



THE CENTER FOR CONSTRUCTION
RESEARCH AND TRAINING

Preventing Exposure to Electrical Hazards in Construction

August 19, 2026

Moderator: Chris Trahan Cain, CIH, Executive Director, CPWR

Panelists:

- **Jocelyn Horner Kelly, Ph.D.**, Executive Director, McElhattan Foundation
- **Babak Memarian, PhD, CSP, CHST**, Senior Risk Engineering Consultant, Zurich Resilience Solutions
- **Joseph McManigal , CSP, CRIS, CESCO, CIT**, Senior Risk Engineering Consultant, Zurich Resilience Solutions

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- Today's webinar will be recorded and automatically shared via follow-up email.
- The recording and slides will also be posted on cpwr.com/webinars.
- Attendees are automatically muted! Please submit panelist questions via the chat or Q&A box.
- Spanish audio is available via simultaneous interpretation

Simultaneous Interpretation

Interpretación simultánea

WINDOWS - MAC (Navegador web/Browser)

1. En los controles del seminario web, haga clic en **Interpretación** 
2. Haga clic en el idioma que desee escuchar.
3. (Opcional) Para escuchar solo el idioma interpretado, haga clic en **Silenciar audio original**.

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ANDROID - iOS (Aplicación móvil/Mobile App)

1. En los controles del seminario web, toque los puntos suspensivos **...**
2. Toque **Interpretación de idiomas**.
3. Toque el idioma que desee escuchar.
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ZERO ELECTROCUTION CHALLENGE



LEARN MORE

www.zec.zero2050.org

**ZERO
2050**

ZERO ELECTROCUTION CHALLENGE

McElhattan Foundation's Zero Electrocution Challenge seeks breakthrough solutions that present pathways to **eliminate life-threatening tasks that lead to fatal electrocution** on the job by the year 2050, while increasing enterprise profitability and productivity. This is the inaugural ZERO 2050 challenge, awarding two Winners up to \$1 million each.



McELHATTAN
FOUNDATION

**ZERO
2050**

To participate, register for
the Zero Electrocution
Challenge no later than
**5:00 PM Eastern Time on
Tuesday, September 1.**



**ZERO
2050**

Preventing Exposure to Electrical Hazards in Construction

Babak Memarian, PhD, CSP, CHST

Sr. Risk Engineering Consultant

Zurich Resilience Solutions

CPWR Webinar

August 19th, 2026



Pre-Task Planning (PTP)

- Research findings suggest that most work-related injuries could be prevented by:
 - Proactively identifying hazards and unsafe conditions associated with each task, tools/equipment, materials, work methods, and jobsite
 - Properly addressing hazards using effective controls before work begins
- Pre-Task Planning (PTP)** is a process performed before each task starts to discuss the steps of work, the hazards, and available controls. It may also be known as JHA, JSA, morning huddle, or other terms.

The gap in the process:

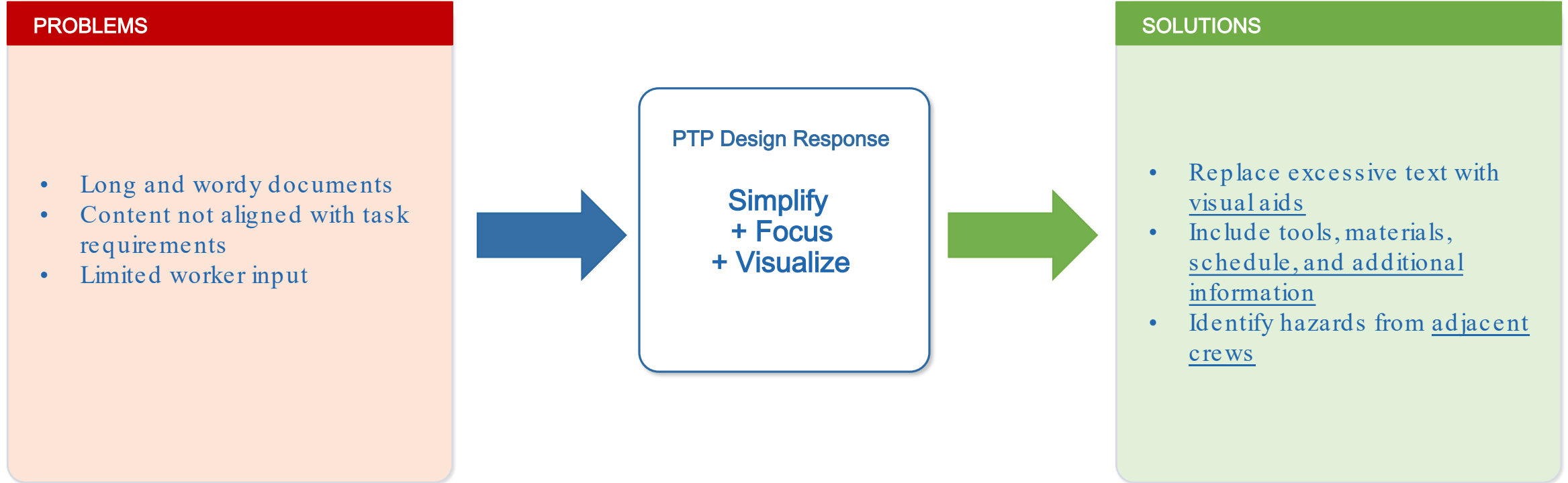
- Lack of comprehensive guidelines
- Mainly from a compliance perspective
- Inconsistent style
- Inconsistent terminology (JHA, JSA, PTP, AHA...)
- Confusion and conflicts on jobsites
- Lack of workers' engagement in site safety planning
- Inconsistency between content and task requirements

FACILITIES SERVICES MAINTENANCE OF FIRE ALARMS, PANELS, AND SENSORS		
TASK	HAZARDS	CONTROLS
1. Preparing work area	Injuries to passersby and bystanders False alarm response, client anxiety/panic, disruption of campus business	Isolate work area with barricades, caution tape, and/or on-site assistant Phone UCPD and notify building clients, schedule work appropriately
2. Using ladders and lifts	Falls, slips, electrical hazards	Refer to ladder safety and aerial lift JSA's
3. Working in sub-vaults, cramped spaces, custodial closets, machine rooms	Muscle strain, repetitive stress injuries Heat stress Head and/or eye injuries from falling or flying debris, dust inhalation Hand and finger injuries from pinch points Skin/eye irritation from dirt and chemicals Tripping hazards from cables and extension cords	Stretching, frequent breaks, adequate hydration, alternate tasks with team partner Frequent breaks, adequate hydration, alternate tasks with team partner Protect head and eyes with hard hat and safety glasses, wear dust mask Protect hands with gloves, avoid pinch points and moving machinery parts Wear safety glasses and long-sleeved shirt Practice careful housekeeping, maintain awareness of location of equipment and tools
4. Repairing, replacing, or maintaining fire alarms, panels, or sensors	Electrical shock	Assess environment for water or damaged wiring/connections before starting work, evaluate condition/scope of building and consult written procedures (confidential to department) for that building before starting work Wear ear plugs, notify building clients and UCPD prior to tests
5. Testing horns	Hearing damage to self and others	

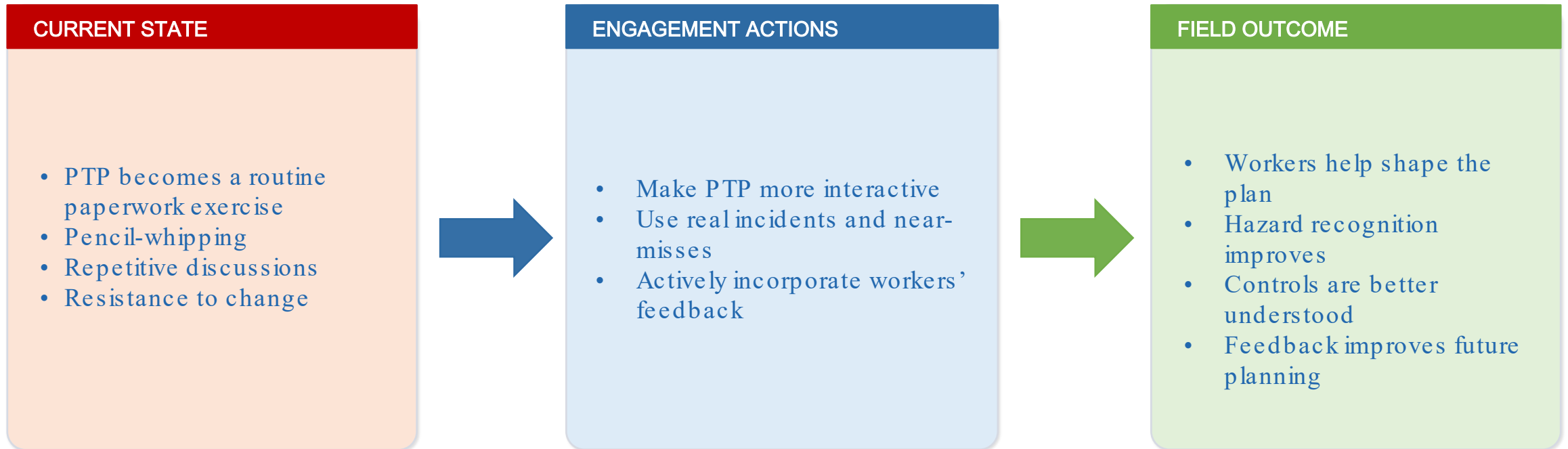
CHECKLIST (Check and Discuss applicable items prior to task)	CHECKLIST (Check and Discuss applicable items prior to task)
YES ☐ SITE SPECIFIC SAFETY ORIENTATION ☐ EVACUATION PLAN/RALLY POINT ☐ SDS REVIEWED (RACCOM) ☐ ACCESS/EGRESS ☐ MATERIAL STORAGE ☐ EQUIPMENT, MACHINE & TOOL INSPECTION ☐ MACHINE & TOOL GUARDS ☐ BARRICADES, SIGNS, TAGS ☐ 100% TIE-OFF ☐ WEATHER HAZARDS ☐ LOCKOUT-TAGOUT VERIFICATION ☐ ADEQUATE LIGHTING ☐ NEAREST FIRE EXTINGUISHER	YES GENERAL SAFETY ☐ GFCI IN USE ☐ EXT CORDS - USER INSPECTED ☐ EXPOSED CONDUCTORS ☐ LOCKOUT / TAGOUT AUTHORIZED PERSONS ☐ ARC FLASH TRAINED ☐ TRAINED / AUTHORIZED PERSONS ☐ WIRE / CABLE PULL - SETUP ☐ WIRE / CABLE PULL - EQUIPMENT INSPECTION ☐ WIRE / CABLE PULL - TENSIONING YES CRANE OPERATIONS / RIGGING ☐ OPERATOR ONLY INSPECTION ☐ ANNUAL INSPECTION CURRENT ☐ TAG LINES USED ☐ PROPER SETUP ☐ RIGGING EQUIP - USER INSPECTED ☐ OPERATOR TRAINING / CERTIFICATION VERIFIED ☐ RIGGER TRAINING / CERTIFICATION VERIFIED YES FALL PROTECTION ☐ USER INSPECTED EQUIP ☐ PROPER ANCHOR POINT USED ☐ FALL CLEARANCE DETERMINED ☐ HARNESS PROPER FIT YES LADDERS ☐ PROPER FOOTING / ANGLE ☐ EXT LADDERS SECURED ☐ EXTENDS 3 FT ABOVE LANDING ☐ STEPLADDER - OPENED / LOCKED ☐ LEVEL / STABLE ☐ PROPER USE ☐ FALL PROTECTION NEAR OPENING
	YES ELECTRICAL ☐ FORK LIFT - DAILY INSPECTION ☐ OPERATOR TRAINING / CERTIFICATION VERIFIED ☐ SEAT BELT USED ☐ LOAD CHART - LULL ☐ MANUAL LIFTING - PROPER BODY POSITION ☐ PROPER LIFTING METHODS ☐ MECHANICAL LIFTING DEVICES NEEDED ☐ ADEQUATE MANPOWER/SPOTTER

PERSON WHO DOES JOB:		DATE:	
SUPERVISOR:		NEW ☐ REVISED ☐	
DEPARTMENT:		ANALYSIS PERFORMED BY:	
		REVIEWED BY:	
SEQUENCE OF JOB STEPS	POTENTIAL HAZARDS	RECOMMENDED ACTION OR PROCEDURE	
1.			
2.			
3.			

Inconsistent PTP practices, compliance -focused behavior, limited worker input, and weak follow -up.

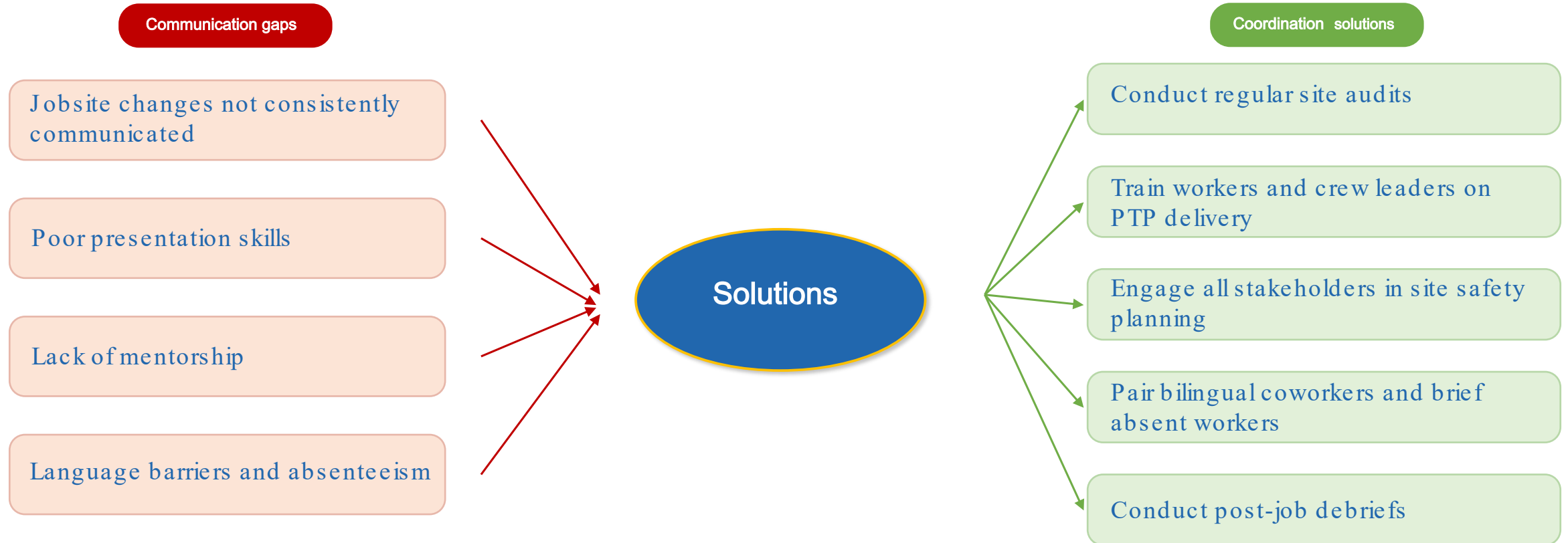


PTP should be short, visual, and directly connected to today's task.



The goal is to move workers from signing the form to shaping the plan.

Strengthening Communication and Coordination



Everyone should start the task with the same understanding of current conditions.

Electrical Construction

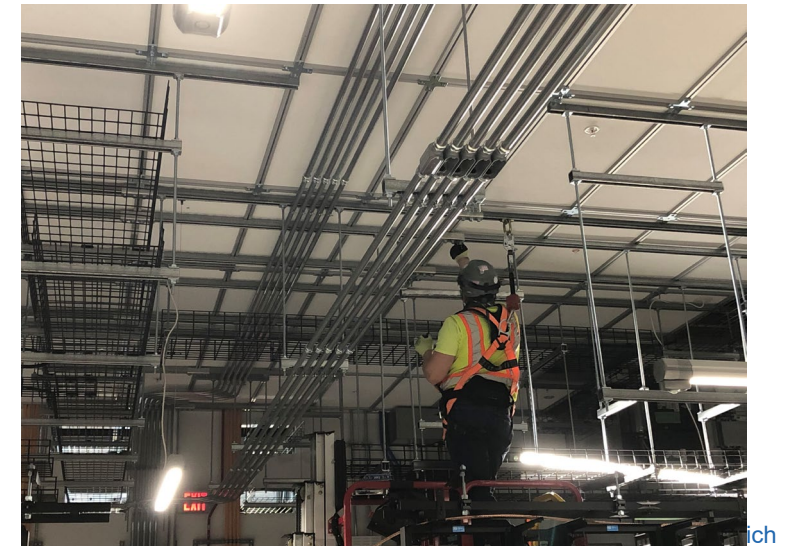
Electrical Tasks

Electrical tasks studied:

- Overhead Conduit Installation
- Installing Lighting Tracks & Supports
- Site Preparation and Layout
- Pulling Wire
- Terminations
- Electrical Demolition
- Cable Tray Installation
- Grounding
- Busway Installation
- Material Handling/Logistics
- Wiring AC Units
- Connecting Building-to-Building Conduit
- Access Card Readers Installation
- Fire Alarm Components Installation
- Receptacles Installation
- Branch Circuits Installation
- Pre-fabricated Components

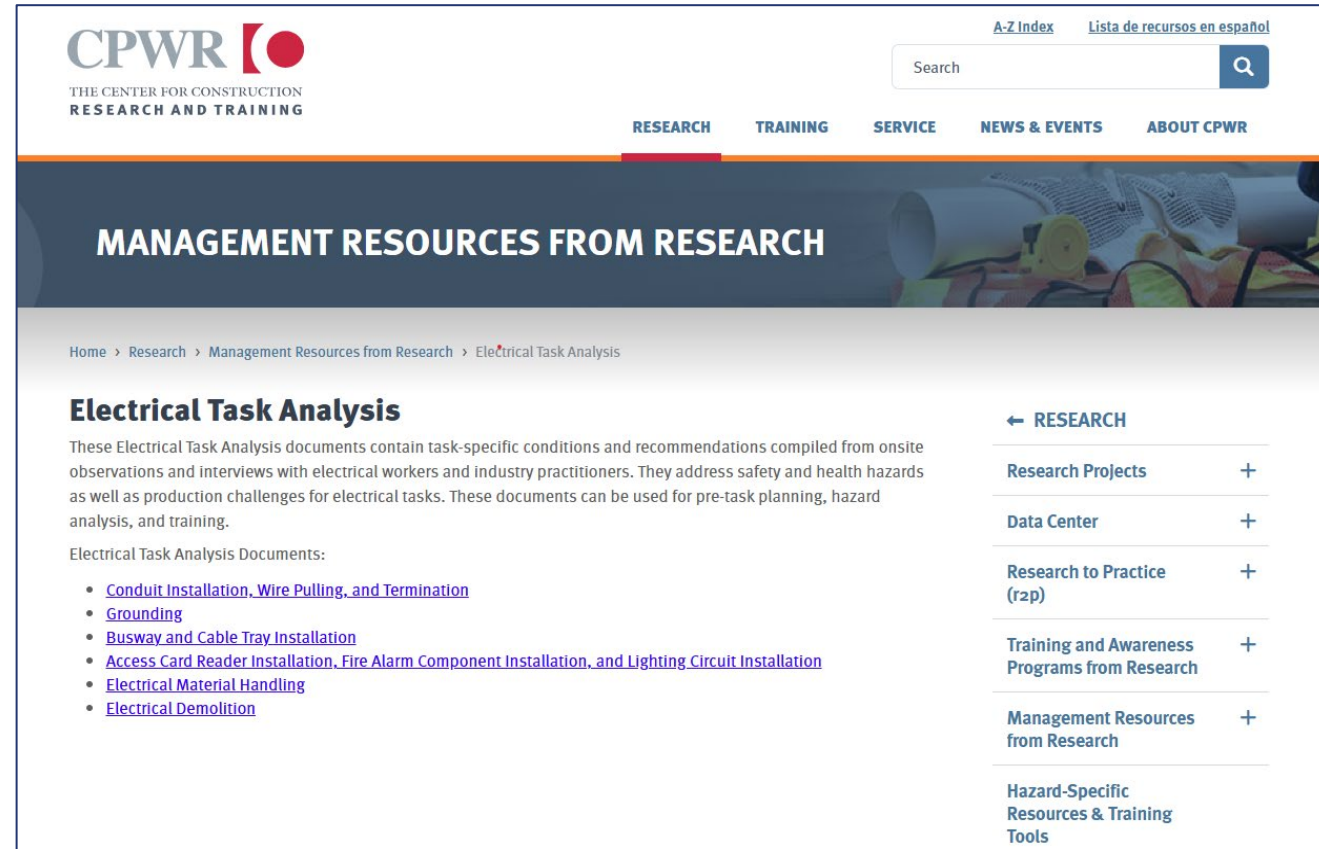
Workers' input on:

- Physical loads
- Mental loads
- Time pressure
- Environmental factors
- Frustration
- Other factors



Electrical Task Analysis Documents

- Organized based on Task and Project Type
- Applicable for Pre-Task Planning, JHA, and Training
- Contains task-specific conditions raised by workers
- Visualizes the situation using images
- Recommends solutions
- Easy to download and use in PDF and MS Word format
- Customizable for specific project needs
- Publicly available at no cost



The screenshot shows the CPWR (The Center for Construction Research and Training) website. The header includes the CPWR logo, a search bar, and navigation links for Research, Training, Service, News & Events, and About CPWR. The main heading is 'MANAGEMENT RESOURCES FROM RESEARCH'. Below this, a breadcrumb trail reads: Home > Research > Management Resources from Research > Electrical Task Analysis. The main content area is titled 'Electrical Task Analysis' and contains a paragraph explaining that these documents contain task-specific conditions and recommendations compiled from onsite observations and interviews with electrical workers and industry practitioners. They address safety and health hazards as well as production challenges for electrical tasks. These documents can be used for pre-task planning, hazard analysis, and training. Below this paragraph, a list of 'Electrical Task Analysis Documents' is provided, including: Conduit Installation, Wire Pulling, and Termination; Grounding; Busway and Cable Tray Installation; Access Card Reader Installation, Fire Alarm Component Installation, and Lighting Circuit Installation; Electrical Material Handling; and Electrical Demolition. On the right side of the page, there is a sidebar titled '← RESEARCH' with a list of links: Research Projects, Data Center, Research to Practice (r2p), Training and Awareness Programs from Research, Management Resources from Research, and Hazard-Specific Resources & Training Tools. Each link has a plus sign next to it.

<https://www.cpwr.com/research/management-resources-from-research/electrical-task-analysis/>

Sample Electrical Task Analysis Documents

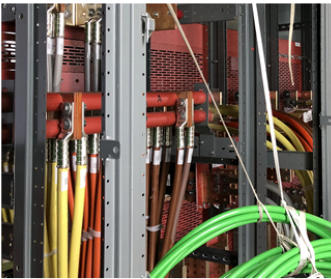


Electrical Task Analysis Document

Conduit Installation, Wire Pulling, and Termination

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CONDITIONS	RECOMMENDATIONS
Handling cables and wires in tight spaces and awkward positions: - Installing cables and wires at ground level in awkward positions increases the risk of ergonomic injuries and lacerations during wire stripping. Additionally, the inherent bend in wires when taken directly off the reel makes handling them and pulling them through conduit more difficult. - The restricted space around switchgear requires manual bending and shaping of heavy cables because mechanical benders will not fit, further elevating the risk of ergonomic injuries.	- Don appropriate hand and arm PPE - Increase the frequency of breaks - Rotate workers if feasible - Stretch and flex - Unbend the wire using available hard surfaces and tools - Use reels to better manage wire pulling activities Hand-held cable strippers Mechanical wire and cable feeder Powered wire-stripping machine Wire dispensing cart
	

CONDITIONS	RECOMMENDATIONS
Running wires to the correct unit: Running the right set of wires to the right unit without damaging the circuit requires concentration and advanced planning. 	- Arrange tools, materials, and project documents in an easily accessible location - Consult the latest revision of the blueprints - Walk the whole wire route from start to finish before beginning work to ensure equipment is properly labeled
Wiring larger junction boxes: Figuring out which wire to connect to each circuit requires advanced planning and memorization, especially when working on larger junction boxes.	- Ensure that current revisions of blueprints are available - Gather all needed tools and materials, as well as a paper or electronic copy of the wiring diagram, at the work location before starting work - Label wires using color-coded wire markers to indicate the feed source - Mark and color-code circuits and box locations on the floor before work begins

Thank You!

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Zurich Resilience Solutions

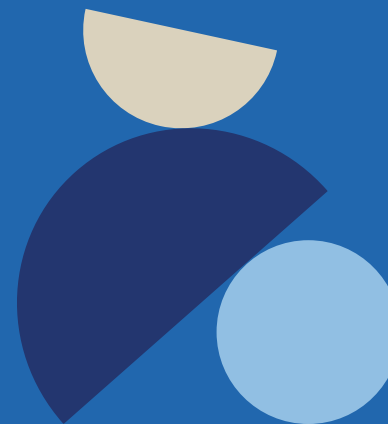
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Construction Electrical Safety Basics

Recognize It. Respect It. Control It.

High-Level Electrical Safety Awareness for
Construction Teams

August 19th, 2026

Joseph McManiga, CSP, CRIS, CEMCP, CIT

Zurich Resilience Solutions



Why Are We Talking About This?

Typical Electrical Shock Claim - Estimated:

- Medical + indemnity costs often range from **\$25,000 to \$150,000+**
- Lost time can range from days to months depending on injuries

Serious Arc Flash Claim - Estimated:

- Frequently exceeds **\$250,000**
- Severe burn cases can exceed **\$1 million**
- Multiple surgeries and rehabilitation common
- Lost time frequently measured in months rather than days

Catastrophic/Fatal Electrocution Event - Potential impacts:

- Workers' compensation
- General liability exposure
- OSHA citations
- Legal expenses
- Schedule delays
- Reputation impacts

Actual total losses can reach several million dollars when all direct and indirect costs are considered.

WORKPLACE ELECTRICAL FATALITIES 2011 - 2024

electrical **safety**
FOUNDATION INTERNATIONAL

Every year, the Electrical Safety Foundation International (ESFI) compiles **workplace safety data** from the **Bureau of Labor Statistics (BLS)** and the **Occupational Safety and Health Administration (OSHA)** to track trends on **electrical safety in the workplace**.

WORKPLACE SAFETY TRENDS

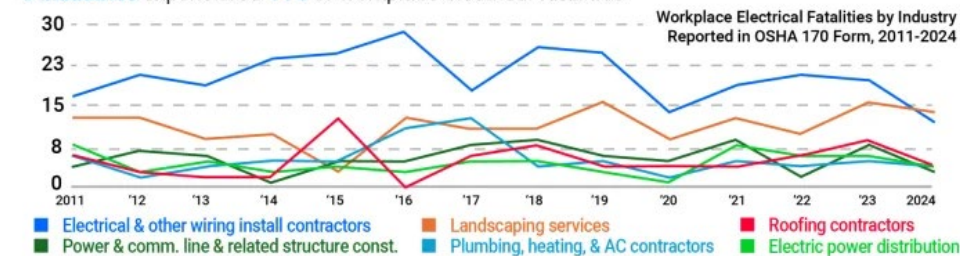
1,654 electrical fatalities in the workplace between 2011 - 2024

70% of all workplace electrical fatalities are in **non-electrical occupations**



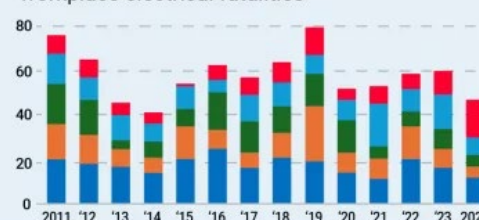
WORKPLACE ELECTRICAL FATALITIES BY INDUSTRIES

6 industries experienced **44%** of workplace electrical fatalities



WORKPLACE ELECTRICAL FATALITIES BY OCCUPATIONS

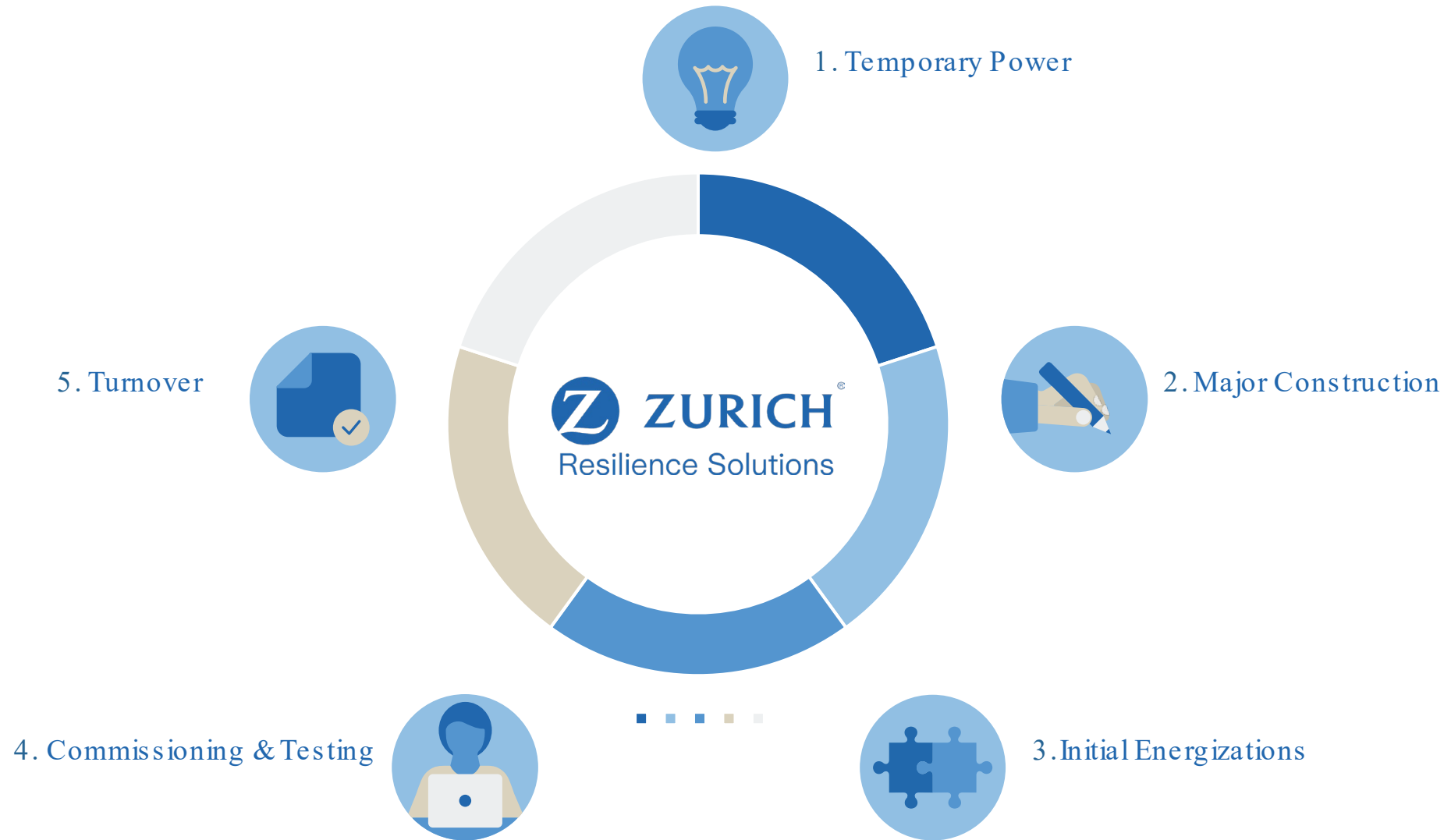
5 Occupations accounted for almost **50%** of all workplace electrical fatalities



Two occupations have a growing number of electrical fatalities



Electrical Risk Exists Throughout the Project Lifecycle

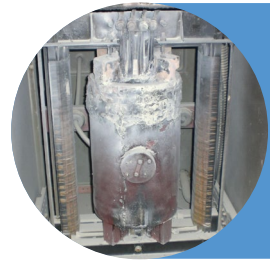


The Big Four Electrical Hazards



Shock

- Current through the body
- Key Factors: Amount of Current, Length of Time



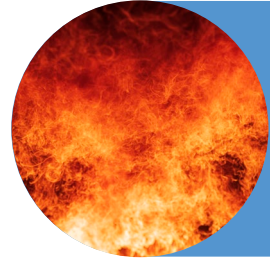
Arc Flash

- Thermal energy release, tens of thousands of degrees Fahrenheit
- > 2nd degree burns inside the Arc Flash Boundary (AFB) with insufficient AF PPE
- Key Factors: available fault current, fault clearing time, distance



Arc Blast

- Pressure waves and projectiles



Fire

- Electrical fault is the ignition source
- Sustained by nearby fuels (non-AR garments, construction materials, trash, debris)

Common Construction Electrical Exposures



Temporary Power, GFCI's and
Extension Cords



Open Panels, Switchgear,
Testing & Commissioning



Underground and Overhead
Utilities

Temporary Power concerns extend beyond GFCI testing, cord management, & assured grounding. Always let Qualified Electricians reset tripped circuit breakers and relocate energized conductors.



Common Assumptions

It's Off

- Off does not equal Safe
- Lockout/Tagout and Zero Voltage Confirmations equal Safe

Someone Else Checked It For Me

- Almost as bad as the Foreman who puts a lock on equipment and then tells everyone to “Go to work” --- trust but verify

It's Only Temporary

- When temporary power gets treated with lower expectations, incidents will occur

It's Low Voltage

- Many agencies define “Low Voltage” to be voltages < 600 Volts
- Low Voltage does NOT equal Low Hazard NOR Low Risk
- Arc Flash incident energies can be either Low or High for either Low or High Voltage

I've Always Done It Like This

- Probably the single most dangerous mindset of workers exposed to electrical hazards.

NFPA 70E in Plain English

- 1 | Identify Hazards
- 2 | Assess Risks (Shock & Arc Flash)
- 3 | Eliminate Exposures
- 4 | Use Qualified Workers
- 5 | Apply Controls & Use PPE



The Most Effective Control: ES WC

Electrically Safe Work Condition – NFPA 70E 120.6

A Condition Formed By A Process

1
Identify
Sources

2
Isolate
Equipment

3
Apply
Lockout/Tagout

4
Verify
Absence of
Voltage

5
Perform
Work



PPE Selection

Shock and Arc Flash Risk Assessments

Help determine protection boundaries and adequate PPE selection. Testing for the absence of voltage requires PPE for both shock and arc flash hazards.

What's the incident energy level of the equipment to be tested?

Live – Dead - Live

Adequately Rated Voltmeter

No Non-Contact Voltage Testers!

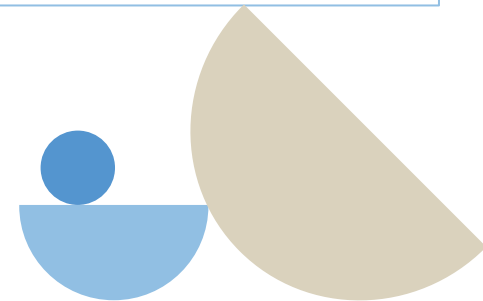
Must be rated for the voltage of the system to be tested.

Must be tested before **AND** after on a known voltage source – Proving Unit

Qualified Workers

Two Workers May Be Required For Energized Work

Additional Personnel May Be Required For Certain Energized Work Activities



Temporary $\neq$ Lower Risk

- 1 | Frequent modifications
- 2 | Multiple contractors
- 3 | Changing power sources
- 4 | Documentation challenges
- 5 | Backfeed hazards



Energized Work Changes Everything

Questions to Ask

1 Can it be de-energized?

- If it can, it should
- Example: Troubleshooting steps that require circuits to be energized vs. steps that do not. Turn it off when you can, turn it back on when you HAVE to

2 Why is energized work necessary?

- Do you meet the justification criteria of NFPA 70E?
- Exceptions listed in 110.2(B):
 - Normal operation if equipment is in normal condition
 - Task is NOT possible in de-energized state
 - De-energizing introduces additional hazards or increased risk
 - Less than 50 volts without increased exposure to electrical burns or arcs

3 Who is qualified?

- Have training records been documented and reviewed?
- How are skills and knowledge evaluated? (written test and practical test?)
- Understand while some workers may be qualified for certain equipment, they may not be qualified for others (Example: low voltage distribution vs. medium voltage distribution)

4 What controls exist?

- Who is approving energized electrical work permits (EEWP's)?
- Are Method of Procedures (MOP's) or similar step-by-step procedures required and utilized?
- Are boundaries established, maintained, and recognizable by everyone on the project?
- Are all workers (non-qualified included) receiving electrical hazard awareness training? (OSHA says construction employers must instruct every employee in the recognition and avoidance of unsafe conditions, 29 CFR 1926.21)
- Underground Utility Avoidance Program/Permit?
- In-wall or in-slab coring/drilling utility identification?
- Overhead power line contact prevention?

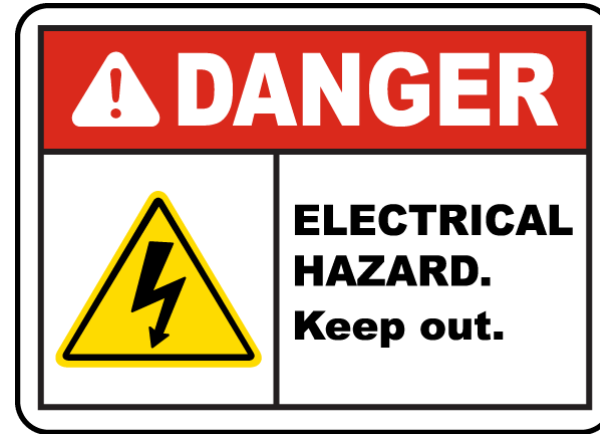
5 Who needs to stay away?

- Short answer – anyone who is not qualified and actively participating in the energized work task
- Establish boundaries and monitor/control entry
- Remember: Arc Flash Boundary = 2nd degree burn..Bigger is better!
- Assume it is energized until it is proven that it is not..Live-Dead-Live is energized work

Who Needs Electrical Hazard Awareness?

What is an Arc Flash? What are the dangers of Electric Shock? When do I need a GFCI?

- Laborers
- Painters
- Drywallers
- Carpenters
- Operators
- HVAC Technicians
- Commissioning Teams
- Superintendents
- 3rd Party Vendors
- Project Managers



Short Answer:
Everyone!



Hot Topics in Construction

- Data Centers
- Battery Energy Storage (BESS)
- Grid Expansion
- Solar Farms
- EV Charging Stations

= Commissioning and Startup

Scenario – SWGR Startup Day

- Covers removed
- Multiple contractors present
- HVAC technicians on standby for startup
- Schedule pressure exists
- Status changes throughout the day



Five Questions to Ask Before Work Starts

1. Is it Energized?
2. Can it be De-energized?
3. Has it been Locked Out?
4. Has Absence of Voltage been Verified? (LDL)
5. Who is the Qualified Person performing the work?



Key Takeaways

- Electrical Hazards Are Often Invisible
- De-Energization Is the Most Effective Control
- Temporary Power Deserves Permanent-Level Attention
- Electrical Safety Is Everyone's Responsibility
- Questions Asked Before Work Begins Prevents Incidents





Q: As a GC, should I request Certifications from the subcontractor (NFPA 70E/LOTO)?

- We talked about qualified workers, training records, skill evaluations
- Let's talk in terms of "Training" not "Certified" – NFPA does not certify, though they do offer credentials (CESCP, CEST, CESW)
- Yes, you should ask for:
 - Electrical safety training (NFPA 70E, every 3 years)
 - Qualified person training (curriculum, classroom vs hands-on)
 - LOTO training (OSHA required for all subcontractors, not just EC)
 - Electrical safety program (or Energy Control Program)
 - Energized work procedures and authorizations



Q: How can we ensure proper LOTO when working on or near energized equipment?

- What Good LOTO looks like:
 - Methods to identify energy sources
 - Written procedures
 - Personal locks
 - Group LOTO when applicable
 - Live-Dead-Live testing and verifications
 - Field verification
 - Periodic audits



Q: What electrical hazard information should be included in a Site Specific Safety Plan (SSSP)?

- Temporary power (red lines, arc flash analysis)
- GFCI strategy (monthly test logs)
- Underground utility avoidance process
- LOTO minimum controls
- Commissioning activities
- Electrical room access
- Shock & Arc Flash hazard awareness training
- Emergency response
- Qualified worker responsibilities



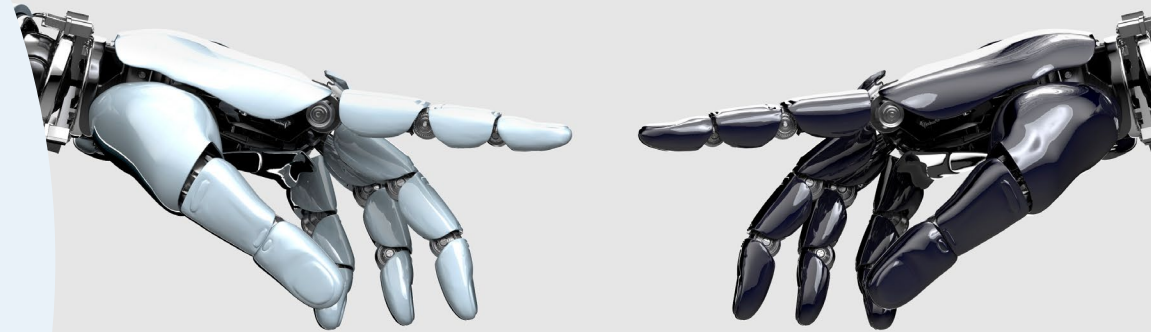
Q: How dangerous is it to have temporary lighting/power or extension cords touching ceiling grid?

- What's the concern?
 - Abrasion and insulation damage
 - Metal grid or ceiling becoming energized
 - Improper support or routing
 - Hidden damage/reduced inspection visibility
 - Possible OSHA/NEC compliance violations
- Better practice: independently support & protect temporary wiring
- References
 - 1926.405(a)(2)(ii)(I)
 - 1926.405(g)(1)(iii)
 - 1926.405(g)(1)(iii)(D)
 - 1926.416(a)(1)
 - NEC 400.12



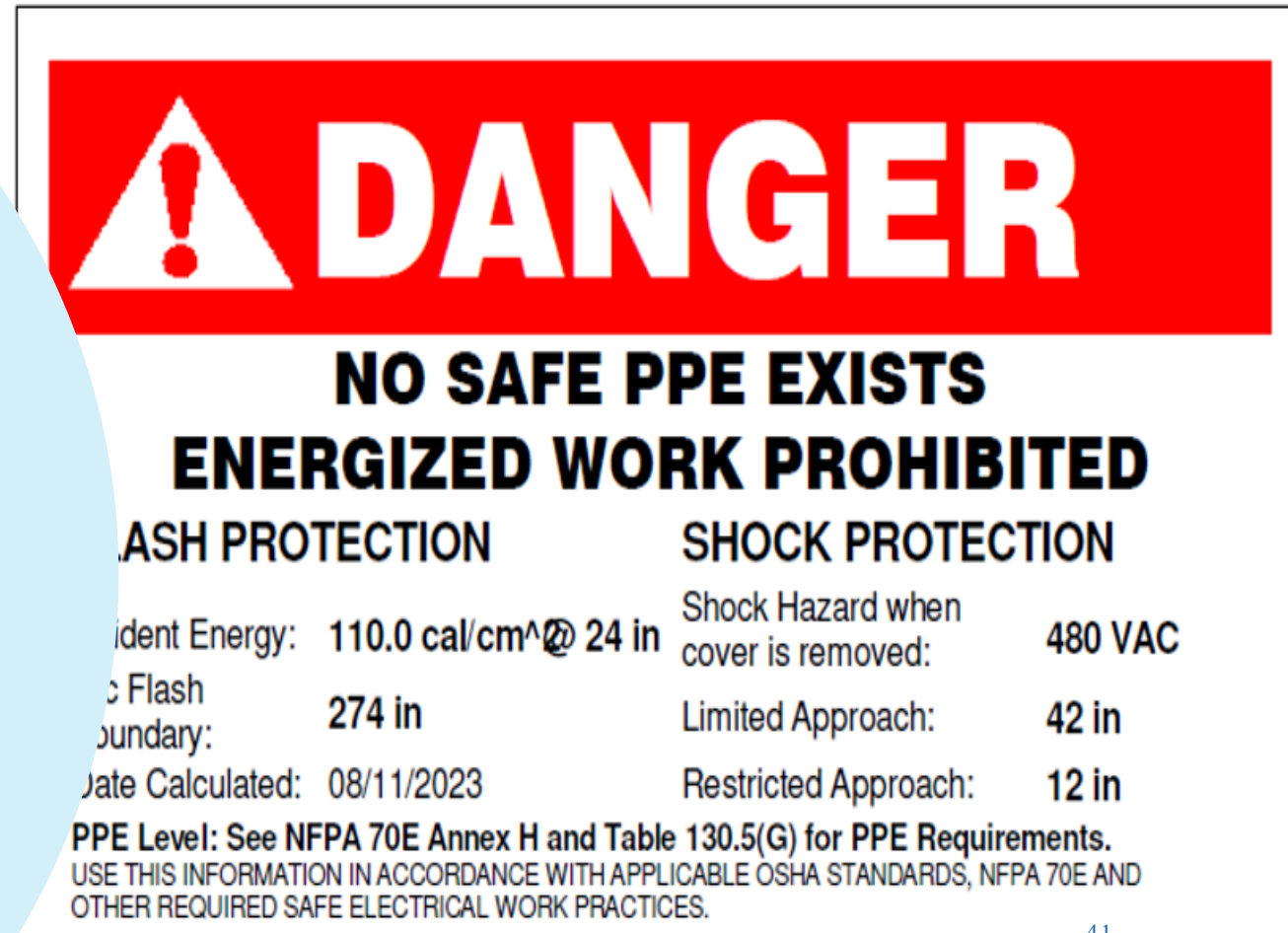
Q: Any new products in regards to electrical safety? Emerging technology to reduce electrical mishaps?

- Remote switching & Robotics
- Fiberoptic flash detection
- Energy reducing maint. switches
- Continuous Thermal monitoring
- Digital LOTO platforms
- Wearables
 - Wristbands
 - Hardhat Sensors
 - Voltage proximity, arc flash detection, falls, man-down alerts, GPS location
- Permanently mounted absence of voltage testers / voltage indicators



Q: What if a building has a main breaker that is labeled “No Safe PPE Exists, Energized Work Prohibited”?

- Available incident energy may exceed the organization’s allowed PPE approach
- Energized interaction should be prohibited or tightly restricted
- Do not solve high incident energy by simply “getting a bigger suit”
- Preferred controls:
 - De-energize
 - Remote operation
 - Upstream isolation
 - Utility disconnect
 - ESWC before exposure



! DANGER

**NO SAFE PPE EXISTS
ENERGIZED WORK PROHIBITED**

FLASH PROTECTION		SHOCK PROTECTION	
Incident Energy:	110.0 cal/cm ² @ 24 in	Shock Hazard when cover is removed:	480 VAC
Flash Boundary:	274 in	Limited Approach:	42 in
Date Calculated:	08/11/2023	Restricted Approach:	12 in

PPE Level: See NFPA 70E Annex H and Table 130.5(G) for PPE Requirements.
USE THIS INFORMATION IN ACCORDANCE WITH APPLICABLE OSHA STANDARDS, NFPA 70E AND OTHER REQUIRED SAFE ELECTRICAL WORK PRACTICES.

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