Construction Efforts at NIOSH

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National Institute for Occupational Safety and Health
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TAUC—The Association of Union Constructors

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.
NIOSH Construction Program
The Construction Falls Prevention Program
Lead Exposures in Construction
Findings from the FACE Program
Prevention through Design
The sole federal government organization charged with conducting occupational safety and health research
Organizational Chart of Federal Entities for Occupational Safety and Health

**Regulation and Enforcement:**
Department of Labor (DOL)
- Mine Safety and Health Administration (MSHA)
- Occupational Safety and Health Administration (OSHA)

**Research and Prevention Recommendations:**
Department of Health and Human Services (HHS)
- Centers for Disease Control and Prevention (CDC)
  - National Institute for Occupational Safety and Health (NIOSH)
“Provide ... leadership to prevent work-related illness, injury, disability, and death by ... gathering information, conducting ... research, and translating the knowledge gained into products, solutions, and services tailored to meet construction needs.”
Program Structure and focus areas

NIOSH Office of Construction Safety and Health

Intramural Research
- Basic Research
- Surveillance
- Methods Research
- Exposure Assessment
- Controls Development
- Applied Research
- Research to Practice

National Construction Center
- Industry Characterization
- Applied Research
- Industry Liaison
- Intervention
- Research to Practice

Extramural Investigator-initiated Grants
- Innovative Ideas
- Opportunities
- State Initiatives

CPWR
Center for Construction Research and Training
Percentage of construction workforce, by class of workers, 2005 and 2010

- **2005**
  - Private employees: 73%
  - Self-employed, unincorporated: 16%
  - Self-employed, incorporated: 7%
  - Public employees: 4%

- **2010**
  - Private employees: 67%
  - Self-employed, unincorporated: 19%
  - Self-employed, incorporated: 9%
  - Public employees: 5%

This research was conducted with restricted access to Bureau of Labor Statistics (BLS) data. The views expressed here do not necessarily reflect the views of the BLS.
Rate of fatalities, selected construction occupations, 2008-2010 average, (all employment)

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Deaths per 100,000 FTEs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power-line installer</td>
<td>56.5</td>
</tr>
<tr>
<td>Ironworker</td>
<td>37.8</td>
</tr>
<tr>
<td>Roofer</td>
<td>32.9</td>
</tr>
<tr>
<td>Truck driver</td>
<td>22.8</td>
</tr>
<tr>
<td>Welder</td>
<td>21.4</td>
</tr>
<tr>
<td>Laborer</td>
<td>17.4</td>
</tr>
<tr>
<td>Foreman</td>
<td>14.6</td>
</tr>
<tr>
<td>Helper</td>
<td>14.3</td>
</tr>
<tr>
<td>Operating engineer</td>
<td>14.3</td>
</tr>
<tr>
<td>Electrician</td>
<td>10.1</td>
</tr>
<tr>
<td>Brickmason</td>
<td>8.8</td>
</tr>
<tr>
<td>Plumber</td>
<td>8.3</td>
</tr>
<tr>
<td>Painter</td>
<td>7.6</td>
</tr>
<tr>
<td>Heat A/C mech</td>
<td>6.3</td>
</tr>
<tr>
<td>Carpenter</td>
<td>6.3</td>
</tr>
<tr>
<td>Drywall</td>
<td>3.8</td>
</tr>
<tr>
<td>Construction manager</td>
<td>3.5</td>
</tr>
<tr>
<td>All construction</td>
<td>9.6</td>
</tr>
</tbody>
</table>

This research was conducted with restricted access to Bureau of Labor Statistics (BLS) data. The views expressed here do not necessarily reflect the views of the BLS.
Distribution of women workers in construction, by occupation type, 1985 and 2010 (all employment)

<table>
<thead>
<tr>
<th>Occupation Type</th>
<th>1985</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clerical &amp; support</td>
<td>16.5%</td>
<td>50.8%</td>
</tr>
<tr>
<td>Manager &amp; professional</td>
<td>15.8%</td>
<td>31.3%</td>
</tr>
<tr>
<td>Production occupation</td>
<td>16.5%</td>
<td>18.0%</td>
</tr>
</tbody>
</table>

This research was conducted with restricted access to Bureau of Labor Statistics (BLS) data. The views expressed here do not necessarily reflect the views of the BLS.
Injury Assessment for Emerging Mast Scaffold Technology

Chris Pan, DSR and team

Photo: Chris Pan
Straight Talk About Nail Gun Safety

Jim Albers and DART team

Published in June 2013

http://www.cdc.gov/niosh/docs/2013-149
Simple Solutions for Home Building Workers

Jim Albers and DART team

Published in June 2013

http://www.cdc.gov/niosh/docs/2013-111/
Ladder Safety Application for Smart Phones

Peter Simeonov, DSR and team

Developed APP to quickly and easily position extension ladder at correct angle

Inclination indicator

Graphic-oriented aid
I worked construction for 10 years before my fall. It shattered my body and my livelihood.

Work safely. Use the right equipment.

FALLS FROM LADDERS, SCAFFOLDS AND ROOFS CAN BE PREVENTED!

PLAN ahead to get the job done safely.
PROVIDE the right equipment.
TRAIN everyone to use the equipment safely.

www.osha.gov/stopfalls.gov

1 (800) 321-OSHA (6742) • TTY 1-877-889-5627
Why a Focus on Falls?

Greatest fall fatality hazards:

- Roofs ~ 33%
- Scaffolds ~ 16%
- Ladders ~ 16%

These 3 hazards combined account for roughly two-thirds of all fatal falls in construction.

They represent, however, very different problems.
FALLS FROM LADDERS CAN BE PREVENTED!

- Choose the right ladder for the job
- Maintain three points of contact
- Secure the ladder
- Always face the ladder

DON'T
- Stand on top or on the top step of a stepladder
- Overreach
- Place the ladder on unlevel footing

PLAN ahead to get the job done safely.
PROVIDE the right ladder and equipment.
TRAIN everyone to use the equipment safely.
FALLS FROM SCAFFOLDS CAN BE PREVENTED!

- Use fully planked scaffolds
- Ensure proper access to scaffold
- Plumb and level
- Complete ALL guardrails
- Ensure stable footing
- Inspect before use (by competent person)

DON'T
- Use a ladder on top of a scaffold
- Stand on guardrails
- Climb cross-braces

PLAN ahead to get the job done safely.
PROVIDE the right scaffold and equipment.
TRAIN everyone to use the equipment safely.
FALLS FROM ROOFS CAN BE PREVENTED!

- Wear a harness and always stay connected
- Make sure your harness fits
- Use guardrails or lifelines
- Inspect all fall protection equipment before use
- Guard or cover all holes, openings, and skylights

DON'T
- disconnect from the lifeline
- work around unprotected openings or skylights
- use defective equipment

PLAN ahead to get the job done safely.
PROVIDE the right roof equipment.
TRAIN everyone to use the equipment safely.
Spot the Hazard: Can You Spot the Hazard?
Web Addresses

Main campaign website (CPWR—The Center for Construction Research and Training)  http://www.stopconstructionfalls.com

Campaign posters and fact sheets
http://www.cdc.gov/niosh/construction/stopfalls.html
http://www.osha.gov/stopfalls/

NIOSH Science blog  http://blogs.cdc.gov/niosh-science-blog/
Fatality Assessment and Control Evaluation Program (FACE) reports  http://www.cdc.gov/niosh/face/

To become a campaign partner: email falls@cpwr.com
CONSTRUCTION

Construction workers and employers build our roads, houses, and workplaces and repair and maintain our nation’s physical infrastructures. Construction includes building new structures, renovations involving additions, alterations, or maintenance, and repair of buildings or engineering projects such as highways or utility systems. The NIOSH Construction Program provides national and world leadership to prevent work-related illness, injury, disability, and death by systematically gathering information, conducting targeted scientific research, and translating the knowledge gained into products, solutions, and services tailored to meet construction needs. In collaboration with industry and labor partners and stakeholders, including OSHA, we are dedicated to improving safety and health conditions for all construction workers.

In 2010, there were 774 fatal on-the-job injuries to workers in the construction industry — more than in any other industry sector and representative of 17% of all work-related deaths in the U.S. that year. Construction is a large, dynamic, and complex industry sector, putting nearly $800 billion of construction in place in 2011. Construction worksites are organizationally complex multi-employer sites and present numerous health and safety challenges.

Spotlights
- Nail Gun Safety: A Guide for Construction Contractors — (Spanish) Seguridad con las pistolas de clavos
- Safety Pays. Falls Cost. Campaign to Prevent Construction Falls Launched
- New on NIOSH FACE: Search Residential and Commercial Construction Falls
- Follow us @NIOSHConstruct on Twitter!

Calendar of Events

View Related Topic in Español (Spanish)
NIOSH Construction Program on Twitter
@NIOSHConstruct

Construction @ NIOSH @NIOSHConstruct
Follow us to learn more about Construction Safety and Health (Our RT, lists or following doesn’t mean endorsement)
http://www.cdc.gov/niosh/construction

Tweets

Construction @ NIOSH @NIOSHConstruct
10,000 construction workers injured a year in falls, more than 200 of them fatally
ls.gd/D1GdFK
Expand

Construction @ NIOSH @NIOSHConstruct
Falls are the number one cause of construction-worker fatalities
StopConstructionFalls.com Follow @NIOSHConstruct
Expand

Construction @ NIOSH @NIOSHConstruct
UK HSE report on accident factors when using Mobile Elevated Work Platforms (MEWPs)
bl.ly/10qPFzx
Expand

FACE @ NIOSH @NIOSHFACE
New Construction Toolbox Talk Guides
tinyurl.com/cyugeth

© 2013 Twitter About Help Terms Privacy
Lead Developments

RIVETBUSTING
Photo: Mt Sinai/CHEP
From eLCOSH Images
Manufacturing had greatest overall number of elevated blood leads (BLL > 25 µg/dl) reported in 2009:

- 72% Manufacturing
- 14% for Construction

However, construction has the greatest proportion of individuals with BLLs ≥40 µg/dL (among those with BLL ≥25 µg/dL) of all industries:

- Painting and Paperhanging: 27.1%
- Bridge, tunnel, elevated highway construction: 25.2%
- Special trade contractors: 26.3%
- Heavy construction: 20.4%
The construction sector is the only sector that did not show a decrease in the percent of samples greater than the PEL (0.05 mg/m³) over the years ...

1979 - 2008
Impact of New Information?

Research suggests that the 1993 OSHA construction lead standard, which was based on the available science for the 1978 general industry lead standard, is no longer sufficiently protective.

Example:
PEL of 50 µg/m³ → designed to keep blood lead below 40 µg/dl of blood trigger

….NIOSH recommends that adult blood lead levels ≥10 µg/dl be considered elevated
## Health Effects at Different BLLs

<table>
<thead>
<tr>
<th>Blood Lead Level (µg/dL)</th>
<th>(5 - 9)</th>
<th>(10 - 19)</th>
<th>(20 - 39)</th>
<th>(40 - 79)</th>
<th>(\geq 80)</th>
</tr>
</thead>
</table>

- Possible adverse population effects suggested by epidemiological studies
- Essential tremor
- Increased risk of hypertension
- Increased blood pressure

**NTP: BLL < 10 µg/dL:**
- Decreased glomerular filtration rate
- Maternal BLL associated with reduced fetal growth

**NTP: BLL < 5 µg/dL:**
- Spontaneous abortion
- Reduced newborn birth weight
- Possible blood pressure changes
- Possible renal dysfunction
- (Possible neurocognitive deficits)
- (Possible postnatal development delay)

**Source:** AOEC’s Medical Management Guidelines. For effects in ( ) Kosnett *et al* and Shih *et al.*
California Department of Public Health Occupational Lead Poisoning Prevention Program recommended a dramatic reduction in the amount of lead in workplace air allowed under the Permissible Exposure Limit.

Health-based PEL ➔ at or below 0.5 – 2.1 μg/m³ to keep workers’ blood lead levels at or below 5 to 10 micrograms per deciliter (μg/dL) over a working lifetime.

Dr. John Howard moderated “Lead in the Workplace: The New Science” in California, Nov 2013
What about the Children of Exposed Workers?

“Based on a meta-analysis of 10 reports from 1987-1994, the children (n=139) of lead-exposed workers (n=222) had a geometric mean blood lead level of 9.3 μg/dL compared to a U.S. population geometric mean of 3.6 μg/dL ($P=0.0006$). Also in this group, 52% of the children had blood lead levels (BLLs) ≥ 10 μg/dL compared to 8.9% in the U.S. ($P=.0010$), and 21% of the children had BLLs ≥ 20μg/dL compared to 1.1% in the U.S. ($P=.0258$).” [emphasis added]
“Failure to screen this population will probably mean that their lead poisoning will be missed because they might not live in neighborhoods or houses which would otherwise make them candidates for targeted screening.”

Roscoe, et al. Conclusions, pg. 480

Trigger levels for childhood blood leads have also been reduced based on new information: From 10 ug/dl to no safe level … with use of 5 ug/dl as a “reference level” to recommend testing

“Children who come in contact with lead-exposed workers should be targeted for blood lead screening”

(ABLES Description webpage)

The Bottom Line: Lead continues to pose challenges for Construction
The Fatality Assessment and Control Evaluation (FACE) Program

FACE Website:  www.cdc.gov/niosh/face

Reports Do Not Use Any Identifiers or Place Blame
Ironworker Dies in Ohio Following a 20’ Fall Through a Skylight Opening, Ohio
Scaffold Erector Dies After Falling 60’ from Scaffold Inside Boiler, South Carolina

FACE Report 9808
Carpenter Dies After Being Struck by Uncontrolled Concrete Bucket When Crane Tips Over, Ohio
4 Construction Workers Die after Cantilever Launching Gantry Collapses at Bridge Construction Site, Ohio
Welder/Ironworker Dies After Becoming Entangled in a Beltline Driveshaft, South Carolina
Mission: Design out hazards and minimize risks associated with:

- Facilities
- Work methods
- Processes
- Equipment
- Products & new technologies
What is Prevention through Design?

Eliminating or reducing work-related hazards and illnesses and minimizing risks associated with

- Construction
- Manufacturing
- Maintenance
- Use, reuse, and disposal of facilities, materials, and equipment
DESIGN MATTERS!
Main finding: design contributes significantly to work-related serious injury.

37% of workplace fatalities are due to design-related issues.

In another 14% of fatalities, design-related issues may have played a role.

From Driscoll et al., 2008

Photo courtesy of Thinkstock
Asphalt repaving

Before and after photos of asphalt fume emissions from highway-class pavers

Cervarich MB. Prevention through Partnerships. PtD in Motion; 2008 (Issue 2).
PtD Process

- Establish PtD expectations
- Include construction and operation perspective
- Identify PtD process and tools

Hecker et al. 2005
Prevention through Design: Basic Steps

- Identify potential hazards
- Evaluate risks
- Eliminate or reduce risks
- Communicate residual risks to downstream users
Why Prevention through Design?

Ethical reasons
Construction dangers
Design-related safety issues
Financial and non-financial benefits
Practical benefits

Photo courtesy of Paklndfun.com
Hierarchy of Controls

- **BEST**
  - **ELIMINATION**
    - Design it out
  - **SUBSTITUTION**
    - Use something else
  - **ENGINEERING CONTROLS**
    - Isolation and guarding
  - **ADMINISTRATIVE CONTROLS**
    - Training and work scheduling
  - **PERSONAL PROTECTIVE EQUIPMENT**
    - Last resort

Control effectiveness

Business value

Per ANSI/AIHA Z10-2005
Personal Protective Equipment (PPE)

Last line of defense against injury

Examples:
- Hard hats
- Steel-toed boots
- Safety glasses
- Gloves
- Harnesses

OSHA [www.osha.gov/Publications/osha3151.html]
Clients Likely to be Interested in PtD

Industrial clients where shut downs are expensive

Hospitals

Lab facilities

Security and emergency response operations

Emerging areas:
- Smart Grid
- Microgeneration
Design is at the top of the Hierarchy of Controls….but safety and health professionals cannot do design alone.

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

→ Need collaborative effort to do PtD
NIOSH Construction Program and PtD

Supported the 2003 “Designing for Safety and Health in Construction” Symposium in Portland, Oregon
Accidents in Construction Linked to Design

22% of 226 injuries linked partly to design, 2000-2002 study in Oregon, Washington, California

42% of 224 fatalities in U.S. during 1990-2003 linked to design

60% of fatal accidents resulted in part from decisions made before site work began, 1991 study in Europe

63% of all fatalities and injuries could be attributed to design decisions or lack of planning
PtD in engineering textbooks
PtD in engineering and H&S curricula
  – 2 dozen university partners
  – ABET
  – NCEES
Develop and disseminate engineering education modules
Develop and disseminate educational programs to health and safety professionals
  – ASSE, AIHA
Websites

Prevention through Design web page
http://www.cdc.gov/niosh/programs/PtDesign/

Research to Practice (r2p) case studies
http://www.cdc.gov/niosh/programs/PtDesign/r2p.html

PtD and Sustainability
http://www.cdc.gov/niosh/topics/ptd/greenjobs.html

PtD 2011 Conference Proceedings
http://www.asse.org/professionalaffairs_new/ptd.php

PtD wiki
http://www.orcehs.org/wiki/display/orcehs/PtD+Case+Studies
Business Value of PtD

Anticipate worker exposures—be proactive
Align health and safety goals with business goals
Modify designs to reduce/eliminate workplace hazards in

<table>
<thead>
<tr>
<th>Facilities</th>
<th>Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tools</td>
<td>Processes</td>
</tr>
<tr>
<td>Products</td>
<td>Work flows</td>
</tr>
</tbody>
</table>

Improve business profitability!

AIHA [www.ihvalue.org/]
Benefits of PtD

Reduced site hazards and thus fewer injuries
Reduced workers’ compensation insurance costs
Increased productivity
Fewer delays due to accidents
Increased designer-constructor collaboration
Reduced absenteeism
Improved morale
Reduced employee turnover
Industries Use PtD Successfully

Construction companies
Computer and communications corporations
Design-build contractors
Electrical power providers
Engineering consulting firms
Oil and gas industries
Water utilities

And many others
Green Building on the Rise

- 76% of Architects
- 66% of Contractors
- 51% of Subcontractors

… believe that green construction will be the norm for their trade or profession by 2016

Is Green Construction Better?
Not Always
IDEA: Integrate Safety & Health into Green Construction

- **GREEN** building is on the increase
- Rating systems (e.g. LEED) are driving best practices
- How do SAFETY and SUSTAINABILITY relate?

**Target:**
- Safety and Health community
- US Green Building Council (USGBC)
- Architects and Designers
- Owners

**LEED** = Leadership in Energy and Environmental Design
OPPORTUNITIES

Can we promote worker safety and health as a fundamental dimension of true sustainability?

Can we encourage Prevention through Design (PtD)?
It is common to assume that green building projects are inherently safer for workers…

EXAMPLE: “Attention to environmental issues during construction leads to a safer and healthier work site”
Los Alamos National Lab Sustainable Design Guide, p64

…and common to overlook safety and health

EXAMPLE: “There currently is a blind spot in sustainable design practice when it comes to worker safety and health… Tremendous focus is placed on materials, energy and the environment, but designers typically give little, if any, consideration to the safety and health of the people who install the green features or build the projects”

Development wins 6 coveted design certifications (Las Vegas, NV)
- More than three months before it opens, the $8.5 billion CityCenter development has received six Leadership in Energy and Environment Design (LEED) gold certifications from the U.S. Green Building Council....(Las Vegas Review Journal, September 14, 2009)

Six deaths during 2007-2008 construction phase
(Las Vegas, NV) - MGM Mirage’s CityCenter
Construction and Maintenance Workers

Key role in building lifecycle
- Build
- Maintain
- Renovate/Refurbish/Replace
- Decommission/Demolish

Face many types of hazards
- **Injuries:** Falls, struck by, electrocution
- **Illness:** Silica, welding, noise, solvents
- **Musculoskeletal Disorders:** Awkward postures, high exertion, heavy lifting

Renovation of Portland Federal Building
Photo: Matt Gillen
Strategies for Integrating Safety and Health into Green Building

“Life Cycle Safety”

Green building is oriented towards “Life Cycle” thinking

Construction and Maintenance workers play key roles in the built environment “Life Cycle”
Operations & Maintenance

Servicing rooftop HVAC equipment

Fall exposures
“Error trap” for workers
Design issues?

No access
No power
No equipment setback from edge
No fall protection

HVAC= Heating, Ventilation, and Air Conditioning

Photo: Matt Gillen
Safety Payoff During Design

Conceptual design

Detailed design

Procurement

Construction

Start-up

Ability to influence safety

High

Low

Project schedule

Adapted from Szymberski 1997
LEED includes some elements related to worker health and well-being

**Building Occupants**
Major LEED focus
Largest worker group – lowest risk

**Custodial Workers**
Minor LEED focus
Smaller worker group – medium risk

**Construction, Maintenance Workers**
Minor LEED focus
Smaller worker group → highest risk potential
## But What is Missing?

<table>
<thead>
<tr>
<th>Type of Worker</th>
<th>HEALTH &amp; WELL-BEING</th>
<th>SAFETY</th>
<th>ERGONOMICS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Building Occupant</strong></td>
<td>Illness</td>
<td>Major focus via IEQ credits</td>
<td>Not addressed</td>
</tr>
<tr>
<td><strong>Custodial Worker</strong></td>
<td>Minor focus</td>
<td>Not addressed</td>
<td>Minor focus</td>
</tr>
<tr>
<td><strong>Operations, Maintenance (O&amp;M), and Construction Worker</strong></td>
<td>Minor focus</td>
<td>Not addressed</td>
<td>Not addressed</td>
</tr>
</tbody>
</table>
“As green and sustainable practices become more common in the U.S, there is an opportunity to promote worker safety and health as a fundamental dimension of true sustainability. …

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.”

NIOSH Science Blog: Going Green: Safe and Healthy Jobs, January 4, 2010
Help make the workplace safer…

Include *Prevention through Design* concepts in your projects.

For more information, please contact the National Institute for Occupational Safety and Health (NIOSH) at

**Telephone:** (513) 533–8304  
**E-mail:** preventionthroughdesign@cdc.gov

Visit these NIOSH Prevention through Design websites:

- [www.cdc.gov/niosh/topics/PtD/](http://www.cdc.gov/niosh/topics/PtD/)  
- [www.cdc.gov/niosh/programs/PtDesign/](http://www.cdc.gov/niosh/programs/PtDesign/)
Summary

PtD is the preferred approach
- Working at the top of the hierarchy of controls is most reliable

PtD provides potential solutions for tackling a major cause of fatalities

PtD provides opportunities for working with owners and clients to improve safety and productivity
“In many respects, PtD is a transformative concept for the 21\textsuperscript{st} century. It views investments in worker safety and health as an integral part of business efficiency and quality, rather than as a cost. It is also a practical concept that has already been used successfully in several model applications.”

John Howard, MD
Director, NIOSH, CDC
November 22, 2010
With thanks to

Matt Gillen
Deputy Director, Office of Construction Safety and Health
NIOSH Construction Program Coordinator

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