Welcome!

G. Scott Earnest

NORA Construction Sector Council Co-Chair

NIOSH Office of Construction Safety and Health

NORA Construction Sector Council

Disclaimer – 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

NORA
National Occupational Research Agenda

Photo by Martin Barraud/Getty Images

https://www.cdc.gov/nora/councils/const

Third Decade of NORA (2016-2026)

10 Sectors and 7 Cross-Sectors

Industry Sectors

Agriculture, Forestry and Fishing

Construction

Healthcare and Social Assistance

Manufacturing

Mining

Oil and Gas Extraction

Public Safety

Services

Transportation, Warehousing and Utilities

Wholesale and Retail Trade

Health & Safety Cross-Sectors

Cancer, Reproductive and Cardiovascular

Hearing Loss Prevention

Immune, Infectious & Dermal

Musculoskeletal Health

Respiratory Health

Traumatic Injury Prevention

Healthy Work Design and Well-being

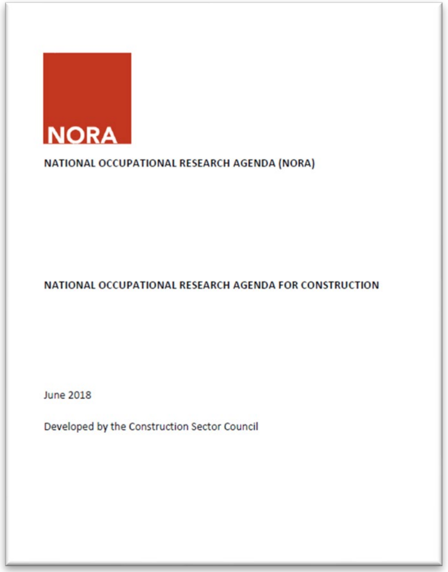
NIOSH Strategic Plan and NORA Research Agenda

- The Construction Program priorities for NIOSH work
  - Based on burden, need, and impact
  - Determined in collaboration with other NIOSH programs

  - Preventing harmful **noise** exposure
  - Reducing occupational **musculoskeletal disorders**
  - Reducing occupational **respiratory** diseases
  - Improving workplace safety to reduce **traumatic injuries** such as falls
  - Promoting safe and **healthy work design**

NIOSH Strategic Plan: FYs 2019–2026

Version 8: August 2023



NORA

NATIONAL OCCUPATIONAL RESEARCH AGENDA (NORA)

NATIONAL OCCUPATIONAL RESEARCH AGENDA FOR CONSTRUCTION

June 2018

Developed by the Construction Sector Council

Purpose of NORA Councils

- Exchanging Information
- Forming Partnerships
- Enhancing dissemination and implementation

Agenda - Wednesday AM

Wednesday, November 20

8:45 AM	Welcome and Overview	Scott Earnest, NIOSH
9:00 AM	Update from the National Construction Center	Chris Cain, Jessica Bunting, CPWR
9:30 AM	Update from NIOSH Construction Office	Scott Earnest, Doug Trout, NIOSH
10:00 AM	Serious Incident and Fatality Prevention Model	Chris Louis, NSC
10:30 AM	Break	
10:45 AM	Milwaukee Tool Safety Efforts	Justin Azbill, Milwaukee Tool
11:15	Ongoing NIOSH efforts related to PPE fit	Katherine Yoon, NIOSH
11:45	Lunch	

Agenda - Wednesday PM

11:45	Lunch	
12:45 PM	Construction safety research: Hazard recognition, etc.	Sogand Hasanzedah, Purdue
1:15 PM	ASU's PtD Initiative: What did we Learn during the Last Five Years?	David Grau, ASU
1:45 PM	Injuries in the Subcontracting Chain	Kevin Conner and Peter Phillips, U Utah
2:15 PM	Break	
2:30 PM	Construction MSD Research at WVU	JuHyeong Ryu, WVU
3:00 PM	Human-Robot Collaboration in Construction	Marvin Cheng, NIOSH
3:30 PM	NIOSH projects: hardhats, exoskeletons	Chris Pan, NIOSH
4:00 PM	Wrap-up and Adjourn	Chris Cain, CPWR

Agenda - Thursday AM

Thursday, November 21

8:45 AM	Welcome	Chris Cain, CPWR
9:00 AM	OSHA DOC update	Tim Irving, OSHA
9:30 AM	MSD Cross-Sector Collaboration	Scott Schneider, Jack Lu, NIOSH
10:15 AM	Roofing stability and slip interventions	John Wu, NIOSH
10:45 AM	BREAK	
11:00 AM	Wildland Fire Smoke and Outdoor Workers	Todd Niemeier, NIOSH
11:30 AM	Evaluation of Silica Exposures During Drywall Sanding	Hannah Echt, NIOSH
12:00 PM	Wrap Up and Adjourn	Scott Earnest and Chris Cain

NIOSH Construction Program Update

Scott Earnest, Ph.D, PE, CSP
Director, NIOSH Office of Construction Safety and Health
Manager, NORA Construction Sector

Doug Trout, MD
Deputy Director, NIOSH Office of Construction Safety and Health

Scott Breloff, Ph.D.
Senior Biomechanical Research Engineer, NIOSH, DFSE

November 2024

NIOSH Office of Construction Safety & Health

National Construction Center Awarded!

- 5-year cooperative agreement
- Budget of approx. $29M

CPWR

THE CENTER FOR CONSTRUCTION RESEARCH AND TRAINING

Congratulations to CPWR for being selected again as the NIOSH National Construction Center for 2024-2029!

PREVENTION THROUGH DESIGN (PtD)

Series of workshops funded by NIOSH in collaboration with Arizona State University

- (2020-2024) 5th Workshop August 27, 2024
- ASU Barrett and O'Connor Ctr, Washington DC

[Prevention through Design | (asu.edu)](https://ptd.engineering.asu.edu)

Arizona State University

Prevention through Design Workshop 2024

Education, Training, & Legislation – Where do we go from here?

Location: ASU Barrett and O'Connor Washington Center at 1800 I St NW, DC 20006

Continuing Education Unit (CEU) credits will be offered

Washington, DC
August 27, 2024
8:00 am – 4:00 pm

NIOSH Award #1 R13OH011707-01-00

CONTACT:
David Grau, Ph.D., PE
david.grau@asu.edu

AGENDA HERE!

CONFIRMED KEYNOTE SPEAKERS
(More to be announced)

George Edward Gibson, Jr., Ph.D., PE, NAC, Dist. M. ASCE
President and CEO
National Academy of Construction

Dennis Else, Ph.D
Global ESG Chair
Multiplex

David Grau, Ph.D. PE
Associate Professor
Arizona State University

Billy Hare, Ph.D
Professor
Glasgow Caledonian University

Helen Lingard, Ph.D
Distinguished Professor
RMIT university

About the 2024 PtD Workshop:

The NIOSH-funded 2024 Prevention through Design (PtD) Workshop 2024 theme will combine legislation, training, and education themes with the aim to propel safety design principles and their adoption by design and construction professionals. Outstanding keynote speakers from academia, industry, and government will share their insights, knowledge, and experiences. Participants will take part in two expert-facilitated breakout sessions to explore how to enhance PtD capabilities through training and the implications of PtD legislation. The workshop will offer additional networking opportunities, interactive sessions, case studies, and collaborative discussions to bring together educators, design and construction professionals, insurance representatives, and policymakers. Its overarching goal is to align research, practice, and legislation to promote safety in construction.

NIOSH · ASU Ira A. Fulton Schools of Engineering, Arizona State University · We built that. · National Academy of Construction · CPWR The Center for Construction Research and Training · MJGrushkaConsulting · Toellner Consulting Safety and Environmental Engineering Services

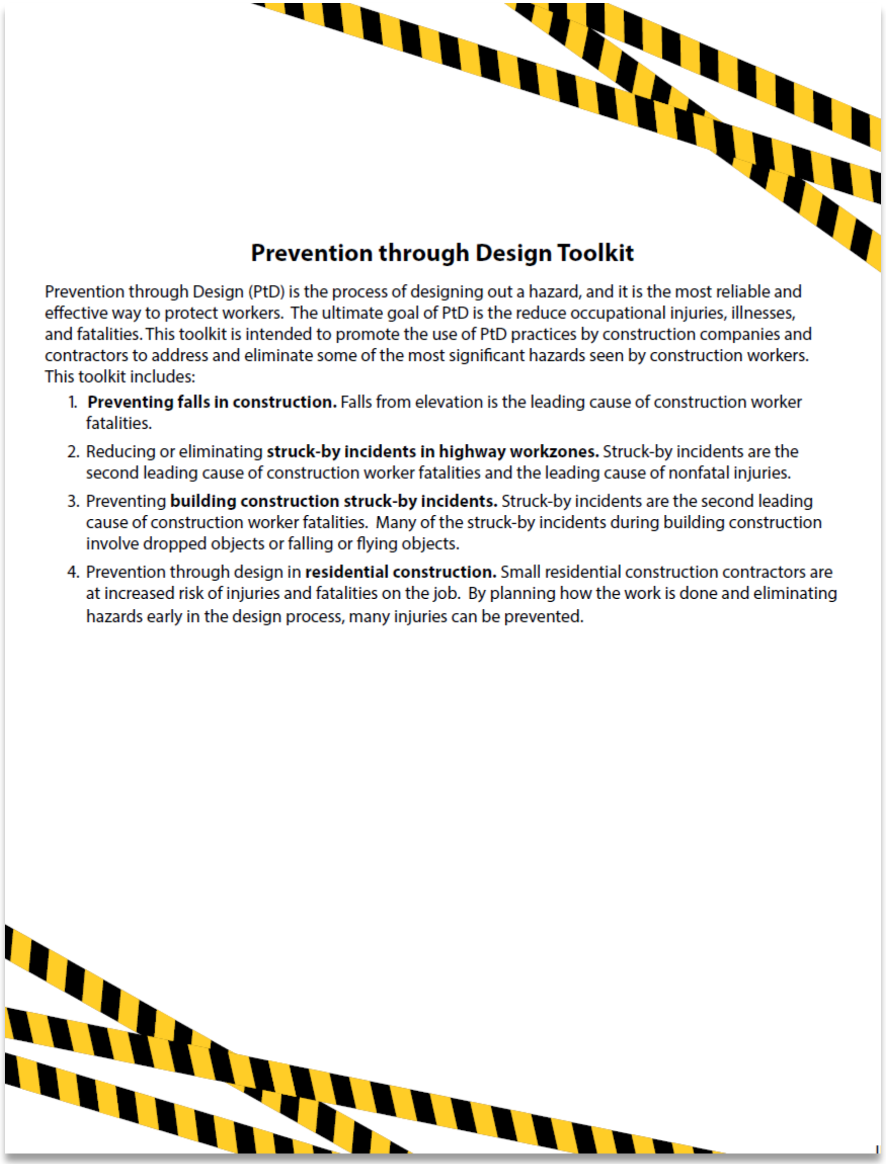
REGISTER HERE!

https://ptd.engineering.asu.edu/ptd-workshop-2024/

PREVENTION THROUGH DESIGN (PtD) Toolkit


Prevention through Design Toolkit for the Construction Industry

CDC NIOSH


Prevention through Design Toolkit

Prevention through Design (PtD) is the process of designing out a hazard, and it is the most reliable and effective way to protect workers. The ultimate goal of PtD is the reduce occupational injuries, illnesses, and fatalities. This toolkit is intended to promote the use of PtD practices by construction companies and contractors to address and eliminate some of the most significant hazards seen by construction workers. This toolkit includes:

1. **Preventing falls in construction.** Falls from elevation is the leading cause of construction worker fatalities.
2. Reducing or eliminating **struck-by incidents in highway workzones.** Struck-by incidents are the second leading cause of construction worker fatalities and the leading cause of nonfatal injuries.
3. Preventing **building construction struck-by incidents.** Struck-by incidents are the second leading cause of construction worker fatalities. Many of the struck-by incidents during building construction involve dropped objects or falling or flying objects.
4. Prevention through design in **residential construction.** Small residential construction contractors are at increased risk of injuries and fatalities on the job. By planning how the work is done and eliminating hazards early in the design process, many injuries can be prevented.

PREVENTION THROUGH DESIGN (PtD) Toolkit

Fall Prevention Toolkit for Architects and Design Engineers

Use this table to minimize common fall exposures during the construction and maintenance of buildings.

PtD recognizes that architects and design engineers can "design out" potential hazards to eliminate or minimize the risk and improve workers' safety and health. This table, used during the planning and design phase, will help/guide architects and design engineers to identify and eliminate potential hazards that are found in building construction and later maintenance of the building or site. To increase PtD application and certainty in the scope of work, PtD controls should be part of bids and contracts associated with the construction and maintenance and included in plans and drawings.

Design Engineer Codes: CE = Civil, ME = Mechanical, SE = Structural, PE = Project

Component	Design Risk	PtD Controls	Architect	Engineer
Roof Openings (skylights, solar tubes, exhaust fans, etc.)	Falling through roof openings during installation, maintenance, or emergency operations due to no or inadequate fall protection systems	• Design permanent guardrails or protective netting around openings	X	CE, SE
		• Specify skylights to have guardrails, load bearing mesh, or certified protective covers that can support the weight of a person	X	SE
		• Design/group roof openings together to create one larger opening with guardrails rather than many smaller openings	X	CE, SE
		• Locate roof access away from roof edges	X	SE
		• Implement clear signage and marking around roof openings to enhance visibility and awareness of potential hazards	–	PE
Roof Access	Falling from unsafe roof access points (Unprotected ladders, unsafe roof hatch openings)	• Design safe access to all roof levels or from level to level (stairs, protected ladder, ships ladder)	X	CE, SE
		• Install a permanent stairway with handrails for safer and easier access to the roof, especially if frequent access is required	X	SE
		• Provide adequate space around roof hatch to allow for safe personnel movement and equipment handling during access and maintenance operations	X	SE
		• Design/provide safety grab bar for hatch access or handrail that extends above the roof level	X	CE, PE
Roof Edges (elevated levels/ changes in elevations)	Falling off exposed edges during construction and maintenance if they are not adequately guarded or protected	• Design minimum 42" height parapets or railings at all roof edges	X	CE, SE
		• Design/specify embedded anchor points: - Locate to enable the end user to safely perform regular maintenance - Involve a fall protection supplier/designer in the plan review	X	CE, PE, SE

Struck-by Toolkit for Design Engineers and Resident Engineers - Roadway Work Zones

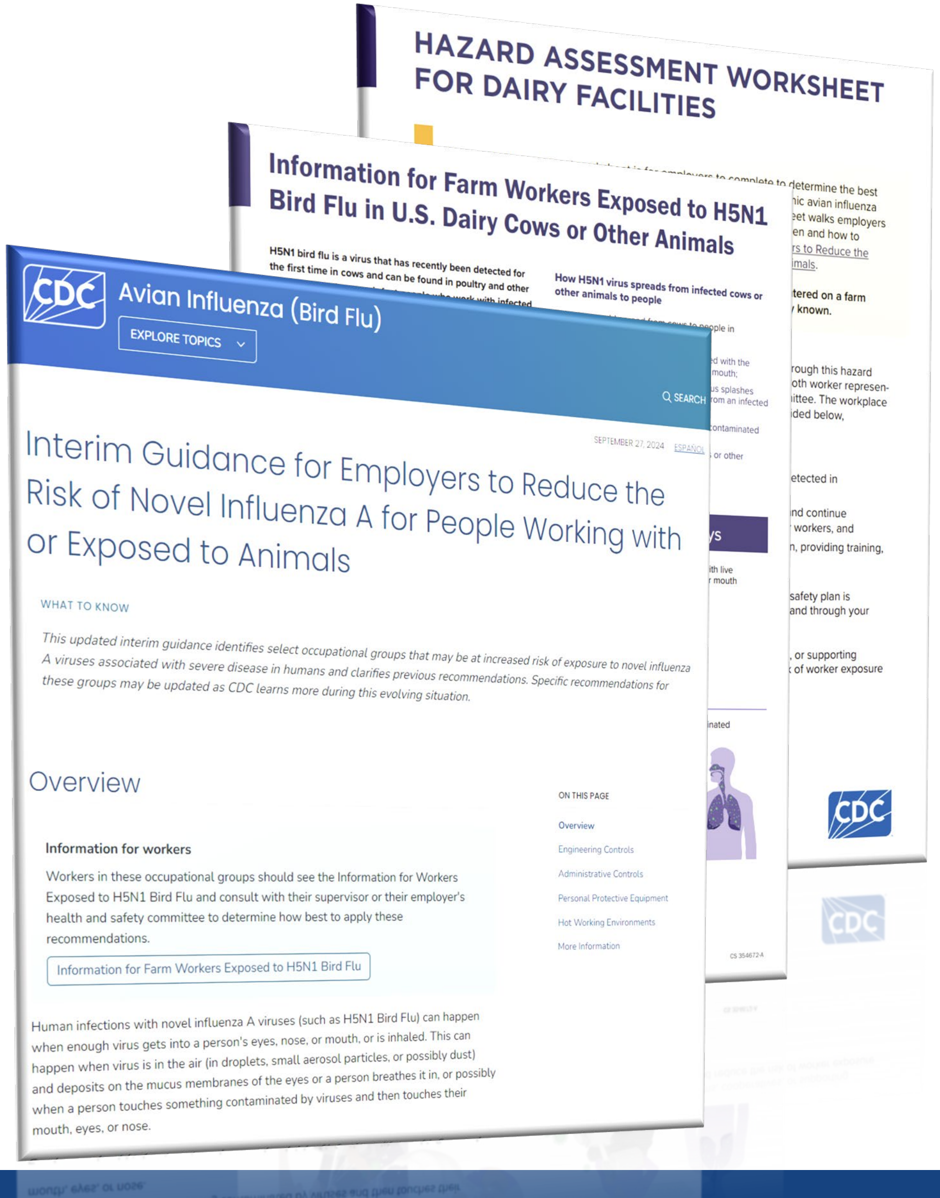
Use this table to prevent through design many common struck-by exposures during the construction and maintenance of roadways.

Prevention through Design (PtD) recognizes that design/resident engineers are able to "design out" potential hazards to eliminate or minimize risk and improve workers' safety and health. This table, when used during the planning and design phase, should help design/resident engineers identify and eliminate hazards when used in roadway construction and maintenance. To increase PtD application and certainty in the scope of work, PtD controls should be part of bids and contracts associated with the construction and maintenance and included in plans and drawings.

Design Engineer Codes: CE = Civil, TE = Traffic, SE = Structural, PE = Project

Component	Design Risk	PtD Controls	Resident Engineer	Design Engineer
Pedestrian worker	Walking adjacent to motor vehicle traffic and construction equipment and vehicles increases the risk of workers being struck by passing vehicles and equipment.	• Develop and use an Internal Traffic Control Plan (ITCP). Specify physical barriers to separate and protect workers from motorist traffic - Ensure positive protection is used to isolate workers from passing motorists	✔	PE, TE
		• Schedule work activities at different times to reduce work crew exposure to passing construction vehicles and equipment	✔	PE
		• Design separate work zone entry and exit points for pedestrian workers and vehicles	✔	PE, TE
		• Design pedestrian worker crossing points so that drivers and pedestrians can see each other - Specify signs and lighting at the crossing points regardless of the time	✔	PE, TE
		• Determine safe movements for workers to/from and within each operation and specify them on site drawings - Design safe access for traffic within the general work zone	✔	PE
		• Identify "pedestrian-free zones" on the site plan in high construction traffic areas such as access/egress points	✔	PE, TE
		• Ensure all heavy equipment used on site has back-up cameras and alarms	✔	-
Vehicle and heavy equipment	Construction vehicle movement and activities can lead to struck-by hazards for workers.	• Design access/egress to minimize construction and motorist traffic conflicts. Design workflow to eliminate the need for spotters	✔	PE, TE
		• Design the order of work to minimize vehicle backing	✔	PE, TE
		• Design the order of work to minimize pedestrian worker and equipment conflicts	✔	PE, TE

2024 Influenza A(H5N1) Response



- **Updated workplace guidance posted September**
- **Collection of over 10 products**
  - Interim Guidance for Employers to Reduce the Risk of Novel Influenza A for People Working with or Exposed to Animals
  - Hazard Assessment Worksheet for Dairy Facilities
  - Information for Workers Exposed to H5N1 Bird Flu
  - Printable job aids
  - Worker infographics

SCAN TO LEARN MORE →

2024 Hurricanes Helene and Milton Response

- **Debris clean up major activity**
- **Media mortality scraping**
  - 255 deaths from Helene
  - 13 worker-related deaths
- **EPRO leading the WSH Task Force**
- **Support from NPPTL, DFSE, RHD, and OD**
- **Coordinating at interagency level through National Response Team**
- **Disseminating WSH guidance and answering technical questions**

Center for Firefighter Safety, Health, and Well-being

KEY POINTS

- NIOSH Firefighter safety and health work is represented across all 50 U.S. states and Washington, D.C.
- The Center for Firefighter Safety, Health, and Well-being was established to provide a central point for engaging with the broad spectrum of research and service NIOSH conducts around firefighters.
- Partner involvement is key to our success.

NIOSH Firefighter safety and health work is represented across the United States. Some highlights include:

- Fatality investigations **750+**
- Health hazard evaluations **85+**
- Research and other communication products **1,400+**
- Respirator approvals **10,000+**
- 9/11 responders who receive healthcare, including 17,000 FDNY firefighters **88,000+**

NIOSH is addressing the top safety and health issues in the fire service.

NATIONAL FIREFIGHTER REGISTRY *for Cancer*
Understanding & Reducing Cancer

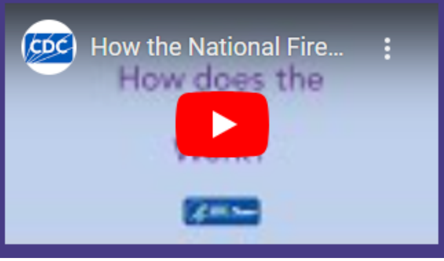
Confirm eligibility and then click "Login.gov" below to create account or sign in.

- [ ] I am at least 18 years of age *
- [ ] I have served or am currently serving as a US firefighter *

Login.gov

Supported by IAFF, IAFC, NVFC and more
Want more information? Visit our website
Need help signing up? View our Tip Sheet

Join the NFR for Cancer - hear fire service members share why joining the NFR is important.



How does the NFR for Cancer work? - learn how the NFR will help researchers investigate the link between firefighting and cancer.

https://nfr.cdc.gov/

INTERNATIONAL
CONFERENCE

PARIS
NOVEMBER 14, 2024

FORESIGHT
FOR OCCUPATIONAL SAFETY AND HEALTH

Anticipating changes in the workplace to prevent occupational risks.

inrs
Institut National de Recherche et de Sécurité

International conference: Foresight for Occupational Safety and Health

European Agency for Safety and Health at Work

National Institute for Occupational Safety and Health NIOSH®

IFA Institut für Arbeitsschutz der Deutschen Gesetzlichen Unfallversicheru

perosh PARTNERSHIP FOR EUROPEAN RESEARCH IN OCCUPATIONAL SAFETY AND HEALTH

Foresight at NIOSH – NIOSH Science Blog

https://blogs.cdc.gov/niosh-science-blog/2023/12/13/strategic-foresight-2023/

Preparing for the Future: NIOSH Applications of Strategic Foresight

December 13, 2023 by Jessica MK Streit, MS, PhD, CHES® and Sarah A Felknor, MS, DrPH

To date, NIOSH has completed two strategic foresight projects to expand our futures thinking and readiness. In early 2023, we published the results of the inaugural NIOSH strategic foresight project, which explored four possible futures and their implications for OSH research and service.[5] This project identified eight evidence-based drivers of change that will likely impact or shape the future of OSH:

- Advanced technologies
- Climate change
- Data security
- Generating new knowledge
- Social credit and trustworthiness
- Work arrangements
- Virtual work
- Workforce demographic shifts

Efforts to Prevent and Address Substance Use Challenges Among Mining Industry Workers

U.S. Department of Labor
MSHA
Mine Safety & Health Administration

Miner Health Partnership

New Cannabis Topic Pages

CDC National Institute for Occupational Safety and Health (NIOSH)

EXPLORE TOPICS

SEARCH

NIOSH > SUBSTANCE USE

AUGUST 28, 2024

Cannabis Use and Workers

WHAT TO KNOW

In light of rapidly changing laws and public attitudes, NIOSH has developed a framework for addressing workers' safety, health, and well-being related to cannabis. The framework focuses on guiding questions for future research.

Overview

Cannabis is a genus of flowering plants. It contains compounds called cannabinoids that can have a wide range of effects on the body and brain. Cannabinoids are products found in a cannabis plant (e.g., tetrahydrocannabinol [THC] and cannabidiol [CBD]).

Employers in all industries face challenges addressing issues of impairment among workers who consume cannabis. This is especially true for workers in safety-sensitive positions. As laws, regulations, and attitudes change related to

ON THIS PAGE

- Overview
- At a glance: Framework
- Guiding questions
- Resources

CDC National Institute for Occupational Safety and Health (NIOSH)

EXPLORE TOPICS

SEARCH

NIOSH > CANNABIS

SEPTEMBER 3, 2024

Workplace Safety and Health Hazards

AT A GLANCE

- Cannabis industry exposures and hazards can be chemical, biological, or related to safety and well-being.
- Employers and workers can take steps to create a safe and healthy workplace

Overview

Cannabis remains illegal under U.S. federal law. However, many states have passed laws to allow the growth and use of cannabis for medical or adult (21+ years of age) use purposes. This has caused the number of workers in the cannabis industry to grow substantially.

Activities in the cannabis production and distribution industry include:

- growing cannabis plants indoors and outdoors,

ON THIS PAGE

- Overview
- Workplace exposures
- Framework
- Guiding questions
- Best practices
- Resources

Opioids and Workers

Opioid-Related Overdose Deaths Among Injured Workers in Massachusetts:
Findings From the Public Health Data Warehouse

Massachusetts Department of Public Health, Occupational Health Surveillance Program SPRING 2024

INTRODUCTION

Massachusetts continues to be impacted by the nationwide opioid epidemic. The state's annual rate of opioid-related overdose deaths more than tripled over the past decade, increasing from 9.9 per 100,000 residents in 2011 to 32.7 per 100,000 residents in 2021,[a] and the emergency department visit rate of suspected opioid-related overdoses (including non-fatal) increased 28% in one year alone from 2019 to 2020.[b]

Our previous analyses of Massachusetts death certificate data indicated that the rate of fatal opioid-related overdose among residents of working age also increased by a similar magnitude from 2011 to 2020 (from 15.3 per 100,000 workers to 49.6 per 100,000 workers).[c] This burden was not borne equally; rates of opioid-related overdose deaths varied significantly by the industry[1] and occupation of the decedents. Workers in certain industry groups, such as Construction and Extraction; Farming, Fishing, and Forestry; and more recently, Accommodation and Food Services, had higher rates of opioid-related overdose death compared with workers in other industries during this period.[d] Furthermore, the rate of fatal opioid-related overdose was higher among workers employed in industries and occupations known to have high rates of work-related injuries and illnesses. This finding is consistent with evidence suggesting common use of prescribed opioids for the management of acute and chronic pain following a work-related injury.[e f g h]

Our past analyses have laid the groundwork for understanding how a work injury could be connected to fatal opioid-related overdose, but they have primarily relied on death certificate data. More evidence beyond what is available through death certificates is needed to understand how work injuries may be connected to fatal opioid-related overdose. A first step is being able to identify that a work injury has occurred among those who died from an opioid-related overdose, a step that was not previously possible in our analyses using death certificate data alone. Using the Massachusetts Department of Public Health (DPH) Public Health Data Warehouse (PHD), we are now able to link information about individuals' employment and work injury status from workers' compensation data with their death certificate data, as well as with information from multiple other state data sources, which can help take our work to the next step.

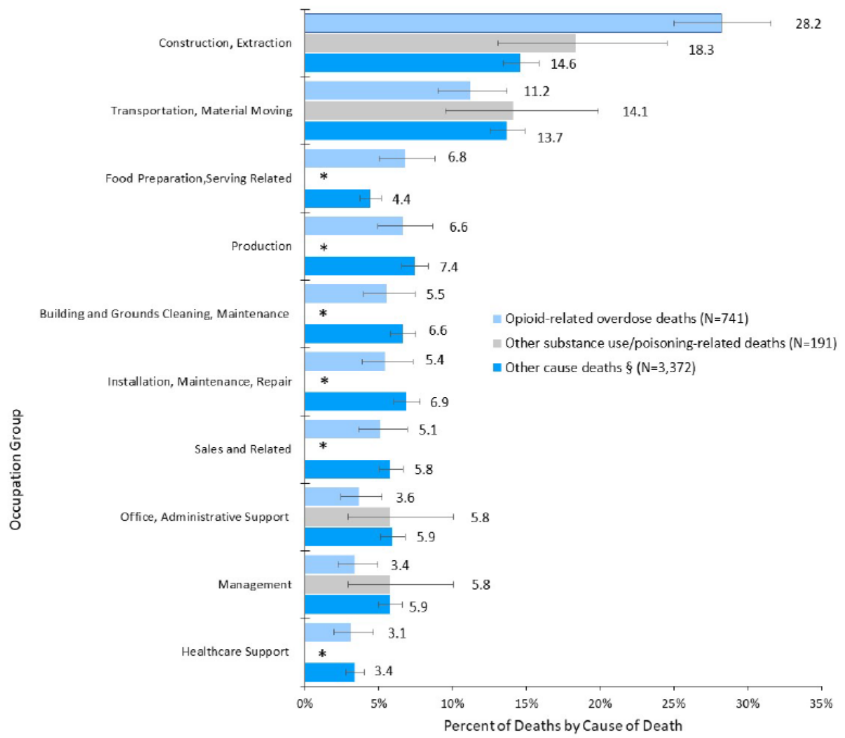
Our goals with this data brief are to:

1) demonstrate the linkage potential of the workers' compensation data with one of the many datasets contained within the PHD for future analyses of occupational-health-related events and opioid-related morbidity and mortality; and,
2) describe a population of workers who were injured at work and also died between 2011 and 2020, focusing on those who suffered a fatal opioid-related overdose. We will characterize deaths among injured workers by demographic factors (binary sex, age, race/Hispanic ethnicity, and nativity), a sociodemographic factor (decedents' occupation), as well as the type of work injury suffered at the time of or prior to death.

[1] Occupation describes the kind of work an individual does to earn a living (i.e., job title), while industry describes the type of business the employer is engaged in.

- There were also lower *numbers* of deaths among residents born outside of the U.S. who were injured at work compared with U.S.-born residents who were injured at work. Immigrant workers injured on the job may be least likely to enter the workers compensation system which may partially explain the low numbers seen in these data.
  - Although not all workers are eligible for workers' compensation benefits, there are many barriers preventing immigrant workers (especially the undocumented) from obtaining the workers' compensation benefits to which they are entitled [k l]

FIGURE 4. Leading occupations¥ among Massachusetts working age residents‡ who died and were previously injured at work, 2011–2020, N = 4,304



*Percent not shown, based on counts between 1 and 10.
‡ Residents of working age were between 16 and 64 years.
§ Other causes of death are those not related to overdose/poisoning from opioids or other drugs/substances.
¥ Occupation is *usual occupation* listed on the death certificate.
NOTE: Occupation was missing for 5% of opioid-related deaths, 5% of other substance use-related deaths, and 4% of other cause deaths.

NORA Construction Sector Work Groups

Preventing Falls

Co-Chairs:

Rich Trewyn

Cheryl Ambrose

Monthly Zoom meetings

Preventing Struck-by

Co-Chairs:

Brad Sant

Alanna Klein

Monthly Zoom meetings

*If interested in joining, reach out to Doug Trout DTrout@cdc.gov

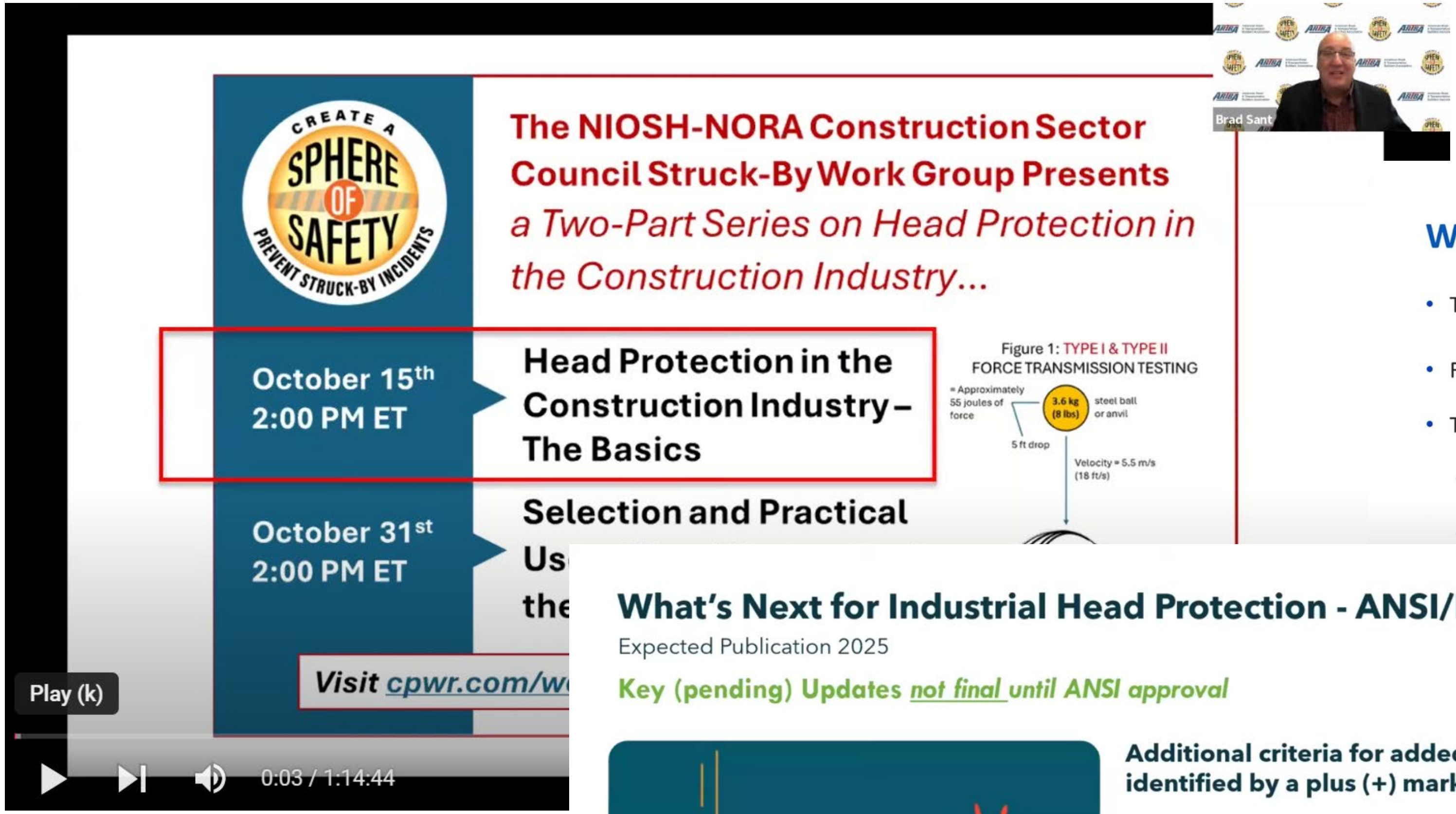
NORA

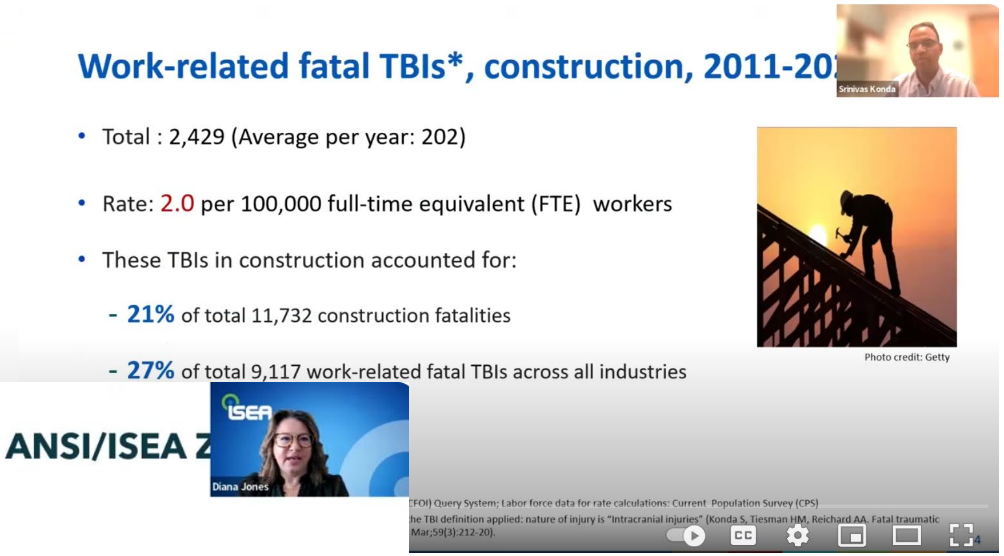
Struck-by & Falls Stand-down Activities/Outputs

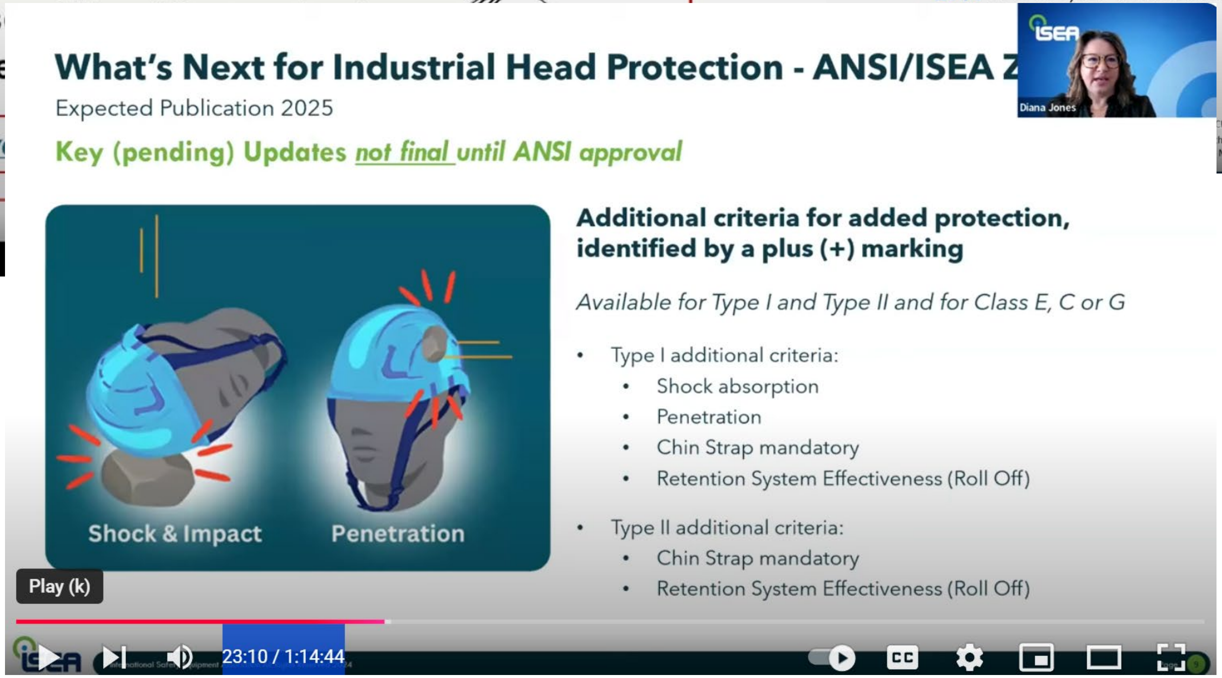
- The Struck-by Stand-down
  - [Struck-by (ITCP) Science Blog]
  - [Kick-off event in Mobile, AL]
  - [ITCP Webinar]
  - Comms products
  - Social media
- The Falls Campaign and Stand-down
  - [Ladder Safety Webinar]
  - [Science Blog]
  - [Falls Campaign Promotion video]
  - Kick-off Webinar
  - Comms products
  - Social media

[www.stopconstructionfalls.com]

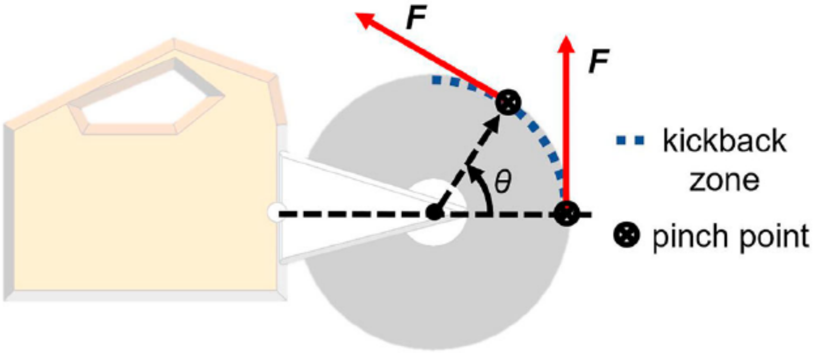
Helmet Webinars







Draft Power Saw Fact Sheet



(a) Circular Cutoff Saw

Investigation Summary

Investigation Nr: 148573.015 **Event**: 08/03/2022 Employee Is Killed By Neck Laceration After Saw Kickback

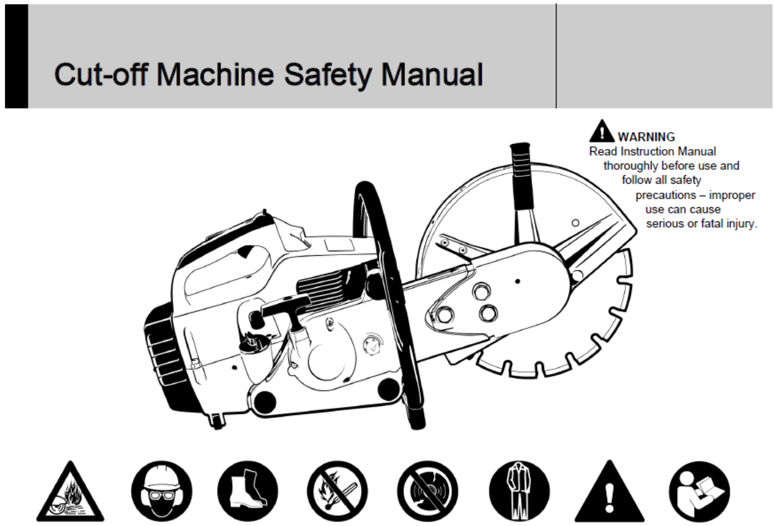
At 11:45 a.m. on August 3, 2022, an employee was installing underground plumbing conduit at a new commercial building under construction. While cutting piping with a power saw, the saw kicked back and the sawblade struck the employee in the neck. The employee was killed by the neck laceration.

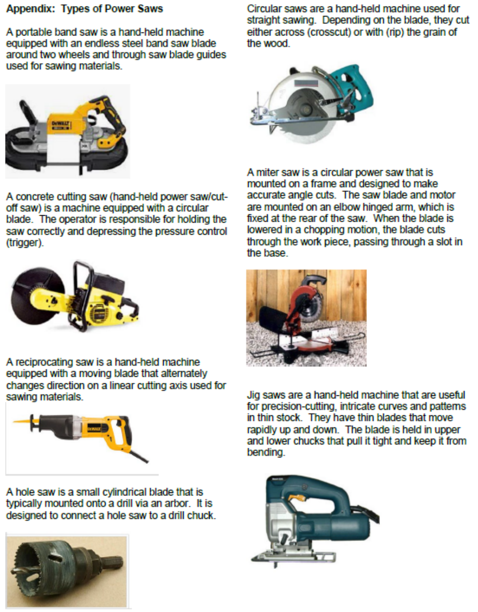
Keywords:construction, kick back, laceration, loss of blood, neck, pipe, plumbing, portable power tool, saw, sawblade, struck by

Investigated Inspection

#	Inspection	Age	Sex	Degree	Nature	Occupation
1	1613010.015			Fatality		

(d) Abrasive Blade





Appendix: Types of Power Saws

A portable band saw is a hand-held machine equipped with an endless steel band saw blade around two wheels and through saw blade guides used for sawing materials.

A concrete cutting saw (hand-held power saw/cut-off saw) is a machine equipped with a circular blade. The operator is responsible for holding the saw correctly and depressing the pressure control (trigger).

A reciprocating saw is a hand-held machine equipped with a moving blade that alternately changes direction on a linear cutting axis used for sawing materials.

A hole saw is a small cylindrical blade that is typically mounted onto a drill via an arbor. It is designed to connect a hole saw to a drill chuck.

Circular saws are a hand-held machine used for straight sawing. Depending on the blade, they cut either across (crosscut) or with (rip) the grain of the wood.

A miter saw is a circular power saw that is mounted on a frame and designed to make accurate angle cuts. The saw blade and motor are mounted on an elbow hinged arm, which is fixed at the rear of the saw. When the blade is lowered in a chopping motion, the blade cuts through the work piece, passing through a slot in the base.

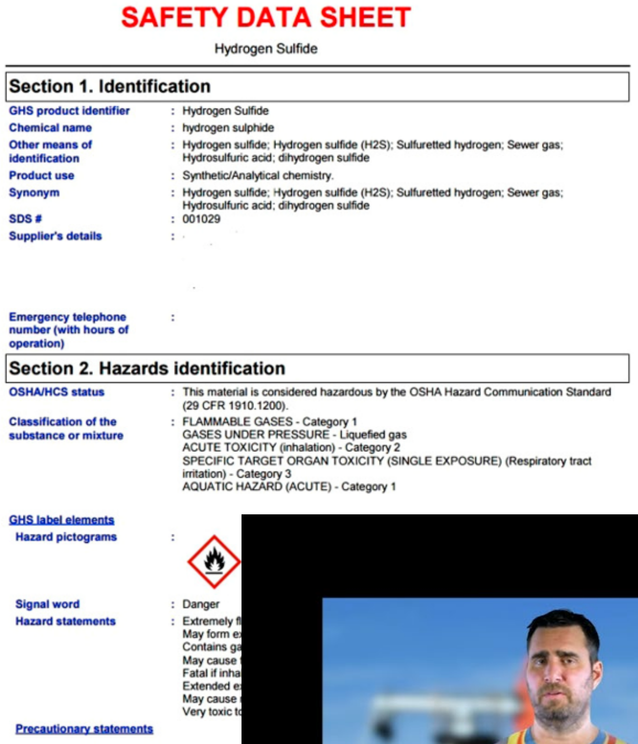
Jig saws are a hand-held machine that are useful for precision-cutting, intricate curves and patterns in thin stock. They have thin blades that move rapidly up and down. The blade is held in upper and lower chucks that pull it tight and keep it from bending.

Construction Noise Videos

[Protecting Against Noise Hazards at My Job (youtube.com)]

[Protecting My Workers Against Noise Hazards (youtube.com)]

Safety Data Sheet (SDS) Video



SAFETY DATA SHEET

Hydrogen Sulfide

Section 1. Identification

GHS product identifier	: Hydrogen Sulfide
Chemical name	: hydrogen sulphide
Other means of identification	: Hydrogen sulfide; Hydrogen sulfide (H2S); Sulfuretted hydrogen; Sewer gas; Hydrosulfuric acid; dihydrogen sulfide
Product use	: Synthetic/Analytical chemistry.
Synonym	: Hydrogen sulfide; Hydrogen sulfide (H2S); Sulfuretted hydrogen; Sewer gas; Hydrosulfuric acid; dihydrogen sulfide
SDS #	: 001029
Supplier's details	:
Emergency telephone number (with hours of operation)	:

Section 2. Hazards identification

OSHA/HCS status	: This material is considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200).
Classification of the substance or mixture	: FLAMMABLE GASES - Category 1 GASES UNDER PRESSURE - Liquefied gas ACUTE TOXICITY (inhalation) - Category 2 SPECIFIC TARGET ORGAN TOXICITY (SINGLE EXPOSURE) (Respiratory tract irritation) - Category 3 AQUATIC HAZARD (ACUTE) - Category 1

GHS label elements

Hazard pictograms	:
Signal word	: Danger
Hazard statements	: Extremely fl May form e Contains ga May cause Fatal if inha Extended e May cause Very toxic t

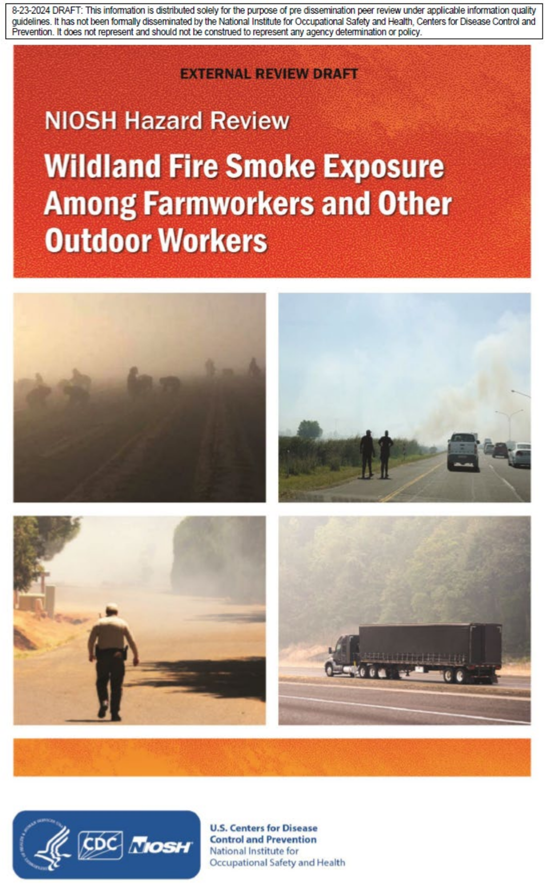
Precautionary statements

Safety Data Sheets provide vital information about potential safety and health hazards for materials used in many industries.

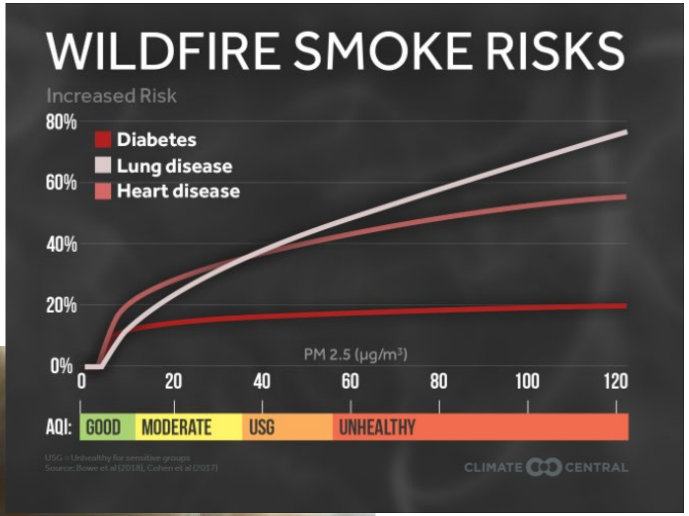
The National Institute for Occupational Safety and Health (NIOSH) wants to ensure workers are aware of this important resource.

[Safety Data Sheets – You have a right to know]

NIOSH Wildland Fire Smoke & Outdoor Worker Report



[Outdoor Workers Exposed to Wildfire Smoke | NIOSH | CDC]



Wildfires may present a major health hazard to outdoor workers from exposure to smoke. Image by NIOSH.

Background Information: : NIOSH [2024]. National Institute for Occupational Safety and Health; Outdoor workers exposed to wildland fire smoke; Request for information. Fed Regist *89*(51):18638. [https://www.federalregister.gov/documents/2024/03/14/2024-05403/national-institute-for-occupational-safety-and-health-outdoor-workers-exposed-to-wildland-fire-smoke]

Coming Up – NIOSH Driver Safety Summit
April 9-10, 2025
12-4 PM each day, virtual
Amber Trueblood & Doug Trout participating in planning

Center for Motor Vehicle Safety

KEY POINTS

- Prevent motor vehicle crashes, the leading cause of work-related deaths in the U.S.
- Address risks for all workers, not limited to specific groups.
- Understand risk factors, develop and assess technological and engineering interventions, and evaluate the effectiveness of motor vehicle safety management programs and practices.

NIOSH CENTER FOR MOTOR VEHICLE SAFETY

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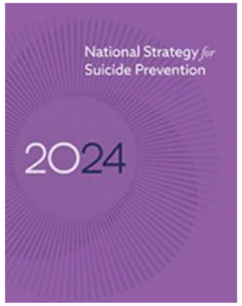
NIOSH Science Blog

How Employers Can Advance the 2024 National Strategy for Suicide Prevention

September 27, 2024 by Hope M. Tiesman, Eric G. Carbone, John Malgeri, L. Casey Chosewood

Suicide is a serious public health threat. In 2022 in the United States, nearly 50,000 adults died by suicide, 13.2 million adults seriously considered suicide, 3.8 million planned a suicide attempt, and 1.6 million attempted suicide.[1] In that same year, 267 adults died by suicide while at work in the United States.[2] That is one person dying in the workplace by suicide every workday in a year. People in certain occupations are at an increased risk for suicide, which makes the workplace an important potential intervention site because many adults spend a significant amount of time at work. Employers and workplaces can play a vital role in suicide prevention.

In 2001, the first National Strategy for Suicide Prevention was released and was updated in 2012 by Surgeon General Dr. Regina Benjamin and the National Action Alliance for Suicide Prevention. In April, the Biden Harris Administration, through the U.S. Department of Health and Human Services (HHS) released the 2024 National Strategy for Suicide Prevention which acknowledges major advancements since 2012, recognizes existing gaps and emerging issues, and calls for a more coordinated and comprehensive public health approach to suicide prevention.[3] The National Strategy is built around four Strategic Directions: (1) Community-Based Suicide Prevention; (2) Treatment and Crisis Services; (3) Surveillance, Quality Improvement, and Research; and (4) Health Equity in Suicide Prevention.



The 2024 National Strategy focuses more on the role of work and workplace culture and calls for expanded workplace efforts in preventing suicide and assisting workers at risk. The National Strategy discusses how employers

Prevent Fungal Diseases in the Workplace

September 16, 2024 by Emily Kirby, BPH; Marie de Perio, MD; Mitsuru Toda, PhD, MS; Samantha Williams, MPH; Ian Hennessee, PhD, MPH

As part of Fungal Disease Awareness Week, we are highlighting fungal diseases that can affect workers. Coccidioidomycosis (Valley fever), blastomycosis, and histoplasmosis are fungal diseases caused by fungi that live in the environment in certain regions. Infections are caused by breathing in fungal spores that get into the air. Some jobs and work activities that disturb soil in areas where the fungi live can release fungal spores into the air and put workers at higher risk. Employers and workers can take steps to reduce risk and prevent workplace exposures to fungal diseases.

Fungal diseases to watch out for

Coccidioidomycosis, or Valley fever, is an infection caused by a fungus called *Coccidioides*. These fungi live in the soil and are found in the southwestern and some parts of pacific northwestern United States.

Blastomycosis is an infection from a fungus called *Blastomyces*. *Blastomyces* mainly lives in the midwestern, south-central, and southeastern states. It is most common in the eastern United States. The fungus lives in the environment in moist soil and decomposing plant matter like wood and leaves.

Histoplasmosis is an infection from a fungus called *Histoplasma*. *Histoplasma* mainly lives in soil in the central and eastern United States. However, it can likely live in other parts of the country as well, especially if the environmental conditions (e.g. soil pH) are highly suitable. It grows especially well in places containing large amounts of bird or bat droppings.

How Employers Can Advance the 2024 National Strategy for Suicide Prevention | Blogs | CDC

Prevent Fungal Diseases in the Workplace | Blogs | CDC

NIOSH Science Blogs

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NIOSH Science Blog

Exploring Approaches to Keep an AI-Enabled Workplace Safe for Workers

September 9, 2024 by John Howard, MD, and Paul A. Schulte, PhD

Artificial intelligence (AI)—the field of computer science that designs machines to perform tasks that typically require human intelligence—has seen rapid advances leading to cutting-edge innovations in language, vision, reasoning, and human-machine collaboration across industries, economies, and labor markets.[1] [2]

In the workplace, the adoption of AI technologies can result in a broad range of hazards and risks to workers, as illustrated by the recent growth in industrial robotics and algorithmic management. [3- 8] Sources of risk from deployment of AI technologies across society and in the workplace have led to numerous government and private sector guidelines that propose principles governing the design and use of trustworthy and ethical AI. As AI capabilities become integrated in devices, machines, and systems across industry sectors, employers, workers, and occupational safety and health practitioners will be challenged to manage AI risks to worker health, safety, and wellbeing.

A new commentary in the American Journal of Industrial Medicine, Managing workplace AI risks and the future of work, discusses these challenges and presents five risk management options to promote the use of trustworthy and ethical AI in workplace devices, machinery, and processes. Excerpts and synopses from the commentary are presented here.

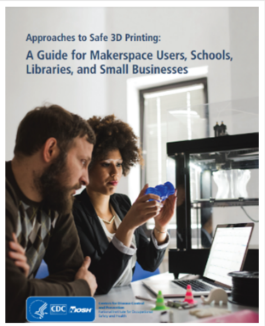
Trustworthy and Ethical AI

The "black-box" nature of AI systems poses challenges to users in understanding their underlying decision-making process. This degrades trust in AI's operations and outcomes, resulting in users being wary about trusting AI. [9] Developing and deploying AI that is "trustworthy" has become the conceptual basis of nearly all approaches that are aimed at promoting the benefits of AI to society while managing its hazards and risks. [10] [11] In its AI Risk Management Framework, the National Institute for Standards and Technology lists seven key components of trustworthy AI. Conversely, the absence of these trustworthiness components can signal that an AI system may present hazards or risks that need to be managed.

Exploring Approaches to Keep an AI-Enabled Workplace Safe for Workers | Blogs | CDC/

Safe 3D Printing is for Everyone, Everywhere

July 29, 2024 by Gary Roth, MS, PhD, and Grace Vixama, MPH, CHES



Three-dimensional (3D) printing has become more popular in recent years. These printers can create objects by building them layer by layer from a digital design. 3D printing is an important part of modern innovation because it speeds up the design and testing of new ideas. It can also help produce complex and precise parts.

The National Institute for Occupational Safety and Health (NIOSH) is working to minimize the potential health and safety risks from using 3D printers. In 2023, NIOSH published Approaches to Safe 3D Printing: A Guide for Makerspace Users, Schools, Libraries, and Small Businesses, a 40-page guide on the proper use of 3D printers.

More American workers have access to 3D printers. You can also now find 3D printers in schools and libraries. Makerspace users and small business owners are also common users of 3D printers. Currently, makerspaces, schools, libraries, and small businesses mostly use two kinds of 3D printers: fused filament fabrication and vat polymerization. Fused filament fabrication involves melting a thermoplastic filament and placing this molten plastic in the desired shape using a moving extruder. Vat polymerization involves using UV light from a laser or projector to cure photopolymer resin in exactly the desired shape. In each case, once a layer is deposited, the build platform is moved vertically to allow creation of another layer.

Health and safety risks from using 3D printers

Using a 3D printer can pose several health concerns. These include potential exposure to ultrafine particles (particles smaller

Safe 3D Printing is for Everyone, Everywhere | Blogs | CDC

NIOSH Science Blogs

Transforming Construction: Automation and Robotics for a Safer Future

November 12, 2024 by Scott Breloff, PhD; Scott Earnest, PhD, PE, CSP; Douglas Trout, MD, MHS; Asha Brogan, MS; Marvin Cheng, PhD; Jacob Carr, PhD

Introduction

At its core, automation is the use of technology to perform tasks that were once done by humans. Technology includes software, tools to automate workflows, and machinery. Some of the early examples of automation in construction are power tools. As technology progresses, construction automation has seen rapid progress over the last decade with the introduction of robots. These robots can do all sorts of tasks such as utility excavation and roadwork, bricklaying, drywall finishing as well as observation, figure 1.

Robots can handle repetitive and labor-intensive tasks with greater speed and precision than humans. This is advantageous in construction because it can boost productivity, reduce musculoskeletal disorders, and potentially improve the quality of work by reducing human error. However, greater use of robots and automation strategies increase, health and safety concerns.

Figure 1: Various concepts of construction robots. Utility excavation (left), bricklaying (right).

As exciting as these automation devices are, we need to make sure that they are not creating new and unrealized safety and health hazards. In this blog, we will discuss how NIOSH and other research entities are studying the adoption of automation and robotics in construction, as well as using technology to improve job safety.

Safe Operations of Construction Robots on Human-Robot Collaborative Construction Sites

When robots or automated systems are used on construction sites, they must be able to navigate a variety of safety concerns. These concerns will be much more difficult for construction robots compared to industrial robots because construction settings are swiftly evolving, marked by constant changes in site conditions, project phases, and the introduction of new technologies. These active and ever-changing jobsites create unique challenges for automation, compared to more controlled and predictable environments such as manufacturing. This will require construction robots to have more computational power and advanced sensors to allow for deployment on construction sites and human-robot interaction.

Organizations such as American National Standards Institute (ANSI) and its subgroup the A3 (Association for Advancing Automation) along with the International Organization for Standardization (ISO) have developed and published safety standards ANSI/RIA R15.06 and technical specifications ISO/TS 15066 that have provided guidelines for safe robot operations in controlled settings. These guidelines include:

- Safety-rated Monitored Stop: Robots stop when humans are detected.
- Power and Force Limiting: Robots limit the force they exert to minimize injury.
- Speed and Separation Monitoring: Robots adjust speed based on human proximity.
- Hand Guiding: Direct human control of robots.

These standards are appropriate for robots that work in controlled environments, like manufacturing, and are more difficult to implement on construction sites.

Transforming Construction: Automation and Robotics for a Safer Future | Blogs | CDC

New FACE Reports

[FACE Program Link](#) [FACE Reports Link](#)

CALIFORNIA State **FACE** Program
Fatality Assessment & Control Evaluation

Occupational Health Branch • California Department of Public Health
850 Marina Bay Pkwy, P-3, Richmond, CA 94804
510-620-5757 • fax 510-620-5743

REPORT#: 23CA003 **REPORT DATE:** July 25, 2024

Ironworker Working in a Trench Dies When He Is Crushed by an Adjacent Retaining Wall That Fell on Him — California

INCIDENT HIGHLIGHTS

- **DATE:** June 7, 2023
- **TIME:** 8:30 a.m.
- **VICTIM:** 49-year-old male ironworker
- **INDUSTRY/NAICS CODE:** Site preparation contractors /238910
- **EMPLOYER:** Construction company
- **SAFETY & TRAINING:** Employer had an IIPP, but no task-specific training
- **SCENE:** Vacant lot on a building site
- **LOCATION:** California
- **EVENT TYPE:** Struck by/crushed

SUMMARY

On June 7, 2023, a 49-year-old male Hispanic ironworker and three co-workers were working in a five-foot-deep trench preparing to install rebar for the foundation of a new perimeter wall. The new wall was being built adjacent to an existing cinderblock retaining wall on a neighboring property. The workers dug below the level of the base or footing of the adjacent retaining wall. Shoring was not in place and no bracing or underpinning was used to ensure the stability of the existing wall. The trench undermined the neighboring wall, which suddenly collapsed. The wall fell on the ironworker in the trench and crushed him to death...READ THE FULL REPORT> (p.3)

CONTRIBUTING FACTORS

- A hazard assessment was not conducted by a competent person
- Lack of worker training on trench safety
- Inadequate bracing of the adjacent wall...LEARN MORE> (p.6)

RECOMMENDATIONS

The California FACE (CA/FACE) investigator determined that, in order to prevent similar incidents, construction companies should:

- Ensure that a competent person conducts daily hazard assessments of the trenching operation.
- Ensure subcontractors and workers are properly supervised and trained in the hazards of working around unsupported masonry walls.
- Ensure that bracing, shoring or underpinning are used to support adjacent walls that are potentially unstable...LEARN MORE> (p.6)

Exhibit 3. The collapsed portion of the wall. Photo courtesy of KTLA 5 News.

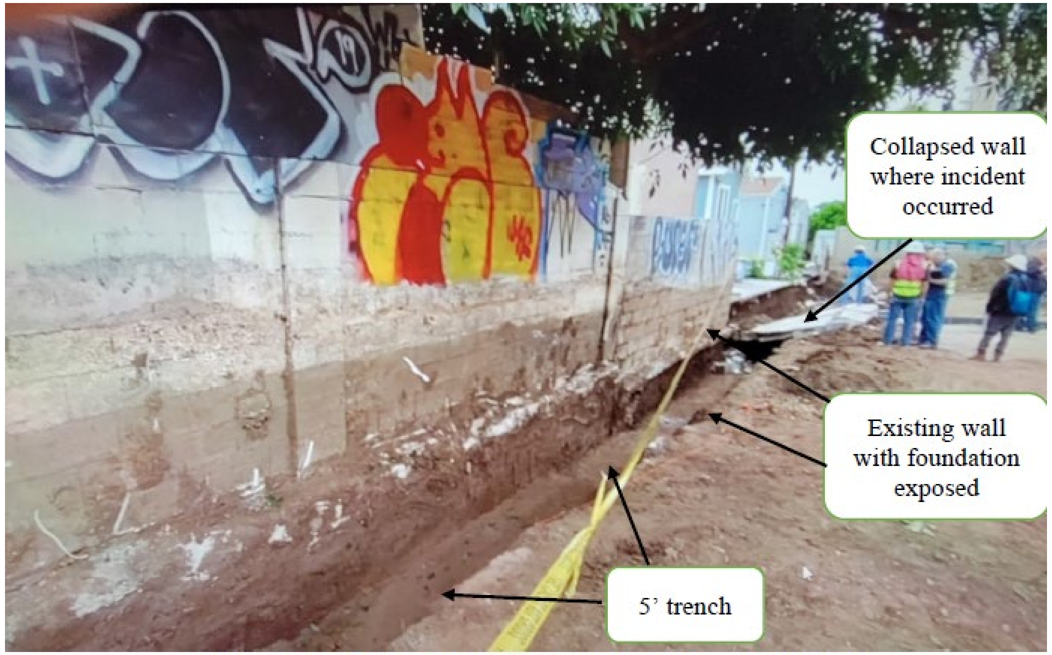


Exhibit 1. The incident scene depicting the trench in relation to the existing retaining wall. Photo courtesy of KTLA 5 News.

[FACE Report No. 23CA003, Ironworker Working in a Trench Dies When He Is Crushed by an Adjacent Retaining Wall That Fell on Him, California](#)

New FACE Reports

WASHINGTON State FACE Program
Fatality Assessment & Control Evaluation

CONSTRUCTION
FATALITY NARRATIVE

FACE

Framer Struck by Beam after Falling from Scissor Lift

INCIDENT FACTS

REPORT #:
71-258-2024

REPORT DATE:
September 25, 2024

INCIDENT DATE:
September 11, 2023

WORKER:
41 years old

INDUSTRY:
New Single-Family Housing Construction

OCCUPATION:
Construction Framer

SCENE:
Apartment complex construction site

EVENT TYPE:
Struck by / Crushed by

Fallen wooden beam and second lift at incident site.

For a slideshow version, click here.

SHARP Safety & Health Assessment & Research for Prevention

Washington State Department of Labor & Industries

SUMMARY

A 41-year-old framer fell from a scissor lift and was then struck by a 418-pound wooden beam. He worked for his employer, a residential framing subcontractor, for two weeks, and was learning on-the-job.

Scissor lift from incident.

The framer was assisting a co-worker at the construction site of a new apartment complex. Their plan was to use two scissor lifts in tandem to raise and insert a glulam wooden beam into the side of a horizontal I-beam over eight feet above the concrete floor. The wooden beam was 22-feet long, 22.5-inches wide, and 3.5-inches thick. They aligned the lifts about 10-feet apart and placed the beam broadside down across the lifts' top guardrails but did not secure it. It was 6.5 feet above the floor. The workers expected to complete the task in two hours, without rushing.

The workers were standing on the floor at opposite ends of the beam. The framer was out of view of his co-worker at the rear of the other lift. He unexpectedly went up the steps or climbed the side of his lift and fell on his back. The beam then fell off the lift on top of him. The co-worker saw the beam fall and ran over to help. He lifted the beam off the injured framer and notified two onsite superintendents who called 911 and began CPR. First responders came shortly after and pronounced the framer dead at the scene from severe head injuries.

Following the incident, investigators found:

- The framer was not trained and authorized to use the lift. His co-worker also had limited knowledge of the hazards of placing and elevating materials on the platform guardrails.
- The employer and workers' supervisor knew of the lift manufacturer's warnings not to put materials on the guardrails. They were unaware of any safer material lifting equipment options.
- Lift operators and helpers at the site spoke Spanish and could not read the employer's job hazard assessment (JHA) for the installation task, which was written in English only. The company's accident prevention program (APP), including a scissor lift operator's checklist, was also in English only.

REQUIREMENTS

Employers must:

- Make sure elevating work platforms are used only for their intended purpose as specified by the manufacturer. See WAC 296-869-60005
- Make sure personnel are trained before they are permitted to operate an aerial lift. See WAC 296-869-20025

RECOMMENDATIONS

FACE investigators concluded, that to help prevent similar occurrences employers, should:

- Use forklifts, cranes, or contractor material lifts to elevate construction materials, not scissor lifts.
- Develop and have supervisors enforce APP policies, JHAs, and standard operating procedures (SOPs), for safe use of elevating work platforms, such as scissor lifts.
- Have APP policies, JHAs, and training resources translated to the worker's preferred language.
- Train operators using the manufacturers' manual and highlight warnings not to put materials on guardrails or have them exceed the confines of the guardrails unless approved by the manufacturer.
- Discuss safe use of elevating work platforms at pre-job crew meetings and monthly safety meetings.

RESOURCES

Free Safety and Health Consultation Program – Washington State Dept. of Labor & Industries

This narrative was developed to alert employers and workers of a tragic incident and is based on preliminary data ONLY and does not represent final determinations regarding the nature of the incident or the cause of the injury. Developed by WA State Fatality Assessment and Control Evaluation (WA FACE) and the Division of Occupational Safety and Health (DOSH), WA State Dept. of Labor & Industries. WA FACE is supported in part by a grant from the National Institute for Occupational Safety and Health (NIOSH grant# 5U60OH008487). For more information visit www.lni.wa.gov/safety-health/safety-research/ongoing-projects/work-related-fatalities-face.

Framer Struck by Beam after Falling from Scissor Lift

Photo 2. Rear view of lift with steps shown in red outline.

New FACE Reports

WASHINGTON State FACE Program — Fatality Assessment & Control Evaluation

CONSTRUCTION INJURY NARRATIVE

FACE

INCIDENT FACTS

REPORT #: 71-256-2024

REPORT DATE: July 18, 2024

INCIDENT DATE: June 30, 2023

WORKER: 16 years old

INDUSTRY: Highway, Street, and Bridge Construction

OCCUPATION: Construction Laborer

SCENE: Residential construction site

EVENT TYPE: Caught in / amputation

Mini skid steer with trencher attachment.

For a slideshow version, click here.

SHARP Safety & Health Assessment & Research for Prevention

Washington State Department of Labor & Industries

Teen Worker Loses Legs to Trencher

SUMMARY

A 16-year-old construction worker had both legs amputated when they were caught in a trencher. He was a high school student in a work-based learning program that allowed him to earn credit and gain job experience. He worked for his employer, a large general contractor, around nine months.

Trencher attachment. Arrow shows chain and digging teeth.

The teen was using a walk-behind mini skid steer with a hydraulic rotary trencher attachment. The day before the incident, the teen received a brief demonstration of the trencher by a supervisor. He then used the trencher for 2 to 3 hours. The next day, a foreman assigned him to use the trencher unsupervised to dig a channel for fence posts. After a half hour, he stopped to check the trench depth. He walked in front of the trencher without shutting it off. As he stood on the 8-inch trench, the sidewall collapsed and his legs were pulled into and severed by the trencher's roller chain.

While lying on the ground badly injured, the teen first tried to phone his mother and then his supervisor, who was off-site, but could not reach them. The teen sent photos of his injured legs to his supervisor, who saw the photos and called the workers at the jobsite. The workers rushed to aid the teen, called 911, and applied tourniquets to each leg. First responders arrived and had a critical care helicopter airlift the teen to the hospital where his life was saved.

Following the incident, investigators found:

- The employer had a student learner exemption permitting minors to do some work that was otherwise prohibited for workers under 18. The skid steer and trencher attachment were not part of the exemption.
- The teen had no proper training or experience that qualified him to operate the trencher and was using it alone and out of sight from co-workers and with no supervisors onsite.
- Requirements and restrictions for minors were not communicated from management to supervisors.

REQUIREMENTS

Employers must:

- Unless granted a variance by the director of the Dept. of Labor & Industries, not allow minors participating in a bona fide work-based learning program certified and monitored by the office of the superintendent of public instruction or the minor employee's school district to perform the prohibited and hazardous employments outlined in WAC 296-125-0303, except those exempted in subsections (5), (8), (9), (11), (13), (15), (16), and (23).
- Permit only those employees qualified by training or experience to operate equipment and machinery. See WAC 296-155-035(2).

RECOMMENDATIONS

FACE investigators concluded, that to help prevent similar occurrences, employers should:

- Develop an accident prevention program (APP) policy that covers relevant employment restrictions for minors in WAC 296-125-0303 and exemptions listed in the employer's approved variance application for minors in work-based learning programs. Communicate the policy at new worker orientation trainings, monthly safety meetings, and daily supervisor-led crew meetings before work begins.
- Ensure supervisors prohibit minors in work-based learning programs from hazardous work without direct supervision and/or alone, from restricted job tasks, and from restricted tools, equipment, or machines.
- Provide minors in work-based learning programs ample training, including refresher training, for each type of tool, equipment, and machine. Evaluate their knowledge and skills before allowing them to work.

RESOURCES

Teen and Young Worker Safety & Health – Washington State Dept. of Labor & Industries

This narrative was developed to alert employers and workers of a tragic incident and is based on preliminary data ONLY and does not represent final determinations regarding the nature of the incident or the cause of the injury. Developed by WA State Fatality Assessment and Control Evaluation (WA FACE) and the Division of Occupational Safety and Health (DOSH), WA State Dept. of Labor & Industries. WA FACE is supported in part by a grant from the National Institute for Occupational Safety and Health (NIOSH grant# 5U60OH008487). For more information visit www.lni.wa.gov/safety-health/safety-research/ongoing-projects/work-related-fatalities-face.

WASHINGTON State FACE Program — Fatality Assessment & Control Evaluation

CONSTRUCTION FATALITY NARRATIVE

FACE

INCIDENT FACTS

REPORT #: 71-255-2024

REPORT DATE: June 10, 2024

INCIDENT DATE: September 20, 2022

WORKER: 34 years old

INDUSTRY: Siding Contractors

OCCUPATION: Gutter/Siding Installer

SCENE: Installing gutters on residence

EVENT TYPE: Fall from patio roof

Personal fall protection harness, lifeline, and lanyard available in the work truck.

For a slideshow version, click here.

SHARP Safety & Health Assessment & Research for Prevention

Washington State Department of Labor & Industries

Gutter Installer Falls from Patio Roof

SUMMARY

A 34-year-old installer and a coworker were installing gutters on a two-story residential home. They started the job at about 6 a.m. The installer's first task was to prepare the upper roof edge in order to hang the gutters. He went to the back of the house and used a ladder to get onto the roof of the patio. His coworker was in the front of the house forming the gutters they were going to hang.

Patio roof (in the lower left of photo) where the installer was standing and prying on the upper roof when he fell.

While standing on the patio roof, the installer started prying between the upper roof shingles and the fascia in order to make a space to attach the gutter flashing. As he continued prying toward the corner of the upper roof, he reached the edge of the patio roof on which he was standing. He either did not see the patio roof edge and stepped off or was extending his reach and lost his balance. He fell 13 feet to the concrete patio.

The employer, who had just arrived, and homeowner found him at approximately 7 a.m. on the patio with his pry bar nearby. He was wearing a tool belt but not the personal fall protection equipment that was available in the work truck. Emergency responders declared him dead at the scene.

Following the incident, investigators found the employer did not:

- Have a written accident prevention program (APP) or a fall protection work plan.
- Provide fall protection training or ensure workers used fall protection equipment.
- Document safety meetings.

REQUIREMENTS

Employers must:

- Develop a formal, written APP. See WAC 296-800-14005
- Develop and implement a written fall protection work plan, including each area of the work place where the employees are assigned and where fall hazards of ten feet or more exist. See WAC 296-880-10020(1)
- Ensure that each employee on a walking/working surface with an unprotected side or edge four feet or more above the ground or lower level is protected by a fall protection system. See WAC 296-880-20005(1)
- Provide training for each employee exposed to fall hazards. See WAC 296-880-10015
- Document attendance and subjects discussed at crew-leader safety meetings. See WAC 296-155-110(6)

RECOMMENDATIONS

FACE investigators concluded that to help prevent similar occurrences, employers should:

- Arrive on-site before work begins or appoint a supervisor to ensure that workers use fall protection and follow fall prevention safe work practices.
- During the pre-job safety meeting, go over the fall protection work plan and discuss workers' responsibilities and the details of how they will implement the plan.
- Make fall prevention a company priority and emphasize to workers to always use fall protection when required.

RESOURCES

Personal Fall Arrest Systems Part 1, Part 2. Washington State Dept. of Labor & Industries

This narrative was developed to alert employers and workers of a tragic incident and is based on preliminary data ONLY and does not represent final determinations regarding the nature of the incident or the cause of the injury. Developed by WA State Fatality Assessment and Control Evaluation (WA FACE) and the Division of Occupational Safety and Health (DOSH), WA State Dept. of Labor & Industries. WA FACE is supported in part by a grant from the National Institute for Occupational Safety and Health (NIOSH grant# 5U60OH008487). For more information visit www.lni.wa.gov/safety-health/safety-research/ongoing-projects/work-related-fatalities-face.

WASHINGTON State FACE Program — Fatality Assessment & Control Evaluation

LANDSCAPING SERVICES FATALITY NARRATIVE

FACE

INCIDENT FACTS

REPORT #: 71-257-2024

REPORT DATE: August 19, 2024

INCIDENT DATE: January 6, 2023

VICTIM: 59 years old

INDUSTRY: Landscaping services

OCCUPATION: Tree Trimmer / Bucket Operator

SCENE: Private residence

EVENT TYPE: Fall from elevation

Fall hazard warning label on base of boom lift.

For a slideshow version, click here.

SHARP Safety & Health Assessment & Research for Prevention

Washington State Department of Labor & Industries

Tree Trimmer Falls 25 Feet from Bucket

SUMMARY

A 59-year-old experienced tree trimmer died after falling from an aerial bucket that got caught on a branch. He worked for his employer, a tree care service company, for 24 years as a trimmer and bucket operator.

Bucket in branches.

He was on a three-member crew pruning birch trees at a private home. They were using a bucket truck to remove damaged branches. He went up in the bucket alone while his co-workers worked on the ground. He was wearing all required personal protective equipment (PPE), including a fall arrest harness. After cutting a few branches, he had to move the truck to change the bucket angle near the tree. He lowered the bucket and unclipped his harness to get out. A co-worker helped him move the truck and set the outriggers. No one saw him re-enter the bucket before he went up again.

As the bucket went up, the ground crew saw the truck tilting toward the passenger side with its wheels off the ground. The bucket appeared to be caught and pressing on a branch with enough force to tilt the truck. When the bucket broke free of the branch, the truck's wheels slammed down and shook the bucket so violently it ejected the trimmer 25 feet to the ground. The ground crew ran to him, called 911, and began CPR as directed by emergency dispatchers. First responders soon arrived but pronounced him dead at the scene from severe fall injuries.

Following the incident, investigators found:

- The worker's fall arrest harness lanyard was not tied-off in the bucket.
- The employer had a fall protection work plan and the crew had a pre-job safety briefing.
- The bucket truck manufacturer inspected and found the vehicle to be in safe operating order.

REQUIREMENTS

Employers must:

- Before elevating the platform (aerial bucket), ensure all persons on the platform wear a full body harness with a lanyard attached to either: (a) The manufacturer's recommended attachment point; or (b) The boom or platform if the manufacturer does not specify an attachment point. The employee must never attach a lanyard to an adjacent pole, structure, or equipment. See WAC 296-880-30015(2)

RECOMMENDATIONS

FACE investigators concluded, that to help prevent similar occurrences, employers should:

- Develop and enforce policies and standard operating procedures (SOP) in their accident prevention program (APP) requiring:
  - A co-worker be present to observe when the bucket operator enters the bucket.
  - The bucket operator to give the co-worker visual confirmation they are wearing a personal fall arrest harness with the lanyard tied-off in the bucket before going up.
  - The co-worker to yell "all stop" or use a small air horn and press the boom's emergency stop switch when an unexpected hazardous situation needs to end quickly to prevent injury.
- Update policies to reflect changes in site conditions and fall protection equipment. Review policies with workers at crew meetings, monthly safety meetings, and annual fall prevention stand-downs.
- Provide recurring hands-on fall protection training and ensure workers maintain skill proficiency.

RESOURCES

5-Minute Safety Talk: Bucket Truck Safety -- National Safety Council

This narrative was developed to alert employers and workers of a tragic incident and is based on preliminary data ONLY and does not represent final determinations regarding the nature of the incident or the cause of the injury. Developed by WA State Fatality Assessment and Control Evaluation (WA FACE) Program and the Division of Occupational Safety and Health (DOSH), WA State Dept. of Labor & Industries. WA FACE is supported in part by a grant from the National Institute for Occupational Safety and Health (NIOSH grant# 5U60OH008487). For more information visit www.lni.wa.gov/safety-health/safety-research/ongoing-projects/work-related-fatalities-face.

Teen Worker Loses Legs to Trencher

Gutter Installer Falls from Patio Roof

Tree Trimmer Falls 25 Feet from Bucket

Articles of Interest

DOI: 10.1002/ajim.23624

COMMENTARY

AMERICAN JOURNAL OF INDUSTRIAL MEDICINE | WILEY

Work-related suicide: Evolving understandings of etiology & intervention

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Abstract
Previously published analyses of suicide case investigations suggest that work or working conditions contribute to 10%–13% of suicide deaths. Yet, the way in which work may increase suicide risk is an underdeveloped area of epidemiologic research. In this

Institution at which the work was performed.
Deakin University.

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DOI: 10.1002/ajim.23632

RESEARCH ARTICLE

AMERICAN JOURNAL OF INDUSTRIAL MEDICINE | WILEY

Suicides among construction workers in the United States, 2021

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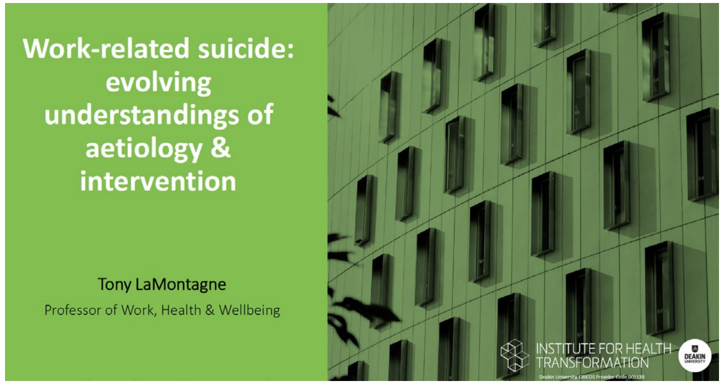
Funding information
National Institute for Occupational Safety and Health, Grant/Award Number: U60OH009762

Abstract
Background: Construction workers have the second highest suicide death rate; despite this, there is limited literature examining suicides in the industry, which is necessary to identify those at higher risk of death by suicide. The objective of this study was to examine the characteristics of those who died by suicide in construction to address this knowledge gap.
Methods: Data from the National Center for Health Statistics National Vital Statistics System 2021 public use Mortality Multiple Cause-of-Death file were used to identify deaths by suicide, while denominator data for rates come from the 2021 Current Population Survey.
Results: In 2021, construction workers were disproportionately affected by suicide deaths. Almost a fifth (17.9%) of deaths by suicide with a reported industry code were in construction, despite construction workers accounting for only 7.4% of the workforce. Male construction workers accounted for a majority (97.8%) of suicide deaths. The highest percent of deaths by suicide were among individuals who were white, non-Hispanic, completed high school or equivalent, and single, across construction and all industries for males and females.
Discussion and Conclusions: Male and female construction workers had the highest rates of suicide across all characteristics when compared to all industries. Our findings support the need for ongoing prevention efforts within the industry. Future research is needed to understand suicide risk among certain characteristics and occupations. In addition, the work environment or other work-related factors should be studied to understand how the unique nature of the construction industry may be associated with higher suicide rates.

KEYWORDS
construction industry, injury prevention, mental health, occupational health, suicide, workplace suicides

Institution at which the work was performed: CPWR—The Center for Construction Research and Training.



https://onlinelibrary.wiley.com/doi/10.1002/ajim.23624

https://onlinelibrary.wiley.com/doi/full/10.1002/ajim.23632

Articles of Interest

How Heavy Equipment Cab Redesigns Improve Safety, Uptime

The addition of comfort and safety features to work carried out in the elements not only provides a positive environment for operators, but also increases contractor productivity and profitability.

Carol Brzozowski
Oct 18, 2024

CASE Construction Equipment recently announced new models and upgrades to empower construction and utility crews facing labor shortages and constrained jobsites in an effort to allow teams to accomplish more with less amidst growing demands from booming infrastructure investments. Source: CASE Construction Equipment

A continued labor shortage in the construction industry means it is a priority for companies

LATEST IN EARTHMOVING EQUIPMENT

Wheel Loader Advancements in Weighing, Tire Monitoring
OCTOBER 16, 2024

New Holland Rolls Out E90D Midi Excavator
OCTOBER 16, 2024

John Deere Launches Extended-Reach 326 P-Tier Telescopic Wheel Loader
AUGUST 1, 2024

The article notes a recent study published in the American Journal of Industrial Medicine found that 79% of the 100,000 workers exposed to RCS above the recommended exposure limit (REL) worked in the construction industry.

Enclosed cabs that are not well designed or functioning properly can expose the operator to harmful concentrations of respirable crystalline silica (RCS) dust. The National Institute for Occupational Safety and Health research found that filter efficiency and the use of a recirculation filter were the most important performance factors for enclosed cabs. An effective filtration system should remove at least 95% of respirable aerosols such as dust, diesel particulate, and droplets.

Source: Hitachi Construction Machinery Americas

Sound insulation can significantly reduce the noise levels that are inherently part of construction activity and provide a quieter working environment for the operator to concentrate on the task at hand.

[How Construction Heavy Equipment Cab Redesigns Improve Safety | For Construction Pros]

Articles of Interest

41st International Symposium on Automation and Robotics in Construction (ISARC 2024)

Safe Operations of Construction Robots on Human-Robot Collaborative Construction Sites

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Abstract –
Construction robots have become essential tools on a variety of jobsites. These devices can be revolutionary tools for improving construction efficiency and reducing musculoskeletal disorders and traumatic injuries. However, this innovative technology comes with corresponding dangers and hazards if a robot is not operated properly. Construction workers can be injured by unexpected contact. Therefore, construction robots need to be operated under specific safety procedures to prevent workers from being injured. In this study, a mechanical approach was proposed to derive the dynamic models of unexpected contact during human-robot interaction. With the dynamic models, contact forces and deformations of body parts of human workers can be estimated. The estimated results can be used as reference values to help safety engineers or others to adjust the operations in different scenarios on the construction jobsite for improved safety.

Keywords –
Collaborative Robots; Safety; Mechanical Model

1 Introduction

With the rapid advances in robotics, the construction industry is beginning to be revolutionized with the help of robots designed for this labor-intensive sector [1]. Robotic devices with various functions have been deployed or studied in different applications in the construction sector. With the deployment of various robotic devices, collaborative workspaces that require human-robot interaction have become more common in the past decade. On construction sites, robots are already used to assist construction workers with labor-intensive tasks, such as bricklaying, carrying heavy materials, and demolition tasks [2-3]. Type C mobile robots have been used in construction logistics to prevent long-term musculoskeletal disorders in construction workers [4].

Various research groups have also investigated how robotic on-site additive manufacturing can speed up the construction process [5,6]. Wearable robotic devices have also been widely used to prevent occupational traumatic injuries and musculoskeletal disorders [7]. However, robotic applications deployed on construction sites remain limited due to the lack of computational power, sensory assessment, and effective human-machine interface capabilities, which are important for construction work that requires multiple steps, various tool sets, and the need to follow specific work protocols.

Modern industrial robotic devices can detect the conditions of the jobsite and communicate among each other, sharing site information in real-time. With the capabilities to efficiently sense and communicate between robots, engineers can program robots for upcoming construction jobs to actively assist workers with repetitive tasks while providing required assistance during heavy-duty manual operations. For example, masonry robots have been used to reduce potential injuries due to the need for construction workers to move heavy objects. The collaborative partnership allows construction workers to focus on the quality of the construction tasks as well. However, an open jobsite such as a construction site is often not an ideal environment for robots to have all necessary sensors to detect worker's movements and environmental changes. Environmental disturbance, noises, and an insufficient number of sensors can greatly affect the ability of the robot to detect surrounding hazards and movements of existing objects in the construction space [8]. Thus, although robotic devices can greatly assist construction workers in performing repetitive and labor-intensive tasks and prevent potential injuries, unexpected contact between robots and construction site workers can still be dangerous and even fatal [9,10].

In a human-robot collaborative environment, robots can perform repetitive and labor-intensive work while construction workers focus on planning and inspecting the results to ensure quality. However, human-robot collaboration on construction sites can be dangerous for

[Safe Operations of Construction Robots on Human-Robot Collaborative Construction Sites](https://onlinelibrary.wiley.com/doi/full/10.1002/ajim.23573)

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DOI: 10.1002/ajim.23573

BRIEF REPORT

AMERICAN JOURNAL OF INDUSTRIAL MEDICINE WILEY

Acute occupational inhalation injuries—United States, 2011–2022

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Abstract

Background: Inhalation injuries due to acute occupational exposures to chemicals are preventable. National surveillance of acute inhalation exposures is limited. This study identified the most common acute inhalation exposure-related incidents by industry sector among US workers.

Methods: To characterize inhalation-related injuries and their exposures during April 2011–March 2022, state and federal records from the Occupational Safety and Health Administration (OSHA) Occupational Safety and Health Information System (OIS) accident database were analyzed. Industry-specific injury, hospitalization, and fatality rates were calculated.

Results: The most frequent acute inhalation incidents investigated by OSHA were caused by inorganic gases (52.9%) such as carbon monoxide (CO) or acids, bases, and oxidizing chemical agents (12.9%) such as anhydrous ammonia. The largest number of fatal and nonfatal injuries were reported in the manufacturing (28.6%) and construction (17.2%) sectors.

Conclusions: Workers were affected by acute inhalation exposures in most industries. Using this surveillance, employers can recognize frequently-occurring preventable acute inhalation exposures by industry, such as inorganic gases in the manufacturing sector, and implement prevention measures. Training of workers on exposure characteristics and limits, adverse health effects, and use of protective equipment by exposure agent can prevent inhalation injuries.

KEYWORDS
acute inhalation exposures, ammonia, carbon monoxide, cleaning materials, fatality rate, hospitalization rate, industry sectors, injury rate, occupational exposures

1 | INTRODUCTION

Occupational inhalation injuries due to acute chemical exposures are preventable. Surveillance to characterize the burden of injuries caused by inhalation exposures has typically been conducted at the state level[1–3] or using emergency department data.[4,5] Publicly accessible data such as the Occupational Safety and Health Administration (OSHA) Severe Injury Reporting available from 2015[6] and Fatality Inspection Data available from 2009[7] provide limited investigation details. Census of Fatal Occupational Injuries[8] and Survey of Occupational Injuries and Illnesses[9] from the United States Bureau of Labor Statistics (US BLS) and the National Poison Data System[10] publish aggregated data. As such, detailed evaluations of recent industry-specific inhalation exposures and their injuries are lacking.

https://onlinelibrary.wiley.com/doi/full/10.1002/ajim.23573

National Vital Statistics Reports
NVSS
Volume 72, Number 7 August 22, 2023

Drug Overdose Mortality by Usual Occupation and Industry: 46 U.S. States and New York City, 2020

Rachael M. Billock, Ph.D., Andrea L. Steege, Ph.D., and Arialdi Miniño, M.P.H., Division of Vital Statistics

Abstract

Objective—This report describes deaths from drug overdoses in 2020 in U.S. residents in 46 states and New York City by usual occupation and industry.

Methods—Frequencies, death rates, and proportionate mortality ratios (PMRs) are presented using the 2020 National Vital Statistics System mortality data file. Data were restricted to decedents aged 16–64 for rates and 15–64 for PMRs with usual occupations and industries in the paid civilian workforce. Age-standardized drug overdose death rates were estimated for usual occupation and industry groups overall, and age-adjusted drug overdose PMRs were estimated for each usual occupation and industry group overall and by sex, race and Hispanic-origin group, type of drug, and drug overdose intent. Age-adjusted drug overdose PMRs were also estimated for individual occupations and industries.

Results—Drug overdose mortality varied by usual occupation and industry. Workers in the construction and extraction occupation group (162.6 deaths per 100,000 workers, 95% confidence interval: 155.8–169.4) and construction industry group (130.9, 126.0–135.8) had the highest drug overdose death rates. The highest group-level drug overdose PMRs were observed in decedents in the construction and extraction occupation group and the construction industry group (145.4, 143.6–147.1 and 144.9, 143.2–146.5, respectively). Differences in drug overdose PMRs by usual occupation and industry group were observed within each sex, within each race and Hispanic-origin group, by drug type, and by drug overdose intent. Among individual occupations and industries, the highest drug overdose PMRs were observed in decedents who worked as fishers and related fishing occupations and in fishing, hunting, and trapping industries (193.1, 166.8–222.4 and 186.5, 161.7–214.1, respectively).

Conclusions—Variation in drug overdose death rates and PMRs by usual occupation and industry in 2020 demonstrates the disproportionate burden of the ongoing drug overdose crisis on certain sectors of the U.S. workforce.

Keywords: worker health • proportionate mortality ratios • census codes • National Vital Statistics System

Introduction

Deaths from drug overdoses are a major public health concern in the United States (1,2), particularly in the working-age population (1). The drug overdose death rate increased in most years from 1999 through 2020 (3). This trend intensified during the COVID-19 pandemic; the U.S. drug overdose death rate in 2021 was 50% higher than in 2019 (1). Increases in drug overdose deaths in 2020 and 2021 contributed to the overall rise in deaths involving drug overdose, suicide, or alcohol abuse during the pandemic (4).

Drug overdose mortality risks vary by occupation, industry, and work-related characteristics, including workplace injury, work-related psychosocial stress, precarious employment, employer-provided health insurance status, and access to paid sick leave (5–8). Workers in each occupation and industry also experienced unique stressors during the COVID-19 pandemic that impacted prevalence and management of substance use disorders (9–12). This report describes U.S. drug overdose mortality by usual occupation and industry for 2020 to expand on and update historical estimates (5). Drug overdose death rates and proportionate mortality ratios (PMRs) are estimated for each occupation and industry group overall. Drug overdose PMRs are also estimated for each individual occupation and industry and for each occupation and industry group within each sex, within each race and Hispanic-origin group, by drug type, and by drug overdose intent.

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Centers for Disease Control and Prevention
National Center for Health Statistics
National Vital Statistics System

NCHS reports can be downloaded from: https://www.cdc.gov/nchs/products/index.htm.

https://stacks.cdc.gov/view/cdc/128631

Articles of Interest

Applied Ergonomics 121 (2024) 104371

Contents lists available at ScienceDirect

Applied Ergonomics

journal homepage: www.elsevier.com/locate/apergo

Effects of extension ladder fly configuration on climbing safety

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ARTICLE INFO

Keywords:
Ladder climbing
Required coefficient of friction
Foot placement
Slips
Falls

ABSTRACT

Fall injuries often occur on extension ladders. The extendable fly section of an extension ladder is typically closer to the user than the base section, though this design is minimally justified. This study investigates the effects of reversing the fly on foot placement, frictional requirements, adverse stepping events (repositioning the foot or kicking the rung), and user preferences. Participant foot placement was farther posterior (rung contacted nearer to toes) in the traditional ladder compared to the reversed fly condition during descent, with farther anterior foot placements during ascent. The reversed configuration had similar friction requirements during early/mid stance and significantly lower frictional requirements during late stance. Increased friction requirements during late stance were associated with farther anterior foot placement and further plantar flexed foot orientation. The reversed fly had 5 adverse stepping events versus 22 that occurred in the traditional configuration. Users typically preferred the reversed fly. These results suggest that a reversed extension ladder configuration offers potential benefits in reducing fall-related injuries that should motivate future research and development work.

1. Introduction

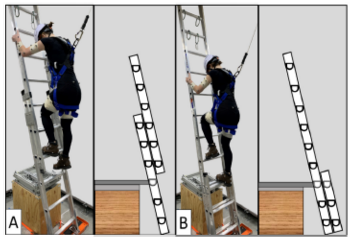

Fig. 1. Extension ladder descent in A) a traditional extension ladder fly configuration and B) a reversed extension ladder fly configuration. The third rung of each ladder was attached to a force plate that measured the shoe-rung forces.

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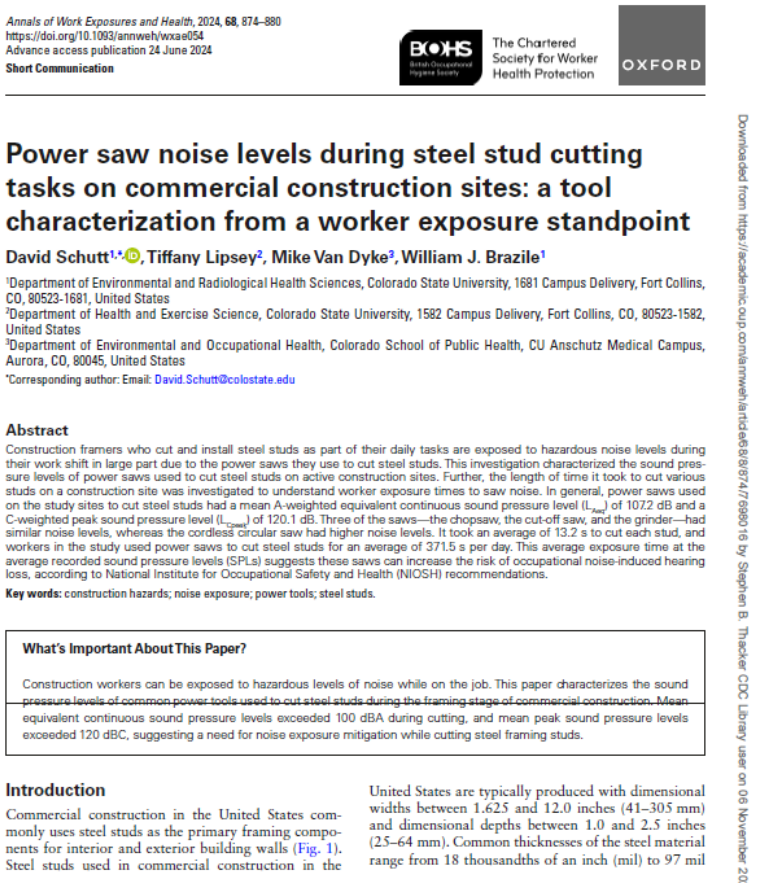

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https://doi.org/10.1093/annweh/wxae054
Advance access publication 24 June 2024
Short Communication

The Chartered Society for Worker Health Protection
OXFORD

Power saw noise levels during steel stud cutting tasks on commercial construction sites: a tool characterization from a worker exposure standpoint

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Abstract

Construction framers who cut and install steel studs as part of their daily tasks are exposed to hazardous noise levels during their work shift in large part due to the power saws they use to cut steel studs. This investigation characterized the sound pressure levels of power saws used to cut steel studs on active construction sites. Further, the length of time it took to cut various studs on a construction site was investigated to understand worker exposure times to saw noise. In general, power saws used on the study sites to cut steel studs had a mean A-weighted equivalent continuous sound pressure level (L_{Aeq}) of 107.2 dB and a C-weighted peak sound pressure level (L_{Cpeak}) of 120.1 dB. Three of the saws—the chopsaw, the cut-off saw, and the grinder—had similar noise levels, whereas the cordless circular saw had higher noise levels. It took an average of 13.2 s to cut each stud, and workers in the study used power saws to cut steel studs for an average of 371.5 s per day. This average exposure time at the average recorded sound pressure levels (SPLs) suggests these saws can increase the risk of occupational noise-induced hearing loss, according to National Institute for Occupational Safety and Health (NIOSH) recommendations.

Key words: construction hazards; noise exposure; power tools; steel studs.

What's Important About This Paper?

Construction workers can be exposed to hazardous levels of noise while on the job. This paper characterizes the sound pressure levels of common power tools used to cut steel studs during the framing stage of commercial construction. Mean equivalent continuous sound pressure levels exceeded 100 dBA during cutting, and mean peak sound pressure levels exceeded 120 dBC, suggesting a need for noise exposure mitigation while cutting steel framing studs.

Introduction

Commercial construction in the United States commonly uses steel studs as the primary framing components for interior and exterior building walls (Fig. 1). Steel studs used in commercial construction in the United States are typically produced with dimensional widths between 1.625 and 12.0 inches (41–305 mm) and dimensional depths between 1.0 and 2.5 inches (25–64 mm). Common thicknesses of the steel material range from 18 thousandths of an inch (mil) to 97 mil

https://academic.oup.com/annweh/article/68/8/874/7698016

Articles of Interest

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Shoulder kinematics during cyclic overhead work are affected by a passive arm support exoskeleton

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ARTICLE INFO

Keywords:
Passive exoskeleton
Joint angles
Arm acceleration

ABSTRACT

Purpose: We investigated the influence of passive arm-support exoskeleton (ASE) with different levels of torque (50, 75, and 100%) on upper arm osteokinematics.
Methods: Twenty participants completed a cyclic overhead drilling task with and without ASE. Task duration, joint angles, and angular acceleration peaks were analyzed during ascent and descent phases of the dominant upper arm.
Results: Maximum ASE torque was associated with decreased peak acceleration during ascent (32.2%; SD 17.8; $p < 0.001$) and descent phases (38.8%; SD 17.8; $p < 0.001$). Task duration remained consistent. Increased torque led to a more flexed (7.2°; SD 5.5; $p > 0.001$) and internally rotated arm posture (17.6°; SD 12.1; $p < 0.001$), with minimal changes in arm abduction.
Conclusion: The small arm accelerations and changes in osteokinematics we observed, support the use of this ASE, even while performing overhead cyclic tasks with the highest level of support.

1. Introduction

The high frequency and severity of work-related musculoskeletal disorders (WMSDs) in the construction industry is a critical issue worldwide. According to the United States Bureau of Labor and Statistics, U.S. private construction industries reported 74,520 injuries and illness cases in 2020, of which approximately 30% involved the upper extremity (UE) (BLS, 2023a). Moreover, data from the 2015 European Working Conditions Survey showed that 54% of construction workers reported pain in the UE (EWCS, 2016).

Construction workers are exposed to high-force demands and extreme postures, which can lead to physical fatigue, pain, injury, and loss of productivity (Meo et al., 2013; Seo et al., 2016). Construction tasks such as electrical work, drywall installation, sanding, drilling, and painting require sustained overhead reach, which is recognized as a major risk factor for the onset of UE-WMSDs (Svendsen et al., 2004; Rempel et al., 2010; Chopp et al., 2010; Alabdulkarim and Nussbaum, 2019; Latella et al., 2022). Moreover, the daily use of power tools that require high-force exertions increases the risk of shoulder tendon injuries (Frost et al., 2002), especially during overhead reach.

Shoulder impingement is the most common cause of shoulder pain and injury (Stenlund et al., 2002) and is related to the osteokinematics and arthrokinematics of the shoulder complex. Osteokinematics describes the gross movement of bones while arthrokinematics describes the motion between joint surfaces. For example, during arm abduction and flexion (osteokinematics), the rotator cuff muscles facilitate the slide, roll, and spin (arthrokinematics) of the humeral head to maintain contact with the glenoid fossa and minimize compression of the supraspinatus tendon under the coracoacromial arch, as detailed in Appendix. Insufficient or abnormal humeral translations (sliding) due to fatigue, muscle imbalances, and postural deviations have been linked to shoulder injury (Dal Maso et al., 2015), likely due to compression of the structures under the coracoacromial arch as arm elevation increases (Muraki et al., 2010; Hughes et al., 2012).

To prevent the development of shoulder WMSDs, passive arm-support exoskeletons (ASEs) have been used to support workers in forward reach or overhead postures (McFarland and Fischer 2019), as they provide a torque that elevates the arms and effectively relieves shoulder burden by transferring the bearing load to another part of the body

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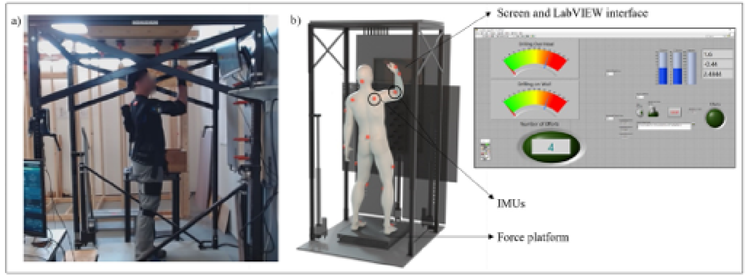

Fig. 1. a) Participant wearing the exoskeleton during the DO task b) Schematic view with an indication of the instrumentation used to provide visual and auditory feedback on the magnitude and duration of each simulated drilling activity.

2.3. Drilling task

Participants started the DO drilling task while standing on the force platform with their arms resting alongside their body. Participants used their non-dominant hands to touch a screw located in the pocket of a tool belt to simulate screw retrieval. Then, they were instructed to move their hands toward the midline of the body to connect the tip of the tool held in the dominant hand with the fingertips of the non-dominant hand. From this position, participants used both hands to elevate the tip of the drill into the hole of one of the four tubes. Upon reaching the target, the non-dominant hand was free to return to the start position. While using the tool, participants exerted a force of approximately 50 N (visually controlled in real-time on a screen) against the target and sustained each effort for 2 s. This magnitude and duration were selected to ensure that all participants could complete the task without experiencing substantial fatigue. Audible and visual feedback was provided to indicate when participants should stop exerting force and resume the initial position. The drilling task was performed cyclically, with 20 replications. A 10-min break was provided between randomized conditions (no ASE, 50, 75, 100% torque). Participants were instructed to perform the task as realistically as possible, by freely moving their lower limbs and feet and self-selecting the rate of movements and duration between each of the cycle.

2.5. Dependent variables

Outcome measures included two kinematic variables, i.e., joint angles and angular accelerations in up to three planes of motion. Also, the duration of the task was measured to evaluate any torque influence on execution time. Specific measures are provided in detail below.

1. Joint angles of the dominant upper arm, following the manufactured recommended ZXY Euler sequence (X: anterior-posterior axis; Y: medial-lateral axis; Z: vertical axis), were used to analyze upper arm posture with respect to the trunk in the sagittal plane (flexion (+)/extension (−), FE), in the coronal plane (abduction (+)/adduction (−), AA), and in the axial plane (internal (+)/external (−) axial rotation, IR/ER) in each direction separately.
2. The total angular acceleration (eq. (1)) of the dominant upper arm relative to the trunk was calculated using all three acceleration components (a_x, around AA axis, a_y, around FE axis, a_z, around IR/ER rotation axis).

$$A_{tot} = \sqrt{a_x^2 + a_y^2 + a_z^2} \quad (1)$$

Both the peak total angular acceleration (A_{tot}) and the absolute peak of the angular acceleration in each plane (a_x, a_y, a_z) were used for the analysis because of potentially greater concern with prolonged exposure.

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Understanding contributing factors to exoskeleton use-intention in construction: a decision tree approach using results from an online survey

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ABSTRACT

Work-related musculoskeletal disorders (WMSDs) are a major health concern in the construction industry. Occupational exoskeletons (EXOs) are a promising ergonomic intervention to help reduce WMSD risk. Their adoption, however, has been low in construction. To understand the contributing factors to EXO use-intention and assist in future decision-making, we built decision trees to predict responses to each of three EXO use-intention questions (Try, Voluntary Use, and Behavioural Intention), using online survey responses. Variable selection and hyperparameter tuning were used respectively to reduce the number of potential predictors and improve prediction performance. The importance of variables in each final tree was calculated to understand which variables had a greater influence. The final trees had moderate prediction performance. The root node of each tree included EXOs becoming standard equipment, fatigue reduction, or performance increase. Important variables were found to be quite specific to different decision trees. Practical implications of the findings are discussed.

Practitioner summary: This study used decision trees to identify key factors influencing the use-intention of occupational exoskeletons (EXOs) in construction, using online survey data. Key factors identified included EXOs becoming standard equipment, fatigue reduction, and performance improvement. Final trees provide intuitive visual representations of the decision-making process for workers to use EXOs.

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