.). When dropping materials it is important to ensure there is a safe and designated area that will be clearly marked to prevent employees from being struck by or caught between the materials.
- **Rescue & Retrieval** – Have safety protocols been put into place for rescue and retrieval in case someone falls through the system? Fall protection is one thing, but even if someone is tied off and they fall through the skylight there will need to be a plan for safely rescuing them from the situation.
- **Environmental Factors** - Are we doing the installation during the winter? If so how are we dealing with rain/slip hazards? Is there a chance there may be ice on the roof? Additional environmental concerns include strong winds, lightning, and excessively hot days where workers on the roof are at a greater risk of heat exhaustion.

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The next system we will look at is exterior shading devices

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Exterior shading devices are being installed on green building projects to prevent heat, from the sun's rays, from entering the building. Exterior shading devices allow daylight to enter a space while keeping direct sunlight and heat out, using nature to reduce cooling and lighting demands.

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As we are walking through the installation it is important to be thinking about the following questions:

- Where is it located?
- Which trades may experience a new situation?
- How is it sequenced?
- What equipment & materials are involved?
- How is it installed?
- How is it operated & maintained

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While shading devices differ depending on the manufacturer and the type of system, typically, they are integrated into a window frame that is designed to allow a shading device to be secured to it.

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Shading devices can be as simple as an open overhang or it can be covered like the installation above. More often than not, the frame of the shading device is installed by field staff working in man lifts. The system shown here will require field crews to install both the frame and the covers using a man lift. The frames can be heavy and awkward so it is important to both prepare for falls, and ensure no one will be subject to over exertion. It may take multiple people to install each section.

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Shown here is a look at a nearly complete installation of an exterior shading system. As you can see, daylight is still able to enter the building, but the sun light which has direct heat exposure is kept outside the space. While this installation is for a smaller 4 story building, additional safety considerations will need to be put into place when installing similar systems on larger projects. After a certain height man lifts will no longer be an option, so what will be needed to do the installation, and what are the safety concerns with that technology?

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Shown here is a look at a nearly complete installation of an exterior shading system. As you can see, daylight is still able to enter the building, but the sun light which has direct heat exposure is kept outside the space. While this installation is for a smaller 4 story building, additional safety considerations will need to be put into place when installing similar systems on larger projects. After a certain height man lifts will no longer be an option, so what will be needed to do the installation, and what are the safety concerns with that technology?

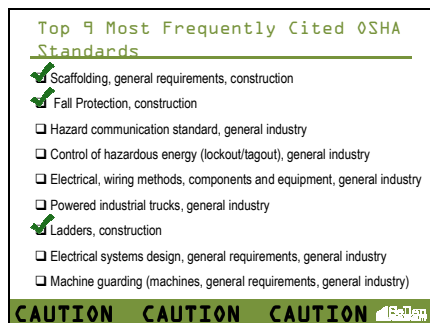
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Some shading devices should require little maintenance while other need to be cleaned periodically and, depending on the type of system, different equipment will be required. A man lift could be used for an installation like the one shown here, but something like a window washers pulley system may be required for larger building installations. Shading systems that span an entire façade of a building will require special procedures for maintenance as access becomes a serious concern.

What if we designed shading devices so that they could be controlled automatically to lower like a draw bridge for easy maintenance/cleaning? (This would also be an ideal solution for hurricane prone areas)

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Shown here is the list of the Top 9 most frequently cited OSHA standards violated in FY2011.

INSTRUCTOR: Ask the audience – Which of these standards may apply to this green building system?

Click for predetermined checkmarks.

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Key takeaways to ensure safety when installing or working on exterior shading devices include:

- **Access** – On smaller installations shading devices will be installed and accessed via manlifts. One important consideration to keep in mind is how operations/maintenance crews will access the devices. Installations should be designed to prevent difficult access scenarios.
- **Sequencing** – If possible, shading devices should be installed when

exterior construction has been completed to ensure no trades, such as the landscapers, will be working below the installation.

○ **Material Handling**

- **Overhead Protection** - Will work be taking place beneath the shading device installation? If so, what steps have we taken to prevent materials or equipment from falling and striking workers below? Do workers beneath the installation know that there is overhead work taking place? Do workers involved with the skylight installation know there is work taking place below? Can we isolate the area so no work will be performed below the installation?
- **Pinch point / Caught between** - When rigging materials to be hoisted for the installation, it is important to be aware of the pinch points (i.e. between shading devices).

○ **Fall Protection** – Typically the system will be installed using a manlift. Despite the guard rail, shading devices can be heavy and awkward and thus employees should be required to tie off to the manlift.

○ **Environmental Factors** – Strong winds are always a concern when working at heights. Additionally, rain may cause shading devices to be slippery and proper protocol should be put into place to prevent workers from dropping parts and pieces of the system.