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What Shapes Our Decisions in Being Safe?

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Your safety yesterday, today, and tomorrow

- How does your past shape YOUR approach to safety?
- How do YOU approach safety today?
- How can YOU reshape your attitude toward being safe?

Electrical Safety and All Safety

- MAY is National Electrical Safety Month
  - Every year we pick a topic to highlight, about electrical safety
  - In your home, in your office, performing electrical work
  - THIS year, our focus is on human decision affecting electrical safety
- THIS talk focuses on human performance in electrical safety
- BUT, you can apply these principles to ALL safety in your everyday life

Your past

- Old Practices?
  - What old habits in electrical work:
    - Come from “the way we have done it” for many years or in the past
    - That no longer meet current safe work practices
- Myths?
  - Are there myths about electricity and electrical safety that
    - Can get us into trouble?
    - We need to be aware of?
- Misunderstanding
  - Do you really understand the hazard, electricity?

Old Practices – from our past – at work

- If in doubt, touch the circuit with the back of your hand.
- Work with only one hand.
- Using a “proximity” tester (wiggy, inductive tester)
- Do not “break the plane” of the enclosure
- I do not need work control (e.g., an IWD) for “Scope of Work,” to determine the repair work to be done
- I do not need a lock in place if the disconnect is within sight
- LOTO does NOT apply to plug control

Verifying zero hazard

- Until you PROVE that there is no hazard, you must assume that the hazard is present and protect yourself accordingly
- Before an electrical circuit is safe you must:
  - Have control of the source (e.g., red lock)
  - Test each conductor voltage with a voltmeter
  - You must be an energized, authorized worker, have a second person, and wear appropriate PPE
- Touching with the back of your hand, or working with only one hand implies that you DO NOT KNOW if the circuit is safe.
- Using a proximity tester is NOT allowed for zero voltage verification
- Apply these principles to other areas

Do not "break the plane" of the enclosure

- Previously we used the rule that if our hands did not pass the plane of the surface of an enclosure with the cover off, then we were not exposed to an electrical hazard, and controls could be relaxed, such as we do not need: PPE, work control document, and/or training
- This practice evolved BEFORE
  - Shock approach boundaries were created
  - Arc flash hazards were recognized and in the standard
- Example: 480 V distribution panel
  - Analysis and work control required BEFORE removing cover
  - Training required at 3.5 ft, which is beyond the plane of the enclosure
  - Shock PPE is required within 1 ft of conductors, often beyond the plane of enclosure
  - Arc rated PPE is required at the arc flash boundary, which can be 0.5 to 5 ft, well beyond the plane of the enclosure

Scope of Work

- This concept evolved in the past, to describe the process of looking at, performing diagnostics, and/or troubleshooting equipment to determine the repair work to be done.
- Problem – Many aspects of the old “Scope of Work” concept require hazardous tasks, such as:
  - Removing the dead front cover
  - Performing LOTO and zero voltage verification
  - Performing diagnostics with a meter
- Most “Scope of Work” processes will require an IWD.

LOTO

- In the past, we allowed no lock in place, if the disconnect is within sight.
  - This is NOT ALLOWED today.
- In the past, our habits were to not place a red lock, if we were “sure that no one could operate the device”
  - This is NOT allowed, accidents happen
- In the past, we performed “zero voltage” with a proximity tester
  - NOT ALLOWED – proximity testers do NOT measure 0 Voltage, do NOT meet NFPA 70E, and have many failure modes
- Some believe that R&D equipment is exempt from LOTO
  - Not true, although there are alternate ways to meet LOTO
- In the past, we allowed one lock to protect many workers
  - NO

LOTO does NOT apply to plug control

- This one is confusing.
- Although a lockout device is not required for cord and plug equipment, OSHA, NFPA 70E, and DOE state that, “The plug must remain in the worker’s control at all times.”
- A lockout device must be used if there is any potential loss of control of the plug by the workers.

Old Practices – from our past – at home

- Eye protection
  - I don't really need eye protection while mowing, hammering, using a chain saw, or jump starting my car.
  - I will squint, look the other way, stand to the side.
- Electrical grounds
  - I live in an old house/apartment in Los Alamos, built in the 50s or 60s. There are no grounds in my outlets. I will just defeat the grounds of modern appliances.
- Electrical work
  - I am such a smart person, working at such a prestigious place. I can do my own electrical work at home. I can fix anything.
  - Common errors – reverse polarization, undersized wiring, unsafe connections, open grounds, overloaded circuits
- Working hot
  - I can work hot, I will just be careful.
  - A recipe for death

Myths

- 120 V shocks are not dangerous, I can work alone on a live circuit
- A GFCI will protect me from shock while I work on the equipment
- Carpet shocks are harmless
- Those receptacle caps will protect children from inserting objects into the outlet
- If my appliance starts arcing, I can always turn it off or unplug it, before my house burns down
- I can do this task safely, because I always have, and I don't need: an IWD, a second person, PPE
- I can manage an outdoor campfire in the national forest, during a High Fire Danger, because I will keep it under control

Myth - 120 V shocks are not dangerous, I can work alone on a live circuit

- Most of us have experienced a 120 V shock. Not too bad, right?
- Many people survive car crashes, trips, gun shots, and 120 V shocks, BUT, many people die.
- Nearly 100% of all electrocutions in the home were from 120 V. Not all were in wet environments.
- There are many uncontrolled factors that can cause that “mild” 120 V shock to be fatal.
  - Sweaty hands
  - Cut on hand
  - Barefoot
  - Unknown heart condition
  - Becoming stuck on the circuit

Myth - A GFCI will protect me from shock while I work on the equipment

- A ground fault circuit interrupter (GFCI) detects ONLY escaped current through a leakage path to ground. This is usually caused by water penetrating an equipment enclosure and bringing electricity into the user environment.
- A GFCI will NOT detect, nor prevent shock through the user who is across the two current carrying conductors.
- Essentially, if you get across the Hot and Neutral (black and white) wires, even on a GFCI circuit, you will be shocked and may die.

Myth – Carpet shocks are harmless

- An Electrostatic Discharge (ESD), such as a carpet shock, is a shock of 10, 000 to 20,000 Volts and 10 Amps. But, it only transfers 0.01 Joules of energy, and can not cause bodily harm from the shock.
- BUT, the majority of fires at the gas pumps are caused by ESD from
  - Sliding across the car seat, or taking of a coat
  - Filling a gas can in the trunk or a car or bed of a truck
- In addition, ESD can kill in the following environments:
  - Any hazardous location, such as paint spraying, find dusts, flammable gases
  - Working with explosives, including detonators, firing caps, gunpowder, etc.
- It is a myth that cell phones are a hazard at the gas pump. All gas pump fires are caused by smoking or ESD.

Myth - Those receptacle caps will protect children from inserting objects into the outlet

- As soon as a child sees another person remove the “child-proof” cover or cap, they know how to remove it. Children are observant, smart and quick learners.
- The majority of electrical injury to small children is from sticking metal objects into the outlet. This occurs even on the old, self applied devices.
- Thus, the 2008 NEC requires child proof devices internal to the outlet, on all new home construction.

Myth - If my appliance starts arcing, I can always turn it off or unplug it, before my house burns down

- If you are using an appliance in the kitchen and are present at all times, then if it begins to smoke, arc, or burn, you could possibly turn it off, unplug it, call the fire department, or evacuate before you are injured.
- BUT, many houses burn down, and people die, because an unattended appliance arcs and sparks while sleeping, or not present.
- Thus, the NEC now requires ALL receptacles in the home to be on Arc Fault Circuit Interrupters (AFCIs)

Myth - I can do this task safely, because I always have, and I don't need: an IWD, a second person, PPE

- "Getting by with it" is NOT a good reason to work unsafely. One day you will "get caught" and be seriously injured or die
- Working safely and following the rules keeps you alive and safe

Myth - I can manage an outdoor campfire in the national forest, during a High Fire Danger, because I will keep it under control

- Many forest fires are caused by unattended campfires.
  - Dome fire
- Even though many campers and national park superintendents believe that they have control of their campfire or “controlled burn,” they do not.
- 80% of all campfires are NOT properly extinguished

Understanding Electricity

- Electricity is the silent killer, and is greatly misunderstood by most people, even those with a technical education.
- Strive to understand the hazards, teach your family and friends, and FOLLOW safe practices

Your past

- Human Performance?
  - Even with the best program, up-to-date training, and excellent safe work practices we:
    - STILL MAKE MISTAKES
    - How do we recognize and prevent human error?

Human Performance in Electrical Work

- Causes of electrical accidents/incidents
- Recent electrical incidents
- The “Final Frontier” – Human Performance
- How can we improve Human Performance?

Causes of electrical accidents/incidents at work

- Inadequate electrical safety program
- Inadequate or incomplete training
- Lack of implementation of electrical safety program
- Goofs (human error)

Causes of electrical accidents/incidents at home

- Ignorance
- Lack of respect for the hazard
- Self confidence, arrogance
- Short cuts
- Goofs (human error)

Historical electrical incidents at LANL

- 1996 – inadequate electrical safety program
  - Continuous major improvement from 1996 – 2007
  - Gradual minor improvement 2007 - present
- 2007 – 2011 – lack of implementation
  - 2009 – programmatic
  - 2010 – construction projects
  - 2011 – subcontractors
- 2012 – 2013
  - Human Performance

How can we improve Human Performance?

- Believe in, and follow requirements
- Remember fundamental assumptions about work
- Recognize and avoid old practices
- Understand and defeat myths
- Continually watch for decision points
- Be diligent throughout
- Question your actions, knowledge, experience

Believe in, and follow requirements

- All electrical safety requirements evolved due to injury and/or death
- No matter how experienced and accident free you are, accidents can happen to you

Pitfalls in performing work safely

- Work changes, sometimes slowly
  - New workers come on board
  - Tasks slowly evolve or change
  - A new task enters into the work
  - The work moves from nonhazardous to hazardous, even though the hazard may seem small
- No work control process (IWD) can anticipate every possible variation in the work process

How to avoid the “wrong path” in decisions

- Requirements change! If you are unsure what are current requirements, then check!
- If you find yourself suddenly performing work that seems unfamiliar, or that you might not have done before, PAUSE, review your Electrical Worker Qualification Form and the requirements.
- ALWAYS ask yourself, do I need an IWD to do this?
- Be very careful using the term “scoping work”

Guide to performing electrical work

- Performing electrical work daily becomes routine and we “let our guard down.” What can we do?
  - Maintain awareness of your actions and conditions
  - Take “pause points” to ask yourself key questions
  - Watch for changes in the situation

Some key elements to an electrical pre-job brief

- Do we have the IWD here? Is it current?
- Does the IWD cover this work that we are about to begin?
- Was this electrical IWD reviewed by an ESO and authorized by an RLM?
- Is every worker's training adequate for this job?
  - EWQF, electrical training and Demonstration of Proficiencies
- Are our PPE, meters, ground sticks, and other electrical tools adequate, up-to-date, and inspected?
- Do we all have experience at this task, and have we done it before?
- But, what might be different this time?
- Do we all understand PAUSE/STOP WORK?
- And more

ASK yourself before touching

- Before touching an electrical circuit with your hands or tools:
  - Is MY lock in place? Or do I have control of the plug?
  - Did I perform a zero voltage (with a meter) or zero energy (with a ground stick) test? Or observe someone else perform it?
  - Can there be any other electrical source to this circuit?
  - Is it possible that the configuration has changed since I applied my lock, or unplugged the circuit.
  - Is there any other electrical source (other circuit, battery, capacitor) in this enclosure, rack, or nearby; that could sneak into my work?

Questions during your work – ask yourself often

- Have I done this task before?
- Do I have the training to do this?
- Was this task discussed in the pre job brief?
- Has any new worker entered into this work who was not at the pre-job brief? Are they on the IWD? Do they have their lock in place?
- Did we take a break, or have an interruption? Did we forget where we were in the process? Do we need a mid-job brief? Did anything change?
- Do I have any concerns about the safety of this task?

Reasons to Pause

- I am not sure if my Electrical Worker Qualification Form (EWQF) shows that I can work:
  - On this hazard class
  - In this mode
  - On this type of equipment
- This is an unfamiliar task, I am not sure that I have ever done this before
- I (we) can not remember the requirements, for sure
  - Electrical, LOTO, or IWM
- I can't remember if we discussed this in the pre-job brief
- Is this task in the IWD?

Remembering Requirements

- Requirements Change!
  - Many of you have worked for 10, 20, or 30 years.
  - Requirements evolve and change, including:
    - 70E, LOTO, Electrical Safety, IWM, PPE, DoP, etc.
- If ever in doubt as to what is the exact requirement, PAUSE, ask, and find out
- There are many examples, I am collecting them

Can an IWD be perfect?

- Despite the requirement for an IWD to cover all of the work, it is often impossible to anticipate ALL possible work tasks when writing an IWD.
- This is absolutely true in:
  - Troubleshooting equipment
  - Development
- Thus, in such cases, we write IWDs with a broader scope, allowing some real time judgment by the experienced worker, i.e., “skill of craft”
- BUT, implement the following:
  - Bounds must be set in the IWD on hazard classes, modes, personnel, etc.
  - If you go outside the bounds set in the IWD, and thus potentially outside the controls set by the IWD, you MUST stop and revisit the IWD.
- CAUTION – new, or less experienced workers, or experienced workers who have not performed this type of work in a while, are VULNERABLE to error in judgment.

Hazard Analysis – still sometimes overlooked

- Hazard analysis is essential to choose the correct protective controls
- Priority One, urgent, or emergency electrical work is NOT exempt from electrical hazard analysis.
- Hazard analysis must be done even if you do not have an IWD.
- Hazard analysis must be done BEFORE
  - Removing the cover
  - Using a meter or ground stick
  - Entering the Limited or Arc Flash Boundaries

Reporting Electrical Incidents

- It is essential to report any abnormal, unexpected, or hazardous electrical incident or situation, why?
- Today's arc, spark, damaged equipment or "mild" shock, is tomorrow's injury and death.
- Report it NOW to:
  - Make sure everyone is OK
  - Prevent further exposure
  - Better understand the equipment, situation
  - Learn, share, improve

Take our safety processes home – apply these in your yard work, home repair, auto repair, and recreational activities

- Train and educate
  - Teach your children to understand and respect hazards
  - Electricity, fire, water, lightning, tools, cars, rotating machines, heights, etc.
- Hazard analysis
  - Perform a hazard analysis for all home and recreational activities
  - e.g., hiking – bears, lions, scorpions, coyotes; poisonous plants; slips, trips, and falls; heat exhaustion, dehydration; sunburn; blisters
- Develop controls
  - PPE, 2nd person, work or recreation plan, pre-job brief
- Hold a prejob brief
  - Before skiing, camping, wilderness hiking, wood cutting, rafting, working on the car, remodeling, etc.
  - Engage all participants

Resources for YOU

- Electrical Safety Committee (28 members)
  - Chair – Jackie Mirabal
  - Vice chair – Dean Barr
- Electrical Safety Officers (ESOs)
  - Chief ESO – Lloyd Gordon
  - Division ESOs - 40
  - Group ESOs - 160
- Your managers and mentors
- ESC website, many resources and tools