Life Cycle Safety: How it supports Social Equity Goals

Christine Branche, PhD, Moderator and Presenter
Principal Associate Director, NIOSH, and
Director, NIOSH Office of Construction Safety and Health

Matt Gillen, CIH, Presenter
Deputy Director, NIOSH Office of Construction Safety and Health

Michael Behm, PhD, CSP, Presenter
Associate Professor, East Carolina University
Understand the links between worker safety and health, social equity, and green and sustainable development.

Become familiar with “Life Cycle Safety” and “Prevention through Design” (PtD) as practical approaches for understanding and addressing safety and health in the built environment.

Become familiar with construction and maintenance safety and health hazards and benefits associated with specific LEED credits.

Gain working knowledge of Life Cycle Safety and PtD through case studies.
1. Rationale for including Safety & Health in sustainable green building and maintenance
   • Seven questions about Social Equity and Safety

2. Life Cycle Safety and LEED credits of interest

3. Vegetated Roofs as a case study

4. Take home messages, questions and discussion

The findings and conclusions in this presentation have not been formally disseminated by the National Institute for Occupational Safety and Health and should not be construed to represent any agency determination or policy.
“A 46-year-old electrical worker died when he fell through a skylight on a roof while installing solar panels”

Photo: California FACE Case 09CA003
Environment and Safety are sister disciplines: so why did this happen?

**IMPORTANT:** No indication that LEED credits were directly connected to poor safety record on this project

2009 wake-up call
Why is social equity important?

- USGBC @ 20 years → Looking ahead to evolve “Green” towards true “Sustainability”
- Sustainability → Raises the bar
  → More comprehensive than green
  → Encompasses Social Equity
- Fostering Social Equity is one of 7 USGBC guiding principles
Is safety and health of buildings a social equity issue?

YES

Buildings connect to work...and work connects to safety

Buildings serve as workplaces

Building occupants are also workers

Health and Safety at work are among the fundamental pillars of decent work; these are also essential for a green economy

World Health Organization: Health in the Green Economy

(http://www.who.int/hia/green_economy/hgebrief_occ.pdf)
How does LEED currently address safety and health?

LEED prerequisites and credits do address HEALTH and WELL-BEING ... but not SAFETY

Primary focus → general building occupants
(e.g. indoor air quality for office workers)

Other types of occupants are a secondary focus
(e.g. construction workers, operations and maintenance (O&M) workers, and custodial workers)
“Other” occupants face higher risks:

Construction, operations, and maintenance involves hazards and exposures for these workers.

Sustainable buildings need to address their needs.
What is the extent of the problem?

Construction experiences a disproportionate share of fatalities

(Source: US Bureau of Labor Statistics)
It’s not just “NEW” construction “O&M” and repair work are important

Fully $\frac{1}{3}$ of those who died while employed in construction were contracted to another industry such as government or real estate when the fatal injury occurred.

These are the workers that help operate, maintain, repair, and refurbish existing buildings and structures.

If these fatalities were grouped with those other industries, it would cause noticeable increases in fatality numbers.

- Education and Health services $\rightarrow$ would increase 12%
- Government $\rightarrow$ would increase 34%
- Financial activities $\rightarrow$ would increase 59%

(Source: US Bureau of Labor Statistics)
How does the US compare internationally?

The United States is NOT the leader in safe building

Lower fatality rates in UK, Australia, some EU nations and Canadian provinces.

<table>
<thead>
<tr>
<th>Country</th>
<th>Fatality Rate (rates are per 100,000 workers)</th>
</tr>
</thead>
<tbody>
<tr>
<td>US</td>
<td>9.5 (2012)</td>
</tr>
<tr>
<td>UK</td>
<td>1.9 (2012-13)</td>
</tr>
<tr>
<td>Singapore</td>
<td>5.0 (2012)</td>
</tr>
</tbody>
</table>
Don’t existing codes and regulations already address these safety issues?

**Building codes**
- Do address general occupant safety issues
- Do not address construction or O&M issues

**OSHA regulations**
- Address “employer” responsibilities
- Silent on owner and designer responsibilities
- Leaves gaps in duties
Safety is important for contractors, but how is it an issue for architects, designers, and LEED APs?

Eliminating hazards by **DESIGN** is the preferred approach to preventing work place risks using the “Hierachy of Controls”

Order of Preference and Effectiveness from high to low →

- **Inherently Safe Design Measures**
- Safeguarding and engineering controls
- Provide Use information, warnings, instructions
- Administrative controls, Procedures
- Training
- **PPE**

Designer
Reduce Major Risk

End user
Reduce Residual Risk
The design of this installation directly affects safety for this O&M worker.

Servicing rooftop HVAC equipment

Is this well-designed?

This is an “error trap”

No access

No power

No equipment setback

No fall protection features

Photo: Matt Gillen
Other countries make use of design to address workplace safety and health

- Safety duties assigned by law to owners and designers
- Safety is part of integrated planning.
- Design process used to
  1) reduce major risks, and
  2) communicate residual risks to contractors and owners

These laws and policies reflect research findings

Example: 42% of 224 construction fatalities included some link to design (US 1990-2003). [Behm, 2005]

Design is at the top of the Hierarchy of Controls.... but safety and health professionals do not have design skills.

Design is done by architects and engineers.... yet they do not currently recognize or appreciate the need, do not have safety and health expertise, or may be concerned about liability.

→ → Need collaborative effort for a “Safety Design Review”
“A sustainable product, process or technology should not only protect the environment and the consumer but also the worker. Green jobs must be safe jobs”


LEED uses DESIGN as its primary intervention

It already addresses worker health in an important way.

It provides an opportunity, in the name of sustainability, to further address safety design issues relevant for construction, operations, maintenance, and custodial workers
2. Life Cycle Safety and LEED Credits of Interest

FACILITY LIFECYCLE

- Raw materials
- Manufacturing
- Transportation
- Initial Construction
- Operation and Use
- Maintenance and Repair
- Recycling
- Re-use/Repurposing
- Deconstruction
- Renovation and Replacement
- Waste Stream
...Looking beyond initial construction

Every building roof needs maintenance

Roof work involves fall hazards

How are O&M workers to be protected?

Photo: Denver Art Museum, Matt Gillen
Life Cycle Safety =

- Life Cycle Assessment Thinking
- Job Hazard Analysis Thinking
- Prevention through Design Thinking

Looking comprehensively at all risks affecting all building stages
RISK = HAZARD X EXPOSURE

HAZARD:
potential source of harm and its severity.

EXPOSURE:
- Health hazard:
  → dose X time

- Safety hazard:
  → proximity to a hazard X time
Life Cycle Safety: Basic Steps

1) Screen: What green features/practices deserve review?

- Credit for Public Transportation Access??? → No
- Credit for Vegetated Roofs??? → Yes

2) Scope: What Life Cycle Stages are relevant?

- Construction
- Operations and Use
- Maintenance and repair
- Renovation and replacement
- Deconstruction or repurposing
3) Identify tasks: What tasks/jobs are done at each stage by what groups?

Example: LEED Reference Guide on Reflective (cool) roofs:

“Materials with high reflectivity must be cleaned to maintain their heat island reduction properties. … at least every 2 years to maintain good reflectance.

4) Evaluate risks: What are the potential risks?
A) Identify key hazards
B) Identify key exposures

- **Slip and trip** from wet slippery surface
- **Fall from roof** when working within 15 feet of edge
5) Apply Hierarchy of Controls:
A) Upstream: Architect/design team
B) Downstream: Building owners and contractors

A) Upstream: Design phase review by architects/engineers

- Eliminate or reduce major risks
  - Design out hazards… or design in engineering control safeguards
- Communicate residual risks downstream

B) Downstream: Work phase review by contractors and building owners

- Address communicated residual risks
  - Use additional controls and administrative measures (supervision, training, pre-task planning, standardized procedures) and PPE to manage remaining risks
Safety Design Review

Example: CHAIR

Construction Hazard Assessment Implication Review

Used in Australia → Integrates 3 Safety Design reviews

CHAIR 1: General Review
CHAIR 2: Construction Review
CHAIR 3: Maintenance and Repair Review

Life Cycle Safety: value proposition

✔ Helps designers include ALL building “occupants”

✔ Takes a Total Cost approach (vs. first cost only)

✔ Aligns with owner interests to improve long term operational efficiency

✔ Safer and more cost-effective O&M and renovation

✔ Increases reliability and safety of green features

“Reduced Operating Costs” cited as top (77%) reason for client interest in Green design.


“Plan methods for cleaning windows and atrium glass, it should not be an afterthought”

“Consider equipment replacement process when locating mechanical and emergency generator rooms”

Veterans Administration Design Alerts http://www.cfm.va.gov/til/Alert.asp
Example: Lurie Children’s Hospital, Chicago

Designers engaged facility O&M personnel in designing a large mechanical floor for a new 23 story hospital. They used BIM to explore tasks and designs.

“The designer or engineer may think they need this type of fan, but the facilities person is thinking – to service this piece of equipment I have to pull it out a certain way and it weighs 150 pounds, so how do I get it out and down safely?

These are the kinds of exercises the team can do on the front end that can make the difference between 50 years of a bad design or a design that is efficient, easy, and safe.”


BIM= Building Information Modeling
Safe design of skyscraper greenery in Singapore

Michael Behm
OCCUPATIONAL SAFETY PROGRAM, EAST CAROLINA UNIVERSITY, GREENVILLE, NORTH CAROLINA, USA, AND POH CHOON HOCK
CUGE RESEARCH, CENTRE FOR URBAN GREENERY AND ECOSYSTEM, SINGAPORE

Abstract
Purpose - Singapore is transforming from a "garden city" to a "city in a garden." Designing for safety is recognized by researchers and some governments as best practice in facilitating eventual worker safety within the built environment. The proposed underlying this research was to understand the practical design and construction implications of green buildings as they pertain to skyscrapers.

Research findings

Safety Risk Quantification for High Performance Sustainable Building Construction

Katherine S. Dewlaney, S.MASCE; Matthew R. Hallowell, A.MASCE; and Bernard R. Fortunato III

Abstract: A recent study found that Leadership in Energy and Environmental Design (LEED) certified buildings have a recordable injury rate that is 9% higher than traditional, non-LEED buildings. A follow-up study showed that there are distinct aspects of the design elements and component methods of construction used to achieve LEED certification that have negative impacts on worker safety. The research design focused on LEED credits that pertain to the creation and implementation of green buildings across multiple building types. The use of LEED credits in a project is expected to reduce the overall safety risk associated with green buildings. The research revealed that LEED credits had a negative impact on worker safety due to design elements that were not accounted for in the design phase.

Technical Note

Safe Design Suggestions for Vegetated Roofs

Michael Behm

Abstract: Rooftop vegetation is becoming increasingly popular because of its environmental benefits and its ability to earn green building certification credits. With the exception of one international guideline, there is little mention of worker safety and health in vegetation roof codes and literature. Observations and field investigations of 19 vegetative roofs in the United States revealed unsafe access for workers and equipment, a lack of fall-protection measures, and other site-specific hazards. Design for safety and integration of life-cycle safety thinking with green building credits are the preferred methods to reduce risk to workers on vegetated roofs. Design suggestions have been developed to add to the body of knowledge. The findings complement several National Institute for Occupational Safety and Health (NIOSH) construction and prevention through design (PDT) goals and are congruent with NIOSH's Safe Green Jobs initiative. Organizations that install and maintain vegetative roofs can utilize the findings to understand hazards, take precautions, and incorporate safety into their buildings.

Author keywords: Vegetated roof; Safe design.

Are Green Building Features Safe for Preventive Maintenance Workers? Examining the Evidence

Mohamed Shamun Omar, S.Ci; Margaret M. Quinn, S.Ci; Bryan Buchholz, PhD, and Ken Geiser, PhD

Background: Many newly constructed green buildings (GB) are certified using the United States Green Building Council (USGBC) Leadership in Energy and Environmental Design (LEED) rating system for new construction and major renovation which focuses on architectural and mechanical design to conserve energy, reduce environmental harm, and enhance indoor air quality. This study evaluated the preventive maintenance (PM) tasks of GBs and the associated hazards. The LEED credits examined covered LEED credits in Version 4.0 for GBs.

Key words: Building maintenance; GBs; LEED; credits; hazards; maintenance; worker safety.
Evaluating LEED Credits

Designers and construction project managers interviewed about 6 LEED projects

Findings

- Potential increase in risk: 13 credits
- Potential decrease in risk: 5 credits
- No or negligible change: 39 credits
- Mixed impact: 2 credits

Identification of Safety Risks for High Performance Sustainable Construction Projects. Fortunato, Hallowell, Behm, Dewlaney JCEM April 2012

NIOSH and Construction safety & health pros reviewed 2009 LEED New Construction credits

Findings

- Potential increase in risk: 11 credits
- Potential decrease in risk: 7 credits
- No or negligible change: 38 credits
- Mixed impact: 1 credit


About 2/3 of LEED credits are “NEUTRAL”

A smaller manageable number affect potential risks

Final safety and health impact depends on whether additional safety design and planning measures are taken
<table>
<thead>
<tr>
<th>Prerequisite or Credit</th>
<th>Risk issue example</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Priority Site</td>
<td>Brownfield site hazardous materials</td>
</tr>
<tr>
<td>Rainwater management</td>
<td>Confined space hazard with cisterns and detention systems</td>
</tr>
<tr>
<td>Heat Island Reduction</td>
<td>Falls from vegetative or reflective roofs</td>
</tr>
<tr>
<td>Renewable Energy Production</td>
<td>Falls from roof-mounted solar and wind features</td>
</tr>
<tr>
<td>Waste Management Planning</td>
<td>Injuries and musculoskeletal disorders from material handling exposures</td>
</tr>
<tr>
<td>Building Reuse and Whole Building Life Cycle Assessment</td>
<td>Material handling injuries, collapse and struck by injuries</td>
</tr>
<tr>
<td>Construction and Demolition Waste Management</td>
<td>Injuries and musculoskeletal disorders from material handling exposures</td>
</tr>
<tr>
<td>Daylighting</td>
<td>Falls from and through skylights and atria</td>
</tr>
</tbody>
</table>
### LEED credits – Potential to DECREASE risks

<table>
<thead>
<tr>
<th>Prerequisite or Credit</th>
<th>Risk issue example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integrated Project Planning and Design</td>
<td>(Healthcare) Opportunity to address safety during design.</td>
</tr>
<tr>
<td>Construction Activity Pollution Prevention</td>
<td>Reduction of dust exposures</td>
</tr>
<tr>
<td>Construction Indoor Air Quality Management Plan</td>
<td>Encouragement to control contaminant generation</td>
</tr>
<tr>
<td>Low-Emitting Interiors</td>
<td>Reduction of toxic chemical exposures</td>
</tr>
<tr>
<td>Prerequisite: Green Cleaning Policy</td>
<td>Reduction of toxic chemical exposures (EBOM)</td>
</tr>
<tr>
<td>PBT Source Reduction: Mercury, Lead, Cadmium</td>
<td>Reduction of toxic chemical exposures</td>
</tr>
<tr>
<td>Credit: Green Cleaning: Equipment</td>
<td>Reduction of musculoskeletal disorders (ergonomics), noise, fatigue</td>
</tr>
</tbody>
</table>
Life Cycle Safety Review example: Photovoltaic (PV) Panels

Photo: NIOSH Draft PtD Solar Panel Case Study
### Summary of Steps 1-3

<table>
<thead>
<tr>
<th>STAGE</th>
<th>GROUP</th>
<th>KEY TASKS</th>
<th>HAZARDS/RISKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installation</td>
<td>Construction - Electricians</td>
<td>- Moving panels and supplies to roof</td>
<td>- Cranes/rigging</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Installing panels and wiring</td>
<td>- Falls from ladder</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Falls from roof</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Material handling</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Electric shock</td>
</tr>
<tr>
<td>Maintenance</td>
<td>Maintenance - In house or electricians</td>
<td>- Replace/repair broken panels</td>
<td>- Falls from roof</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Clean panels</td>
<td>- Electric shock</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Inspection</td>
<td></td>
</tr>
<tr>
<td>Recycle and replace</td>
<td>Construction - Electricians</td>
<td>- Removal of panels after 25 year life span</td>
<td>- Cranes/rigging</td>
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<tr>
<td></td>
<td></td>
<td>- Moving new panels to roof</td>
<td>- Falls from ladder</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Installing new panels and wiring</td>
<td>- Falls from roof</td>
</tr>
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<td></td>
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<td></td>
<td>- Material handling</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Electric shock</td>
</tr>
</tbody>
</table>

### O&M considerations for Onsite Renewable Energy Credit

“Provide building operators with the manufacturer’s recommendations for operating and maintenance procedures. Operators may need guidance on how to maximize efficiency, including information about cleaning method and frequency for solar panels”

LEED Reference Guide
Apply the Hierarchy of Controls

Upstream: design options to reduce fall hazard:

Designer to provide for fall protection via:

- Parapet
- or Permanent guard rail
- or anchors and horizontal lifeline for fall restraint or fall arrest system

Another strategy: design to build sections on ground
Downstream Planning:
Contractor to set up using a scissor lift to aid in the PV panel installation process.
A 46-year-old electrical worker died when he fell through a skylight on a roof while installing solar panels. The victim was carrying solar panels and walking backwards because of the limited space around the skylight. As the victim was walking backwards, he tripped on the raised edge of the skylight frame and fell onto the skylight.

http://www.cdc.gov/niosh/face/stateface/CA/09CA003.html
Other emerging Life Cycle Safety issues for PV?

- Firefighter safety when roof access needed
- Recycling of old solar panels
- Others?

Need for safety guidance

Rooftop solar panels become new enemy of U.S. firefighters

Thu, Sep 5 2013
By Daniel Kelley

DELANCO, N.J., Sept 5 (Reuters) - Putrid air hung over a luncheon meats warehouse long after a blaze consumed the building where frustrated firefighters met their enemy: rooftop solar panels.

Loved by the green movement, solar panels pose a growing threat to firefighters, who may suffer electrical shocks from panels that typically cannot be turned off, said John Drengenberg, consumer safety director for Underwriters Laboratories.

Even when systems are equipped with shutoffs, any light can keep panels and their wires energized, Drengenberg said.

Gaining access to roofs gives firefighters advantages such as venting gases, and the panels get in the way, said Ken Willette, who manages the public fire protection division at the National Fire Protection Association.


by Chris Clarke
on October 17, 2013 3:33 PM
3. Vegetated Roofs as a Case Study

Potential relevant LEED credits

- Site Development, Protect or Restore Habitat
- Site Development, Maximize Open Space
- Storm Water Design, Quantity Control
- Heat Island Effect, Roof

From 2-9 points possible

http://www.greenrooftechnology.com/leed/leed_Greenroofs
Project schedule

- Conceptual
- Detailed Engineering / Design
- Procurement
- Construction
- Start-up

Ability to Influence Safety

High Ability

Low Ability

Start Date

End Date
Photo: Mike Behm
When fall protection anchorage is not designed into the roof, workers use whatever they can to tie off….

…..even if it will not support a fall arrest
Yes

Photo: Mike Behm
Skylight guards

Non-fragile skylights

Photo: Mike Behm
### Comparing Singapore and the U.S. Safe Access to extensive Green Roofs

<table>
<thead>
<tr>
<th>Rating</th>
<th>Singapore</th>
<th></th>
<th>US</th>
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<tbody>
<tr>
<td></td>
<td>N</td>
<td>%</td>
<td>N</td>
</tr>
<tr>
<td>Excellent</td>
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<td>18.2</td>
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<td>Poor</td>
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<tr>
<td>Total</td>
<td>11</td>
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Comparing Singapore and the U.S. Fall Protection on extensive Green Roofs

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<td>%</td>
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<td>Excellent</td>
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<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>9</td>
<td>100.0</td>
</tr>
</tbody>
</table>
Green Walls

Design...
or lack of design affects safety
Green Wall with rear access
Good design is safe and efficient
Rotating Plant Column
Good design is safe and efficient
Using Life Cycle Safety and PtD for vegetated roofs

<table>
<thead>
<tr>
<th>LIFE CYCLE STAGE</th>
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<td>Construction</td>
<td>-Moving materials to roof</td>
<td>-Crane and rigging</td>
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<tr>
<td></td>
<td>-Roofers</td>
<td>-Installing materials and plants</td>
<td>-Material handling</td>
</tr>
<tr>
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<td>-Landscapers</td>
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<td>-Falls from roof</td>
</tr>
<tr>
<td>Maintenance</td>
<td>Maintenance</td>
<td>-Plant care</td>
<td>-Roof access</td>
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<tr>
<td></td>
<td>-In house or landscapers</td>
<td>-Irrigation</td>
<td>-Slips and trips</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Inspection</td>
<td>-Falls from roof</td>
</tr>
</tbody>
</table>

**Bottom line:**
Vegetated roofs require regular roof access over their Life Cycle.
Plantings: up to roof edge (Option 1) vs. safety buffer zone (Option 2)?

Selection of plants: consider maintenance needs

Safe access to roof: for workers... and for water and equipment

Fall Protection:

- Isolate fall hazards using parapet or permanent guardrail?
- Secure the worker using fall restraint or fall arrest system with anchors?
Integrate safety into information transmitted to facility owner

LEED Reference Guide O&M considerations:

The Project team should establish an operations plan for inspecting the roof membrane as well as maintaining drainage paths.

This plan can also include information on fall protection features and measures to be used for inspection, maintenance, and replacement tasks.
What really is Exemplary Performance?


**Exemplary Performance**

*Projects may earn an Innovation in Design credit for exemplary performance by demonstrating that **100% of the project’s roof area** (excluding any mechanical equipment, photovoltaic panels, and skylights) consists of a vegetated roof system.*

This means that plantings would go right up to the roof edge

→ Increased exposure to falls during maintenance

→ Increased need for fall protection

*Is it really exemplary if no fall protection is designed in?*
4. Closing Comments

How are green and conventional building practices similar?

- Underlying tasks are mostly similar
- PtD and Life Cycle Safety needed…but NOT typically done
- Safety viewed solely as:
  - a contractor responsibility
  - an OSHA compliance issue
How are green and conventional building practices different?

FOR GREEN:

- Many **NEW** features and practices
- Emphasis on “Best Practice” …not compliance
- Some unique hazards and exposures, and gaps in establishing safety guidance
- Some changes in work sequencing

Cisterns for rainwater harvesting create confined space hazards

60,000 gallon cistern for LEED Silver facility
http://www.dentistry.unc.edu/foundation/dentalexcellence/constructionviews.cfm
Why should LEED be different when it comes to Life Cycle Safety?

- LEED is about leadership, sustainability, and “Best in Class building strategies”*

- Source of Innovation. LEED is about “transforming the way we think about how our buildings and communities are designed, constructed, maintained and operated across the globe”....* (* from http://www.usgbc.org/leed)

- LEED already provides health benefits for construction, O&M, and custodial workers → foundation for future efforts

- LEED already encourages integrated project planning and during design → foundation for adding safety perspectives
Good initial focus for collaboration: LEED features on roofs

- Falls → leading killer of construction workers
  - Falls from roofs → top source of construction falls.

- Several relevant LEED credits involve roof work
  - Daylighting (skylights)
  - Heat Island reduction (vegetative and reflective roofs)
  - Energy production (rooftop solar and wind installations)

Use a "Safe Roof Plan" to describe roof-related Life Cycle safety issues and resulting design and planning options.
Essence of a Safe Roof Plan = Think “Occupant-ready”

1) Group O&M workers with regular building occupants

2) Design the green roof feature for regular building occupant access and use

Publicly accessible green roofs are required to have fall protection features

Occupant-accessible green roofs are a key amenity at the CityCenterDC project under development
The meaning of ‘green’ is evolving, to more fully include human and social relationships to the built environment.

USGBC Strategic Plan (2009)

Sustainability raises the "green" discussion from materials and processes to include marketing, distribution, disposal and **human labor**.

Evans (2006), San Francisco Chronicle
NIOSH initiatives underway

- Dialogue with USGBC
- Outreach to share ideas
- Concepts for:
  - pilot credits to address safety
  - safety guidance for existing credits
  - Webinars and education sessions
- Further development of Life Cycle Safety and PtD tools and approaches
- Concepts for case studies to evaluate PtD benefits on lifecycle cost of ownership and constructability
- Support for research and engagement
Examples of available Tools

http://sustainablesafetyandhealth.org/

http://www.constructionsliderule.org/


http://www.designforconstructionsafety.org/
AUDIENCE QUESTIONS and DISCUSSION
Thanks! and contact information

Christine Branche, PhD, NIOSH
202.245.0625   Cbranche@cdc.gov

Michael Behm, PhD, CSP, East Carolina University
(252) 328-9674   BEHMM@ecu.edu

Matt Gillen, CIH, NIOSH
202-245-0651   Mgillen@cdc.gov

http://www.cdc.gov/niosh/topics/construction/
Follow NIOSH Construction at www.twitter.com/NIOSHConstruct