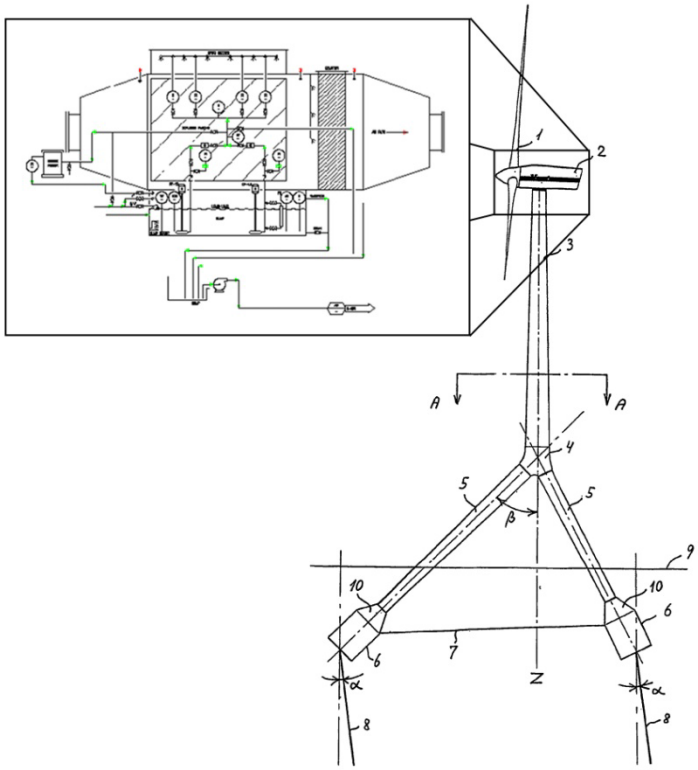


Image courtesy of Thinkstock

PtD
Prevention through Design

Mechanical–Electrical Systems

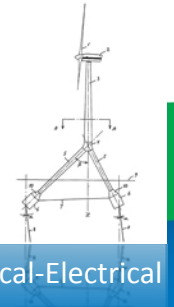
EDUCATION MODULE

Developed by James McGlothlin, MPH, Ph.D., CPE
Associate Professor, School of Health Science
John R. Weaver, Facility Manager, Birck Nanotechnology Center
Anna Menze, Research Assistant
Purdue University

CDC Workplace Safety and Health
NIOSH

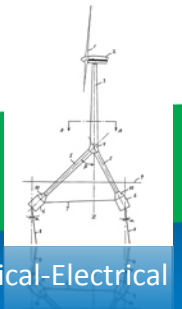
Guide for Instructors

Topic	Slide numbers	Approx. minutes
Introduction to Prevention through Design	5–29	45
Electrical Hazards	30–36	10
Wind Farm Case Study	37–42	10
Nanotechnology Laboratory	43–59	50
Recap	60–61	5
References and Other Sources	62–64	—



Learning Objectives

- Explain the Prevention through Design (PtD) concept.
- List reasons why project owners may wish to incorporate PtD in their projects.
- Identify workplace hazards and risks associated with design decisions and recommend design alternatives to alleviate or lessen those risks.



Overview

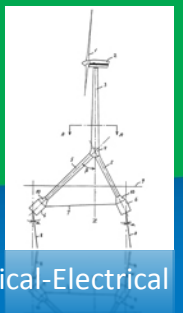
- PtD Concept
- Wind Farm
- Nanotechnology Laboratory

Photo courtesy of Thinkstock

PtD™
Prevention through Design

Introduction to Prevention through Design

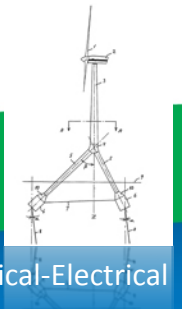
EDUCATION MODULE



Mechanical-Electrical

Occupational Safety and Health

- Occupational Safety and Health Administration (OSHA) www.osha.gov
  - Part of the Department of Labor
  - Assures safe and healthful workplaces
  - Sets and enforces standards
  - Provides training, outreach, education, and assistance
  - State regulations possibly more stringent
- National Institute for Occupational Safety and Health (NIOSH) www.cdc.gov/niosh
  - Part of the Department of Health and Human Services, Centers for Disease Control and Prevention
  - Conducts research and makes recommendations for the prevention of work-related injury and illness



Construction Hazards

- Cuts
- Electrocution
- Falls
- Falling objects
- Heat/cold stress
- Musculoskeletal disease
- Tripping

[BLS 2006; Lipscomb et al. 2006]

Graphic courtesy of OSHA

Construction Accidents in the United States

Construction is one of the most hazardous occupations. This industry accounts for

- 8% of the U.S. workforce, but 20% of fatalities
- About 1,100 deaths annually
- About 170,000 serious injuries annually

[CPWR 2008]

Photo courtesy of Thinkstock

Design as a Risk Factor: Australian Study, 2000–2002

- Main finding: design contributes significantly to work-related serious injury.
- 37% of workplace fatalities are due to design-related issues.
- In another 14% of fatalities, design-related issues may have played a role.

[Driscoll et al. 2008]

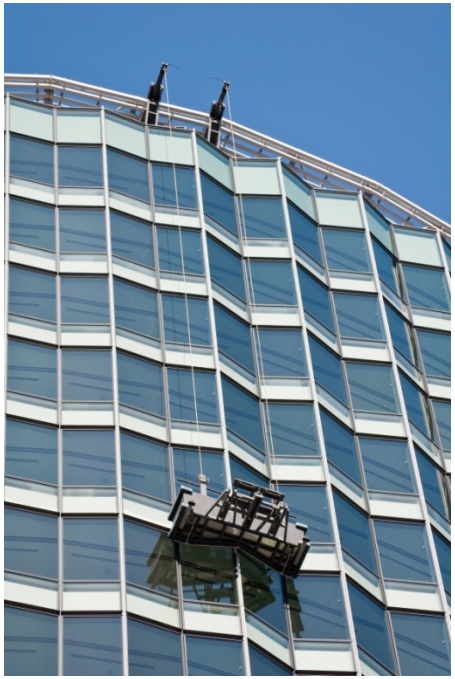
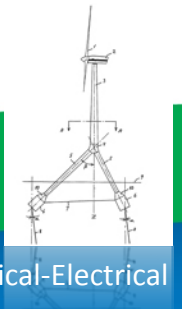


Photo courtesy of Thinkstock

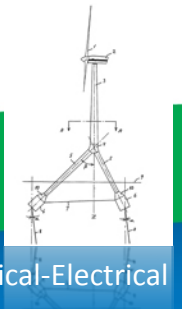
Accidents Linked to Design

- 22% of 226 injuries that occurred from 2000 to 2002 in Oregon, Washington, and California were linked partly to design [Behm 2005]
- 42% of 224 fatalities in U.S. between 1990 and 2003 were linked to design [Behm 2005]
- In Europe, a 1991 study concluded that 60% of fatal accidents resulted in part from decisions made before site work began [European Foundation for the Improvement of Living and Working Conditions 1991]
- 63% of all fatalities and injuries could be attributed to design decisions or lack of planning [NOHSC 2001]

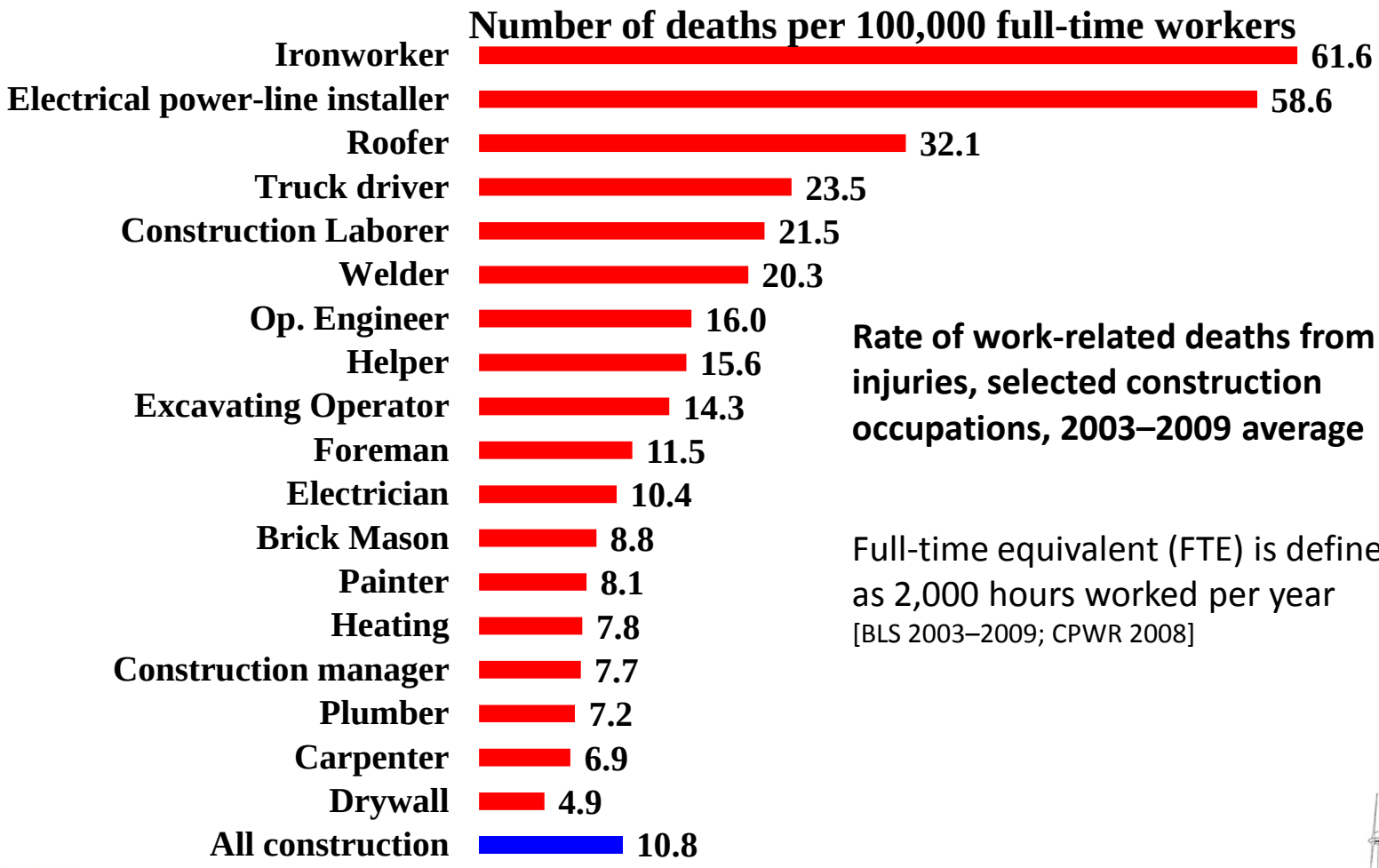


Falls

- Number one cause of construction fatalities
  - in 2010, 35% of 751 deaths
    www.bls.gov/news.release/cfoi.t02.htm
- Common situations include making connections, walking on beams or near openings such as floors or windows
- Fall protection is required at height of 6 feet above a surface [29 CFR 1926.760].
- Common causes: slippery surfaces, unexpected vibrations, misalignment, and unexpected loads



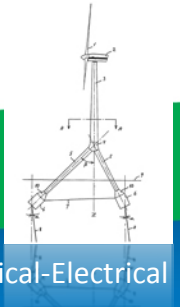
Death from Injury



Rate of work-related deaths from injuries, selected construction occupations, 2003–2009 average

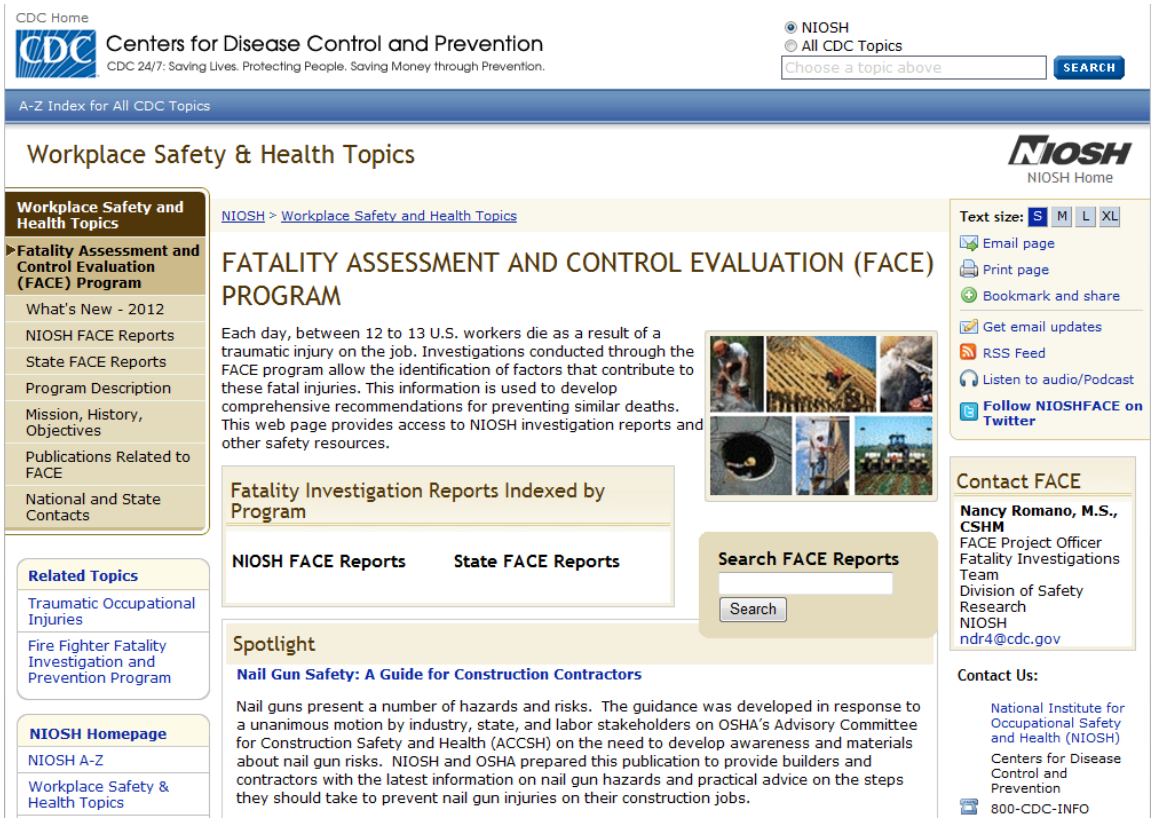
Full-time equivalent (FTE) is defined as 2,000 hours worked per year

[BLS 2003–2009; CPWR 2008]



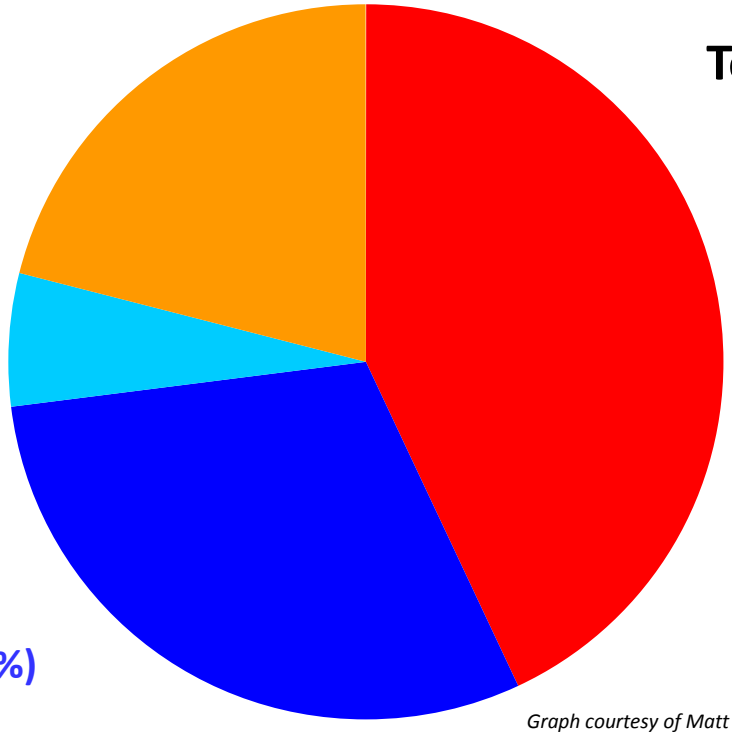
Fatality Assessment and Control Evaluation

NIOSH FACE Program www.cdc.gov/niosh/face



Death by Electrocution

Deaths caused by contact with electricity among electrical workers in construction, total for 2003–2009 [BLS 2003-2009]

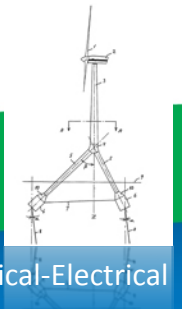


Graph courtesy of Matt Gillen

What is Prevention through Design?

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

- Construction
- Manufacturing
- Maintenance
- Use, reuse, and disposal of facilities, materials, and equipment



Mechanical-Electrical

Hierarchy of Controls per ANSI/AIHA Z10-2005

BEST

Control effectiveness

ELIMINATION
Design it out

SUBSTITUTION
Use something else

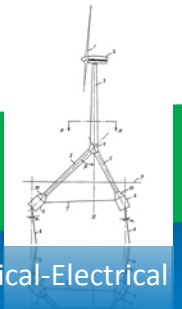
ENGINEERING CONTROLS
Isolation and guarding

ADMINISTRATIVE CONTROLS
Training and work scheduling

PERSONAL PROTECTIVE EQUIPMENT
Last resort

BEST

Business value



Personal Protective Equipment (PPE)

- Last line of defense against injury
- Examples:
  - Hard hats
  - Steel-toed boots
  - Safety glasses
  - Gloves
  - Harnesses

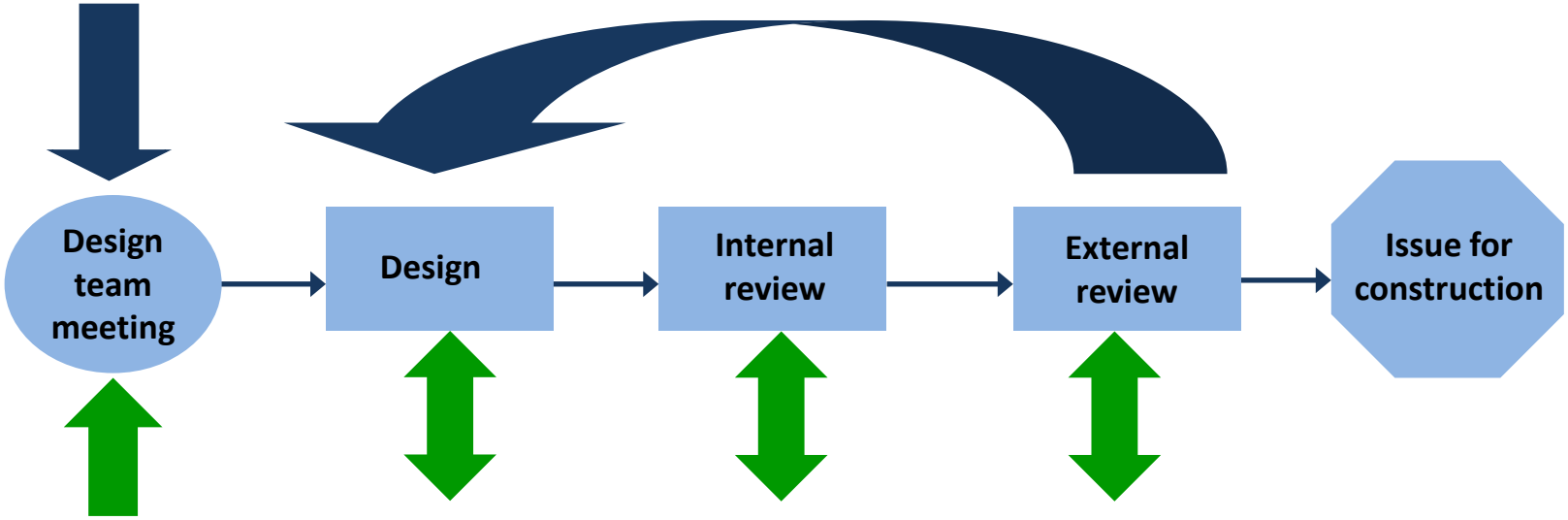
Photo courtesy of Thinkstock

OSHA www.osha.gov/Publications/osha3151.html

PtD Process

[Hecker et al. 2005]

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

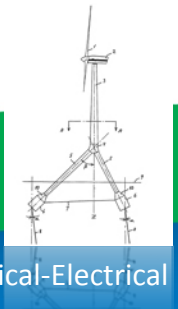


- **Owner**
- **Architect**
- **Project Manager**
- **Health & Safety Professional**

- **Trade contractor**
- **Health & Safety review**

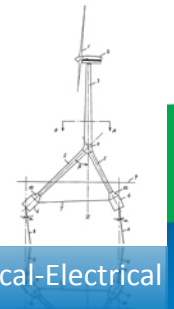
- **Quality Assurance/ Quality Control**
- **Health & Safety review**
- **Value Engineering review**

- **Focused Health & Safety review**
- **Owner review**



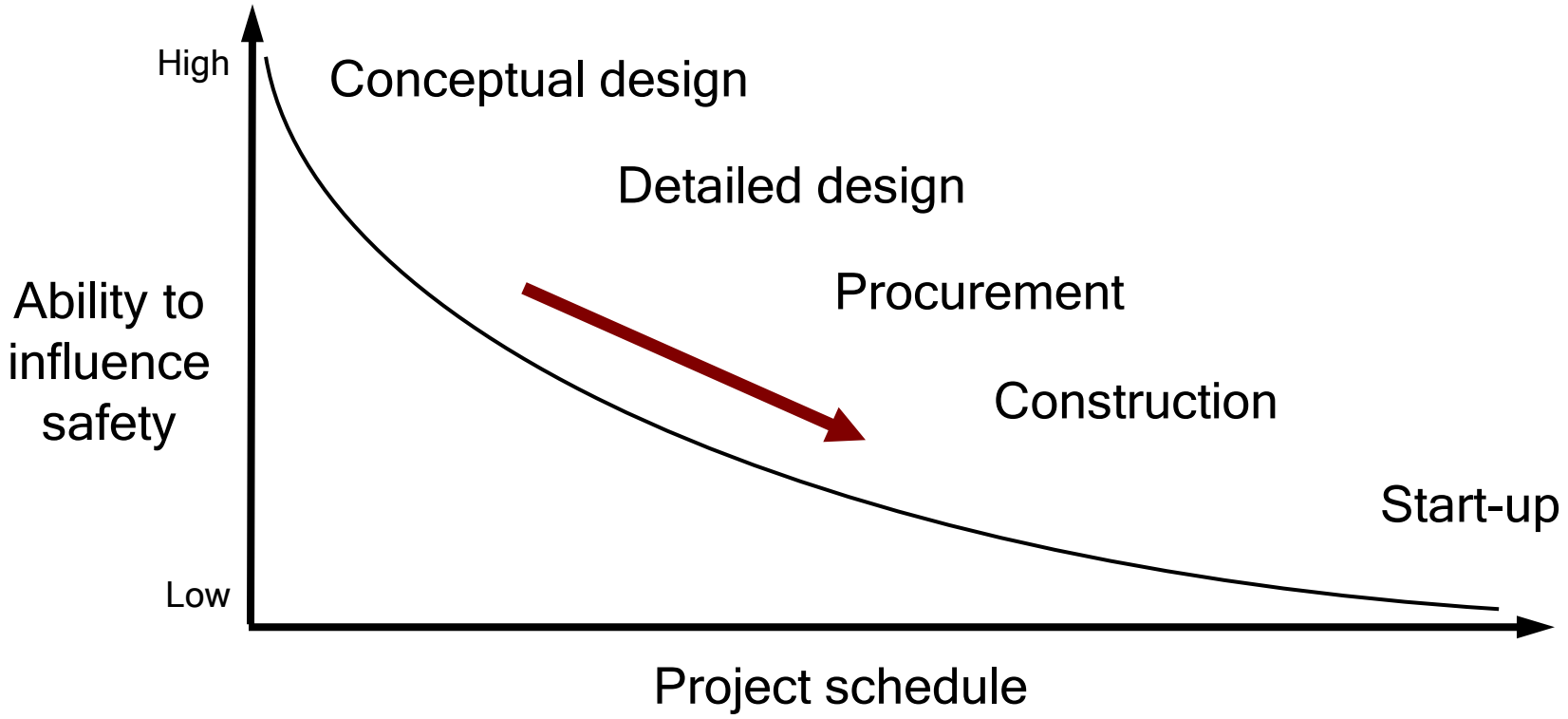
Integrating Occupational Safety and Health with the Design Process

Stage	Activities
Conceptual design	Establish occupational safety and health goals, identify occupational hazards
Preliminary design	Eliminate hazards, if possible; substitute less hazardous agents/processes; establish risk minimization targets for remaining hazards; assess risk; and develop risk control alternatives. Write project specifications.
Detailed design	Select controls; conduct process hazard reviews
Procurement	Develop equipment specifications and include in procurements; develop “checks and tests” for factory acceptance testing and commissioning
Construction	Ensure construction site safety and contractor safety
Commissioning	Conduct “checks and tests,” including factory acceptance; pre–start up safety reviews; development of standard operating procedures (SOPs); risk/exposure assessment; and management of residual risks
Start up and occupancy	Educate; manage changes; modify SOPs



Safety Payoff During Design

[Adapted from Szymberski 1997]



PtD Process Tasks

[Adapted from Toole 2005; Hinze and Wiegand 1992]

- Perform a hazard analysis
- Incorporate safety into the design documents
- Make a CAD model for member labeling and erection sequencing

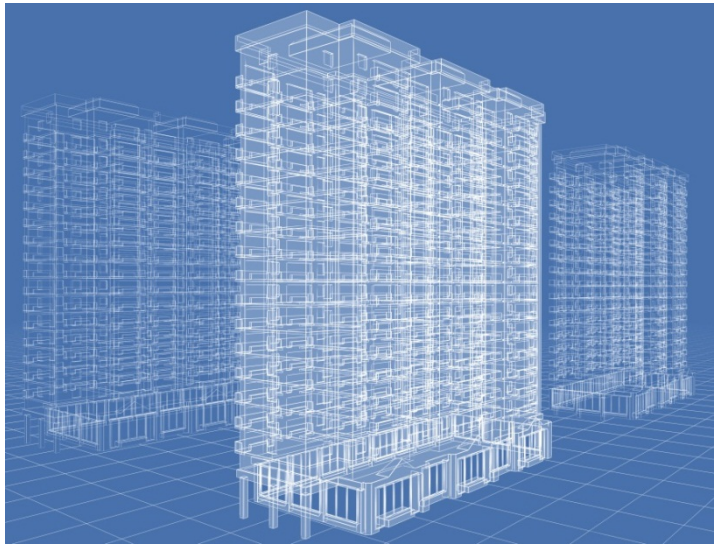
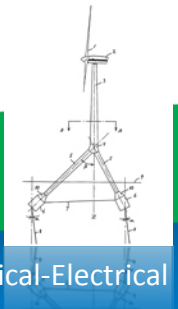
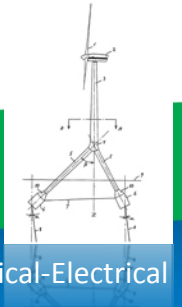


Photo courtesy of Thinkstock



Designer Tools

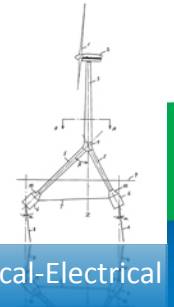
- Checklists for construction safety [Main and Ward 1992]
- Design for construction safety toolbox [Gambatese et al. 1997]
- Construction safety tools from the UK or Australia
  - Construction Hazard Assessment Implication Review, known as CHAIR [NOHSC 2001]



Example Checklist

Item	Description
1.0	**Structural Framing**
1.1	Space slab and mat foundation top reinforcing steel at no more than 6 inches on center each way to provide a safe walking surface.
1.2	Design floor perimeter beams and beams above floor openings to support lanyards.
1.3	Design steel columns with holes at 21 and 42 inches above the floor level to support guardrail cables.
2.0	**Accessibility**
2.1	Provide adequate access to all valves and controls.
2.2	Orient equipment and controls so that they do not obstruct walkways and work areas.
2.3	Locate shutoff valves and switches in sight of the equipment which they control.
2.4	Provide adequate head room for access to equipment, electrical panels, and storage areas.
2.5	Design welded connections such that the weld locations can be safely accessed.

[Checklist courtesy of John Gambatese]



Why Prevention through Design?

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

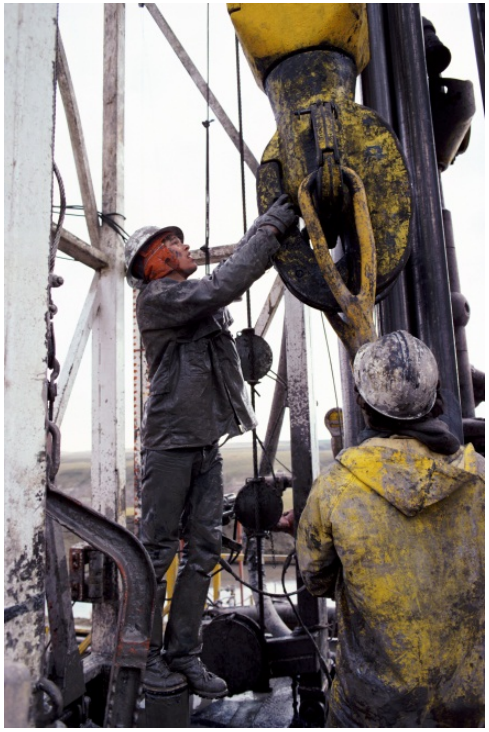


Photo courtesy of Thinkstock

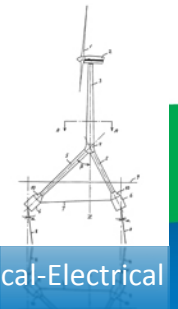
Ethical Reasons for PtD

- National Society of Professional Engineers' Code of Ethics and the American Society of Mechanical Engineers' Code of Ethics clearly states:

"Engineers shall hold paramount the safety, health and welfare of the public in the performance of their professional duties."

NSPE www.nspe.org/Ethics/CodeofEthics/index.html

ASME www.sections.asme.org/Colorado/ethics.html



PtD Applies to Constructability

- How reasonable is the design?
  - Cost
  - Duration
  - Quality
  - Safety

Photo courtesy of the Cincinnati Museum Center www.cincymuseum.org

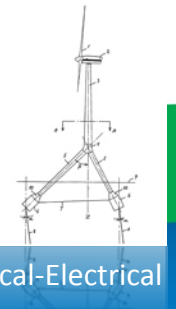
Business Value of PtD

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

Facilities	Equipment
Tools	Processes
Products	Work flows

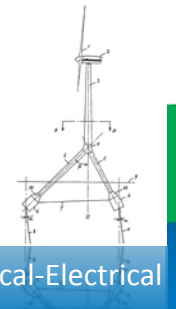
→ Improve business profitability!

AIHA www.ihvalue.org



Benefits of PtD

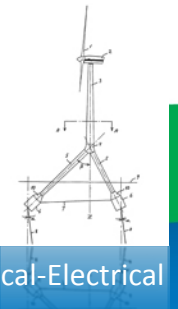
- Reduced site hazards and thus fewer injuries
- Reduced workers' compensation insurance costs
- Increased productivity
- Fewer delays due to accidents
- Increased designer-constructor collaboration
- Reduced absenteeism
- Improved morale
- Reduced employee turnover



Industries Use PtD Successfully

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

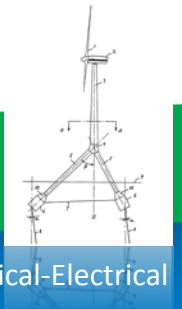
And many others



Mechanical-Electrical

MECHANICAL–ELECTRICAL SYSTEMS

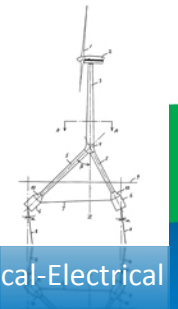
Electrical Hazards



Working Live

"In more than half of electrical worker electrocutions, the hazard resulted because of a failure to de-energize and lock out or tag out electrical circuits and equipment. The high percentage of electrocutions caused by work on live light fixtures, especially 277 volt circuits, is especially noteworthy." [CPWR 2008]

www.elcosh.org

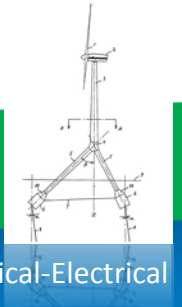


OSHA Electrical Standards

29 CFR 1910.333(a)(1)

"Deenergized parts. Live parts to which an employee may be exposed shall be deenergized before the employee works on or near them, unless the employer can demonstrate that deenergizing introduces additional or increased hazards **or is infeasible due to equipment design** or operational limitations."

High School Maintenance Worker Electrocuted After Contacting a 277 Volt Electrical Cable. New Jersey FACE Investigation 95NJ070
www.cdc.gov/niosh/face/stateface/nj/95nj070.html



Overhead Power Lines

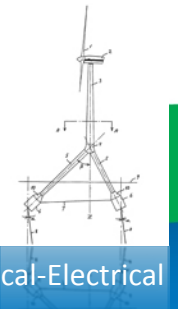
NORA Electrical Safety Goals Targeting Top Causes:

"Goal 2.1—Investigate ways to improve power line proximity warning alarms to protect operators of mobile vehicles, cranes, and nearby construction workers."

Goal 2.2—Investigate ways to protect construction workers from electrocution hazards involving power line contact through hand-carried metallic objects and vehicle-related contacts."

"Goal 2.3—Investigate ways to protect construction workers from contact with live electrical wiring and components by studying electrical installation, maintenance, and repair tasks and recommending ways to improve work practices, techniques, and tools."

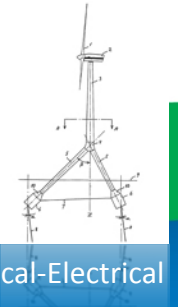
NORA Construction Agenda
www.cdc.gov/niosh/nora/comment/agendas/construction/pdfs/ConstOct2008.pdf



Site Activities

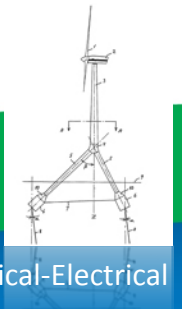
Case Study: Site Precautions to Prevent Electrocution

www.cdc.gov/niosh/face/stateface/co/94co035.html [NIOSH FACE 1994]



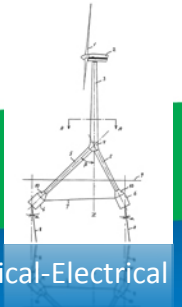
Design of Equipment

"Much can be done to improve operational safety by the careful design and selection of electrical equipment…..Circuits and equipment should be installed so that all sections of the system can be isolated as necessary…. Switch disconnectors should be suitably located and arranged so that circuits and equipment can be isolated without disconnecting other circuits that are required to continue in service." [UK HSE 2003]



Control Panels

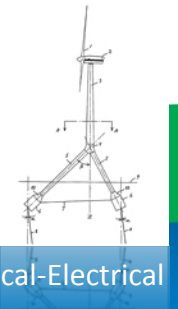
"…Control panels should be designed with insulated conductors and shrouded terminals so that commissioning tests, fault-finding, calibration, etc. can be carried out with a minimum of risk." [UK HSE 2003]



PtD
Prevention through Design

MECHANICAL–ELECTRICAL SYSTEMS

Wind Farm Case Study

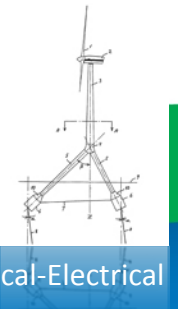


CDC Workplace Safety and Health
NIOSH

Mechanical-Electrical

Fall Prevention

PtD Elements for Wind Tower and Turbine
Numerous 5,000-lb. anchorage points for tie-off
Ladder fall arrest system (installed at factory)
Factory-mounted worker platforms with attached guardrails
Specially designed crane rigging attachments
Preassembly of numerous components (modular construction)
Construction sequencing to reduce workers' exposure to fall hazards
Careful planning for worker accessibility throughout the entire wind turbine structure and nacelle



Ladder Fall Arrest System

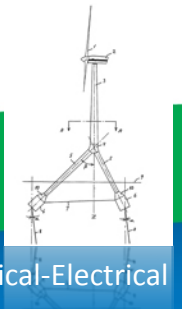
Photo courtesy of Jim McGlothlin

Crane Rigging Attachments

Photo courtesy of Jim McGlothlin

Propeller Accessibility Hatch

Photo courtesy of Jim McGlothlin

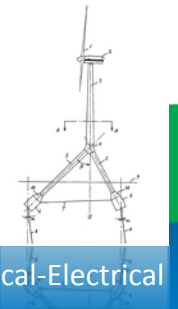


Anchor Points

Photo courtesy of Jim McGlothlin

MECHANICAL–ELECTRICAL SYSTEMS

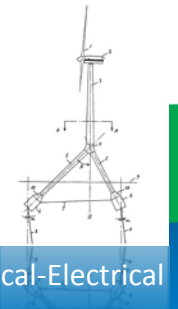
Nanotechnology Laboratory



MECHANICAL–ELECTRICAL SYSTEMS

Dock Management

Nanotechnology Laboratory



Video of Dock Management System

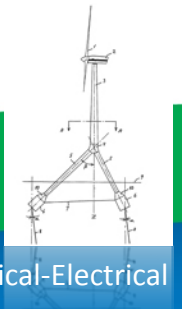
Video courtesy of Purdue University

Captioned video is available at
http://streaming.cdc.gov/vod.php?id=842fba716738e3046a3657a20ab7b5e220130730154947421

MECHANICAL–ELECTRICAL SYSTEMS

Laboratory Safety

Nanotechnology Laboratory



Gas Storage and Monitoring System

- Ultrapure gases are distributed through stainless steel tubing.
- Hazardous gases are doubly contained, with continuous monitoring for leaks.

Photo courtesy of Purdue University

Gas Distribution System

- Clearly marked main gas lines run down the subfab spine
- Bulk gases stored outside the building in cabinets
- Hazardous gases stored in fireproof bunker
- All lines are supported by a chase
- Hydrogen generated on site

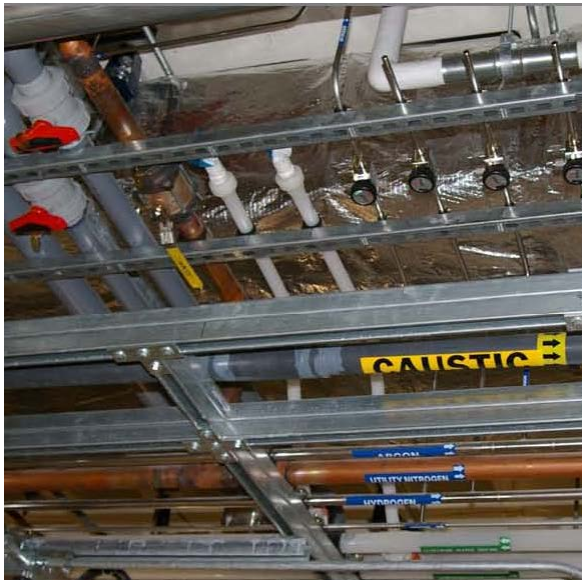


Photo courtesy of Purdue University

Video of Gas Detection System

Video courtesy of Purdue University

Captioned video is available at
http://streaming.cdc.gov/vod.php?id=7475cd1dc67bd951782a61474e607c4320130730155502593

Video of Chemical Spill Vent System

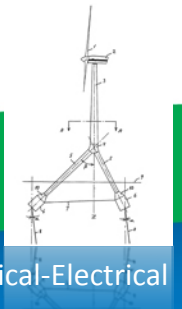
Video courtesy of Purdue University

Captioned video is available at
http://streaming.cdc.gov/vod.php?id=52b2e256ceb7522018400338d040e48c20130730155232359

MECHANICAL–ELECTRICAL SYSTEMS

Scrubber System

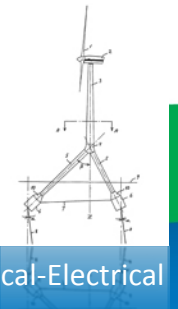
Nanotechnology Laboratory



Mechanical-Electrical

Exhaust Gas Scrubber System

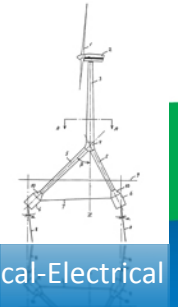
- Provides exhaust flow for all systems where acid or base fumes and vapors may exist
- Redundant fans provide high air flow through system
- Utilizes water flowing over high-surface-area beads to remove acids and bases from air stream
- Clean air is then released into the atmosphere



Video of Scrubber System

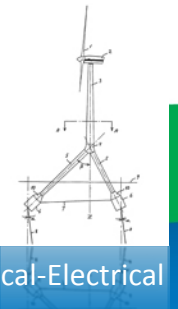
Video courtesy of Purdue University

Captioned video is available at
http://streaming.cdc.gov/vod.php?id=41661e0436dde76257d454107b309dca20130730155711906



Evidence of PtD

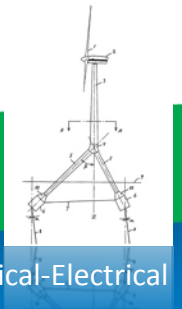
- Two banks of batteries
- Monthly tests
- Specific key sequence for maintenance bypass
- Maintaining cool room temperature
- Environmental enclosure



MECHANICAL–ELECTRICAL SYSTEMS

Uninterrupted Power System

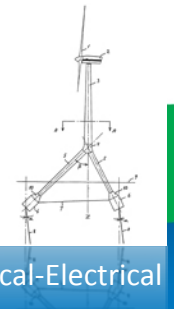
Nanotechnology Laboratory



Nanotechnology Center Power System Design

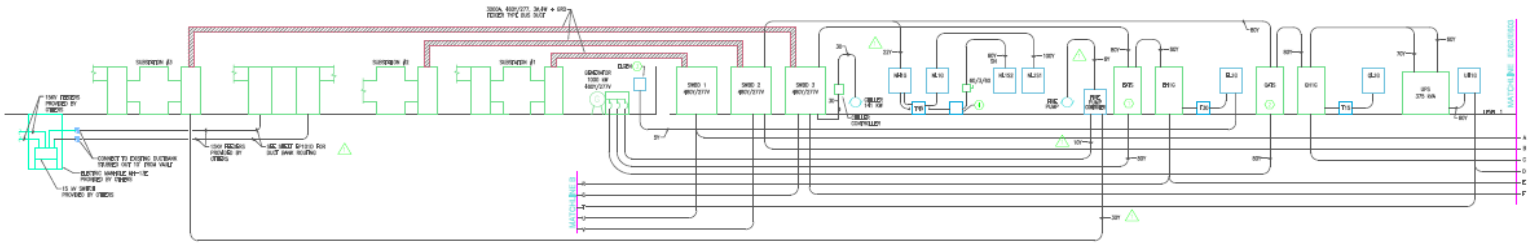
- Electrical power is required to maintain safety in the facility
  - Exhaust systems
  - Makeup air systems
  - Lighting
  - Building security systems
  - Hazardous-materials monitoring systems
  - Life-safety equipment
- Utilizing PtD in the design of the power system ensures continued availability of power, even during emergency situations

[ANSI/ASSE 2011]

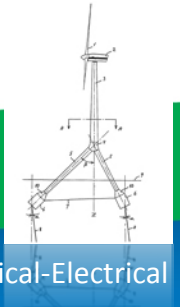


Design of Power System

- Primary power is supplied from campus power distribution system
- Internal power distribution system within the facility provides dedicated power sources
  - Normal power
  - Sensitive power
  - Uninterrupted power
  - Emergency power



Purdue University www.purdue.edu/discoverypark/Nanotechnology



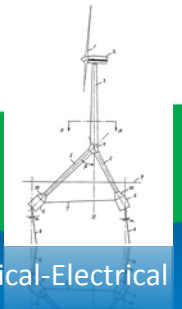
Video of Uninterrupted Power System

Video courtesy of Purdue University

Captioned video is available at
http://streaming.cdc.gov/vod.php?id=b681f15fc233ddf4ba8eb00b5e2a004320130730155839828

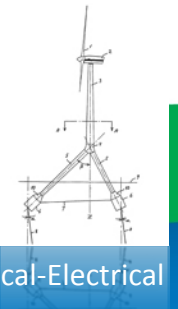
Evidence of PtD

- Special airflow damper prevents air backflow of exhaust air during fan maintenance
- Redundant fans and pumps ensure continuous operation of system, maintaining safety inside of laboratories
- Anomalies of operation trigger text message alert to key personnel so that action can be taken prior to system failure
- System operates on emergency power
- pH and temperature are monitored to ensure proper operation of system
- “Soft” switch-over of fans to ensure continuous operation
- Critical drives kept in environmentally controlled areas



Recap

- PtD initiative is key to ensuring continuous operation of critical facility systems that guarantee the safety of those working in the facility.
- Electrical engineering elements of PtD can be understood by evaluating the building electrical distribution system.
- Mechanical engineering elements of PtD can be understood by evaluating the Exhaust Gas Scrubber system.



Help make the workplace safer…

Include *Prevention through Design* concepts in your projects.

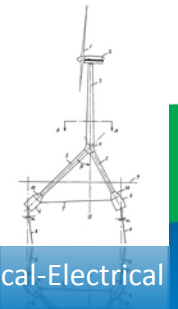
For more information, please contact the National Institute for Occupational Safety and Health (NIOSH) at

Telephone: (513) 533–8302
E-mail: preventionthroughdesign@cdc.gov

Visit these NIOSH Prevention through Design Web sites:

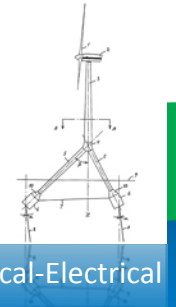
www.cdc.gov/niosh/topics/PtD/

www.cdc.gov/niosh/programs/PtDesign/



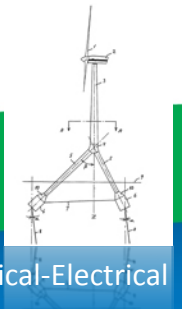
References

- American Institute of Industrial Hygienists [AIHA] [2008]. Strategy to demonstrate the value of industrial hygiene www.aiha.org/votp_NEW/pdf/votp_exec_summary.pdf.
- ANSI/ASSE [2011]. American national standard: prevention through design guidelines for addressing occupational hazards and risks in design and redesign processes. Des Plaines, IL: American Society of Safety Engineers. ANSI/ASSE Z590.3-2011.
- Behm M [2005]. Linking construction fatalities to the design for construction safety concept. Safety Sci 43:589–611.
- Bureau of Labor Statistics [BLS] [2003–2009]. Census of Fatal Occupational Injuries. Washington, DC: U.S. Department of Labor, Bureau of Labor Statistics www.bls.gov/iif/oshcfoi1.htm.
- BLS [2003–2009]. Current Population Survey. Washington, DC: U.S. Department of Labor, Bureau of Labor Statistics www.bls.gov/cps/home.htm.



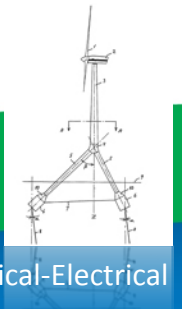
References

- BLS [2006]. Injuries, illnesses, and fatalities in construction, 2004. By Meyer SW, Pegula SM. Washington, DC: U.S. Department of Labor, Bureau of Labor Statistics, Office of Safety, Health, and Working Conditions www.bls.gov/opub/cwc/sh20060519ar01p1.htm.
- BLS [2011]. Census of Fatal Occupational Injuries. Washington, DC: U.S. Department of Labor, Bureau of Labor Statistics. www.bls.gov/news.release/cfoi.t02.htm.
- BLS [2011]. Injuries, Illnesses, and Fatalities (IIF). Washington, DC: U.S. Department of Labor, Bureau of Labor Statistics. www.bls.gov/iif/home.htm.
- Center for Construction Research and Training [2008]. The construction chart book: the U.S. construction industry and its workers. Silver Spring, MD: CPWR—The Center for Construction Research and Training.



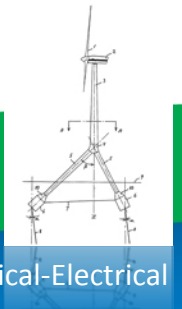
References

- Driscoll TR, Harrison JE, Bradley C, Newson RS [2008]. The role of design issues in work-related fatal injury in Australia. J Safety Res 39(2):209–214.
- European Foundation for the Improvement of Living and Working Conditions [1991]. From drawing board to building site (EF/88/17/FR). Dublin: European Foundation for the Improvement of Living and Working Conditions.
- Gambatese JA, Hinze J, Haas CT [1997]. Tool to design for construction worker safety. J Arch Eng 3(1):2–41.



References

- Hecker S, Gambatese J, Weinstein M [2005]. Designing for worker safety: moving the construction safety process upstream. Professional Safety, Journal of the American Society of Safety Engineers (ASSE) 50(9):32–44.
- Hinze J, Wiegand F [1992]. Role of designers in construction worker safety. Journal of Construction Engineering and Management 118(4):677–684.
- Lipscomb HJ, Glazner JE, Bondy J, Guarini K, Lezotte D [2006]. Injuries from slips and trips in construction. Appl Ergonomics 37(3):267–274.
- Main BW, Ward AC [1992]. What do engineers really know and do about safety? Implications for education, training, and practice. Mechanical Engineering 114(8):44–51.

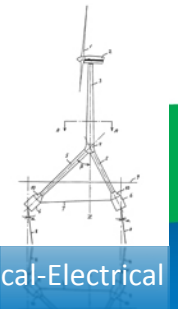


References

- New York State Department of Health [2007]. A plumber dies after the collapse of a trench wall. Case report 07NY033 www.cdc.gov/niosh/face/pdfs/07NY033.pdf.
- NIOSH [2007]Preventing Worker Deaths and Injuries from Contacting Overhead Power Lines with Metal Ladders. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2007–155. www.cdc.gov/niosh/docs/wp-solutions/2007-155. NIOSH Fatality Assessment and Control Evaluation (FACE) Program [1983]. Fatal incident summary report: scaffold collapse involving a painter. FACE 8306 www.cdc.gov/niosh/face/In-house/full8306.html.

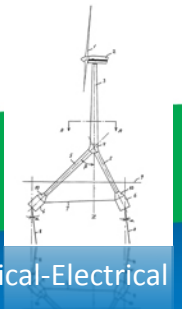
References

- NIOSH Fatality Assessment and Control Evaluation (FACE) Program [1995]. High School Maintenance Worker Electrocuted After Contacting a 277 Volt Electrical Cable. New Jersey FACE Investigation 95NJ070 www.cdc.gov/niosh/face/stateface/nj/95nj070.html.
- NIOSH Fatality Assessment and Control Evaluation (FACE) Program [1994]. A 35-year-old Painter Was Electrocuted When the Aluminum Ladder He Was Moving Contacted a 7,620-volt Power Line. Colorado report no. 94co035 www.cdc.gov/niosh/face/stateface/co/94co035.html.
- NIOSH [2008] NORA Construction Agenda. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health. www.cdc.gov/niosh/nora/comment/agendas/construction/pdfs/ConstOct2008.pdf.



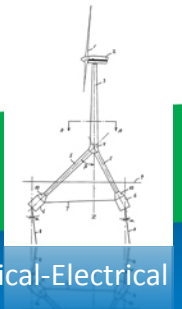
References

- NOHSC [2001]. CHAIR safety in design tool. New South Wales, Australia: National Occupational Health & Safety Commission.
- Occupational Safety and Health Administration [OSHA] [2001]. Standard number 1926.760: fall protection. Washington, DC: U.S. Department of Labor, Occupational Safety and Health Administration.
- OSHA [ND]. Fatal Facts Accident Reports Index [foreman electrocuted]. Accident summary no. 17 http://www.setonresourcecenter.com/MSDS_Hazcom/FatalFacts/index.htm.
- OSHA [ND]. Fatal Facts Accident Reports Index [laborer struck by falling wall]. Accident summary no. 59 http://www.setonresourcecenter.com/MSDS_Hazcom/FatalFacts/index.htm.
- Szymberski R [1997]. Construction project planning. TAPPI J 80(11):69–74.



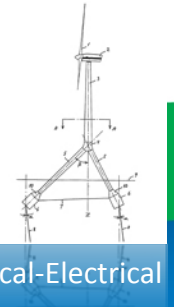
References

- Toole TM [2005]. Increasing engineers' role in construction safety: opportunities and barriers. Journal of Professional Issues in Engineering Education and Practice 131(3):199–207.
- United Kingdom Health and Safety Executive [UK HSE]. [2003] Electricity at Work: Safe working practices P. 6 ISBN 978 0 7176 2164 4 www.hse.gov.uk/pubns/books/hsg85.htm.



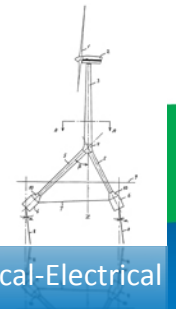
Other Sources

- American Society of Mechanical Engineers [ASME]
  www.sections.asme.org/Colorado/ethics.html
- NIOSH Fatality Assessment and Control Evaluation Program
  www.cdc.gov/niosh/face
- National Society of Professional Engineers [NSPE]
  www.nspe.org/ethics
- NIOSH Prevention through Design Web sites:
  www.cdc.gov/niosh/topics/PtD
  www.cdc.gov/niosh/programs/PtDesign



Other Sources

- OSHA Fatal Facts
  www.setonresourcecenter.com/MSDS_Hazcom/FatalFacts/index.htm
- OSHA home page
  www.osha.gov/pls/oshaweb/owastand.display_standard_group?p_toc_level=1&p_part_number=1926
- OSHA PPE publications
  www.osha.gov/Publications/osha3151.html
  www.osha.gov/OshDoc/data_General_Facts/ppe-factsheet.pdf
  www.osha.gov/OshDoc/data_Hurricane_Facts/construction_ppe.pdf



DISCLAIMER

The opinions expressed in this presentation are those of the speakers and do not necessarily represent the official position of the National Institute for Occupational Safety and Health (NIOSH). Mention of any company or product does not constitute endorsement by NIOSH. In addition, citations to Web sites external to NIOSH do not constitute NIOSH endorsement of the sponsoring organizations or their programs or products. Furthermore, NIOSH is not responsible for the content of these Web sites.