

Human Performance and Electrical Safety.

What does the employer need to know?

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Online Evaluation



Objectives

- What is “human performance”?
- How does it impact safety?
- The employers risk assessment procedure
- The hierarchy of risk controls
- Human error
- Identifying the potential for human error
- The principles of human performance



Objectives

- How employees process information
- Typical error modes
- Error precursors (how do we identify them?)
- Warning flags
- Human performance tools
- Methods to involve the entire company/organization to improve safety and the job-site *culture*



Objectives

- Our presentation and discussion today revolves around human performance and electrical safety
- Human performance impacts much, much more!
- Not limited to electrical hazards, all hazards
- Productivity
- If we want to be successful we must address human performance in all disciplines



Human Performance (HP)

- In the context of safe electrical work practices, what is HP?
- It is our human contribution to the overall performance of the electrical safety program
- Who does this apply to, just JW and apprentices right?
- NO! It applies to everyone in your organization from the owner to the brand new apprentice
- Every requirement in NFPA 70E intends to impact HP



Human Performance (HP)

- A common misconception is that human error occurs only at the point of failure, the incident
 - This mindset immediately assigns responsibility to the injured worker
 - They should have known better
- Is that always the case?
- Can the failure of HP in the managerial chain upstream be responsible?



Human Performance (HP)

- HP is:
 - how we go about our job
 - how do we perform each task or directions given
 - Is our head in the game?
 - Have we performed required risk assessments?
 - Did we perform them properly?
- People are in many cases the source of risk
- In all cases, people are an integral part of identifying and managing risk
- The answer is under our nose, it is our people



Human Error

- What is human error?
- What do you think it is?
- Human error is a label or a tag applied to any action that has a negative consequence or an action that does not achieve the desired goal
- There is research that suggests we make a lot of errors
- 3 to 6 per hour... 50 per day or per shift



Human Error

- Does human error impact you? It impacts me...
- Ever sent an email and forgot the attachment?
- Ever sent an email and want it back?
- Made a left turn when today it should have been a right?
- Walk into a room and forget why you went there?
- Added a tbsp instead of a tsp in recipe?
- Human error does not always result injury



Safety Programs

- Safety programs are developed and implemented to prevent injury
- All safety programs (regardless of type) address human performance
- To get there we build the best safety programs, policies and procedures
- The effectiveness of the program is impacted significantly by human behavior
- Are your programs effectively applied at all levels?



Electrical Safety Program (ESP)

- NFPA 70E requires the employer implement and document an overall ESP
- This program must direct activity appropriate to the risk associated with electrical hazards
- Who is the employer?
- The program addresses work practices and administrative controls



Electrical Safety Program (ESP)

- The ESP requires:
 - Elements that consider the condition of maintenance and the equipment operating condition
 - Awareness and self-discipline
 - Procedures utilized before work begins
 - Risk assessment procedure
 - Job safety planning and briefing
 - Incident investigations
 - ESWC policy
 - LOTO Program
 - Auditing



ESP, risk assessment procedure

- The ESP must include a risk assessment procedure
- Elements of this procedure must include:
 - “NFPA 70E: The risk assessment procedure shall address employee exposure to electrical hazards and shall identify the process to be used before work is started to carry out the following:
 - Identify hazards
 - Assess risks
 - Implement risk control according to the hierarchy of risk control methods”
- This should apply to all hazards! (JSA/JHA)



ESP, risk assessment procedure

- What is risk? Risk assessment?
 - Defined in Article 100
- Can your employees define “risk”?
- They will immediately mention their 401k and stock market volatility!
- We need to do a better job making sure they understand
- **Risk.** A combination of the **likelihood of occurrence of injury or damage to health** and the **severity of injury or damage to health** that results from a hazard.



ESP, risk assessment procedure

- Likelihood?
- Likelihood + Severity = RISK
- **Risk Assessment.** An overall process that identifies hazards, estimates the likelihood of occurrence of injury or damage to health, estimates the potential severity of injury or damage to health, and determines if protective measures are required.
- Informational Note: As used in this standard, *arc flash risk assessment* and *shock risk assessment* are types of risk assessment



ESP, risk assessment procedure

- Can human performance be impacted by *risk assessments*?
- Everyone performs risk assessments every day
- When was your last risk assessment performed?
- Would your employer and your family be happy with the risks you take?
- Would you be happy if you knew what others were doing?
- An example is helpful, let's walk through the risk assessment procedure together



Risk Assessment



- Doing 65 mph
- A text comes in.....
- You reach for your cellphone
- Oh no, you were supposed to take care of this.....
- Your thumb is not opening the phone
- A six digit code must be entered while doing 65mph in a 4 ton vehicle



Risk Assessment, it is a PROCESS



- (1) Can you identify a hazard
- (2) Estimate the likelihood of occurrence
- (3) Estimates potential severity
- (4) Determines if protective measures are required



Risk Assessment



- Now we can understand the mindset of the JW as they approach an energized panelboard
- They know hazards exist
- They instantly, and subconsciously make a determination that there is no likelihood of occurrence
- Because..... Well, they do this all the time!



ESP, risk assessment procedure

- The ESP must address **the potential for human error**
 - Negative consequences on people, processes and equipment relative to the electrical hazard(s)
- An IN in this section informs the standard user that their risk assessment procedure could include identifying when a second person is required



ESP, risk assessment procedure

- The risk assessment procedure:
 - (1) Identify hazards
 - (2) Assess risks
 - (3) Implement risk control according to the hierarchy of risk control methods
- Required shock and arc flash risk assessments include all three steps
- (1) Identify hazards, *shock/arc flash*
- (2) Assess risks, *voltage, ASCC, clearing times*
- (3) Implement risk control according to the hierarchy of risk control methods



ESP, risk assessment procedure

- “**Hierarchy of Risk Control Methods.** The risk assessment procedure shall require that preventive and protective risk control methods be implemented in accordance with the following hierarchy:
 - Elimination
 - Substitution
 - Engineering controls
 - Awareness
 - Administrative controls
 - PPE”



Hierarchy of Risk Control Methods

- The purpose of these controls is to either:
 - Reduce the likelihood of an incident occurring or to
 - Prevent or mitigate the severity of consequence
- No control is infallible
- All of the controls are subject to errors in human performance, whether at the design, implementation, or use phase.



Table F.3 The Hierarchy of Risk Control Methods

Risk Control Method	Examples
(1) Elimination	Conductors and circuit parts in an electrically safe working condition
(2) Substitution	Reduce energy by replacing 120 V control circuitry with 24 Vac or Vdc control circuitry
(3) Engineering controls	Guard energized electrical conductors and circuit parts to reduce the likelihood of electrical contact or arcing faults
(4) Awareness	Signs alerting of the potential presence of hazards
(5) Administrative controls	Procedures and job planning tools
(6) PPE	Shock and arc flash PPE



Principles of Human Performance

- People are fallible, and **even the best people make mistakes.**
- Error-likely situations and conditions are **predictable, manageable, and preventable.**
- Individual performance is influenced by organizational processes and values.
- People achieve **high levels of performance largely because of the encouragement and reinforcement received from leaders, peers, and subordinates.**
- Incidents can be avoided through an understanding of the reasons mistakes occur and application of the lessons learned from past incidents.



Human Performance, we already understand!

- HP plays a role in everything we do!
- People achieve **high levels of performance largely because of the encouragement and reinforcement received from leaders, peers, and subordinates.**
- Attaboys go a long, long way!!!!
- When we **encourage and reinforce** any behavior, it is strengthened and employees will replicate that behavior *on their own!*
- But you already knew that.....



Raising children..... HP, yes!

- A ten year old is playing intramural baseball
- They strike out four times, never made contact
- Dropped a fly ball
- At the end of the game, they are feeling lousy about their performance
- What do you do?
- You encourage, identify little things that went right, the good catch, good throw, the EFFORT!
- You promise to help, to practice to get better
- That's HP! That's a CORE VALUE!



HP Modes and Associated Errors

- There are three HP modes
- *Rule-Based* Performance Mode
- *Knowledge-Based* Performance Mode
- *Skill-Based* Performance Mode



Rule-Based Mode

- The Rule-Based Performance Mode occurs when the employee:
 - Has encountered this task or issue before or
 - Has been trained to deal with this task or issue or
 - It is covered by a procedure
 - The employee is applying memorized or written rules
 - Information processing occurs in seconds
 - In theory, this is the most desirable mode
 - An experienced worker may unconsciously default to skill-based mode



Rule-Based Mode Errors

- The Rule-Based Performance Mode is essentially an “if X, then Y”
- Misinterpretation is the most prevalent error
- Workers may deviate from a procedure
- Workers may apply the correct procedure to the wrong situation



Knowledge-Based Mode

- Applies where there is uncertainty about what to do
- No skill or rule seems to apply
- Worker must rely on their own understanding and knowledge of the situation
- They need information.. uncertainty requires focus
- Time and energy must be devoted making the response time minutes to hours



Knowledge-Based Mode Errors

- The prevalent error is an inaccurate mental picture of the situation
- Decisions are made through problem solving
- This can be an unfamiliar situation with high stress
- Workers must “think on their feet”
- The tendency is to focus on limited information, one aspect of the problem, others get excluded
- Decisions are flawed when problem solving is based on incomplete or inaccurate information



Skill-Based Mode

- Applies in common or familiar situations
- A task practiced many times
- The worker is following their own mental instructions based on experience and not external conditions
- Decision response time is fast, milliseconds
- Writing your signature is a skill-based task



Skill-Based Mode Errors

- There is a low demand on attentional resources
- Primarily execution errors
- Perceived reduction in risk. As familiarity increases the workers perception of risk is compromised
- This perceived reduction in risk (they are comfortable) results in “inattentional blindness” and an insensitivity to the hazards that exist



HP Modes and Associated Errors

Modes of Error	
Rule-Based Performance Mode	Inattention
Knowledge-Based Performance Mode	Inaccurate mental picture
Skill-Based Performance Mode	Misinterpretation



Error Precursors

- What is a precursor?
 - A fore runner, something happens or exists and developed or influenced an outcome
 - The first robin is a precursor of spring
- Precursors are situations where the task demands and the environment exceed individual capabilities
- Error precursors can be unfavorable conditions that increase the probability of an error



Error Precursors

- **Task Demands:** when specific mental, physical, or team requirements to perform a task either exceed the capabilities or challenge the limitations of the individual assigned to the task.
- Task demands include but are not limited to:
 - Time pressure, in a hurry
 - High workload, memory
 - Multiple tasks
 - Repetitive, monotonous tasks
 - Unclear goals, roles or responsibilities



Error Precursors

- **Work environment:** when general influences of the workplace, organizational, and cultural conditions affect individual performance.
- Work environment includes but is not limited to:
 - Distractions, interruptions
 - Change in scope, not routine
 - Unexpected equipment conditions
 - Personality conflicts



Error Precursors

- **Individual capabilities:** when an individual's unique mental, physical, and emotional characteristics do not match the demands of the specific task
- Individual capabilities includes but is not limited to:
 - First time performing this task
 - Lack of knowledge
 - New technique, not previously used
 - Weak problem solving skills
 - Poor communication skills



Error Precursors

- **Human nature:** when traits, dispositions, and limitations common to all persons incline an individual to err under unfavorable conditions.
- Human nature includes but is not limited to:
 - Stress
 - Assumptions
 - Mind set
 - Mental short cut or limited short term memory
 - Complacency/Overconfidence
 - Inaccurate risk perception



Human Performance Tools

- HP tools reduce the likelihood of error when applied to error precursors
- **Consistent** use of human performance tools by an organization will facilitate the incorporation of *best practice work*.
- **Job Planning and Pre-Job Briefing Tool**
- Create a job plan and conduct pre-job briefings to assist personnel to focus on the performance of the tasks and to understand their roles in the execution of the tasks.



Human Performance Tools

- **Job Planning and Pre-Job Briefing Tool**
- Summarize the critical steps of the job that, **if performed improperly**, will cause irreversible harm to persons or equipment, or will significantly impact operation of a process.
- **Anticipate error precursors** for each critical step.
- **Foresee probable and worst-case consequences** if an error occurs during each critical step.
- **Evaluate controls or contingencies** at each critical step to prevent, catch, and recover from errors and to reduce their consequences.
- Review **previous experience and lessons learned** relevant to the specific task and critical steps.



Human Performance Tools

- **Job Site Review Tool.**
- Incorporating a job site review into job planning **facilitates the identification of hazards and potential barriers and delays**. A job site review can be performed any time prior or during work.
- **Post-Job Review Tool.**
- A post-job review is a positive opportunity to capture feedback and lessons learned from the job that can be applied to future jobs. The use of or lack of use of human performance tools should be incorporated into the review.



Human Performance Tools

- **Procedure Use and Adherence Tool.**
- Adhering to a written step-by-step sequential procedure is a human performance tool.....
- An accurate and current account of progress should be kept by marking each step in the procedure as it is completed.....
- If the procedure cannot be used as written, or if the expected result cannot be accurately predicted, then the activity should be stopped and the issues resolved before continuing.
- An example.... is a switching sequence, wherein the sequential order of operation of electrical distribution equipment is identified and documented for the purposes of de-energizing and re-energizing.



Human Performance Tools

- **Self-Check with Verbalization Tool.**
- The self-check with verbalization tool is also known by the acronym STAR — Stop, Think, Act, and Review. Before, during, and after performing a task that cannot be reversed, the worker should stop, think, and openly verbalize their actions.
- Verbalizing permits the individual's brain to slow down to their body speed. It has the effect of keeping the individual focused, thus enabling them to act and then review their actions.
- Do you talk to yourself?



Human Performance Tools

- **Self-Check with Verbalization Tool.**
- Example: A worker has one more routine task to complete before the end of shift — to approach a group of motor control panels and close a circuit breaker in one of those panels. The error precursors are task demands (in a hurry) and human nature (complacency). **If the worker verbalizes each step in the task and the expected outcome of each step, he or she is less likely to operate the wrong circuit breaker** and will be prepared in the event that the outcome of an action does not match the expectation.



Human Performance Tools

- **Self-Check with Verbalization Tool.**
- For example, the worker self checks and verbalizes:
 - I am at Panel 12 Bravo (12B).
 - I am about to close Circuit Breaker 4 Bravo (4B).
 - The pump motor heater indicator light will engage bright red on Panel 10 Bravo (10B).
 - The pump motor should not start.
 - If the pump motor starts then I will open Circuit Breaker 4 Bravo.
 - I am now closing Circuit Breaker 4 Bravo.



Human Performance Tools

- **Three-Way Communication Tool.**
- The three-way communication tool facilitates a mutual understanding of the message between the sender and receiver. After a directive or statement is made by the sender, it is repeated by the receiver to confirm the accuracy of the message.
- When the message includes the use of letters, then whenever possible the letters should be communicated using the phonetic alphabet.



Human Performance Tools

- **Three-Way Communication Tool.**
- Example: A sender issues a directive over a radio communication device: “Close circuit breaker 4 Bravo.” The receiver repeats the message: “I understand, close circuit breaker 4 Bravo.” The sender validates that the proper response was understood: “That is correct” or “Affirmative.”



Human Performance Tools

- **Stop When Unsure Tool.**
- When a worker is unable to follow a procedure or process step, if something unexpected occurs or if the worker has a “gut feeling” that something is not right, then the worker should stop and obtain further direction. The “stop when unsure” tool requires that the worker maintain a questioning attitude at all times.
- Phrases such as “I think” or “I’m pretty sure,” whether verbalized or not, indicate that the worker is in knowledge-based mode and needs to transition to rule-based mode. This transition should be communicated to co-workers.



Human Performance Tools

- **Flagging and Blocking Tools**
- Flagging is a method to ensure the correct component is manipulated or worked on at the required time under the required conditions. A flag could be a marker, label, or device.
- It should be used when an error-likely situation or condition is present, such as one of the following:
 - (1) Similar or “look-alike” equipment
 - (2) Work on multiple components
 - (3) Frequent operations performed in a short period of time
 - (4) Interruption of process critical equipment



Human Performance Tools

- **Flagging and Blocking Tools**
- **Blocking** is a method of physically preventing access to an area or equipment controls.
- Hinged covers on control buttons or switches, barricades, fences or other physical barriers, whether temporary or permanent, are examples of blocking tools.
- Blocking can be used in conjunction with flagging.



Human Performance Warning Flags

- **Human Performance Warning Flags.**
- **General.**
- **Program or Process.**
- **Organizational Performance.**
- **Supervisory Performance.**
- **Worker Performance.**



Workplace Culture

- **What is a safety culture?**
- A safety culture is an organizational culture that places a high level of importance on safety beliefs, values and attitudes—and these are shared by the majority of people within the company or workplace. It can be characterized as **“the way we do things around here”**



Workplace Culture

- **General.** The reduction or elimination of electrical incidents requires that all members at the workplace cultivate and consistently exhibit a culture that supports the use of human performance tools and principles. Workers, supervisors, and managers must all work together to implement strong human performance practices.



Workplace Culture

- **Workers.**
-Five general practices that should be consistently demonstrated by workers include the following:
- (1) **Communication** to support a consistent understanding
- (2) Anticipation of error-likely situations and conditions
- (3) *Desire to improve personal capabilities*
- (4) Reports on all incidents (including “near-miss” incidents)
- (5) **A commitment to utilize human performance tools and principles**



Workplace Culture

- **Supervisors and Managers.**
- Through their actions, supervisors focus worker and team efforts in order to accomplish a task. To be effective, supervisors must understand what influences worker performance. **Supervisors promote positive outcomes into the workplace environment to encourage desired performance and results.** Supervisors must demonstrate a passion for identifying and preventing human performance errors. They influence both individual and company performance in order to achieve high levels of workplace electrical safety.



Workplace Culture

- **Supervisors and Managers.**
- Five general practices that should be consistently demonstrated by supervisors include the following:
- (1) Promote open communication
- (2) Encourage teamwork to eliminate error-likely situations and conditions
- (3) Seek out and eliminate broader company weaknesses that may create opportunity for error
- (4) **Reinforce** desired workplace culture
- (5) Recognize the value in *preventing errors*, reporting of *near-miss incidents*, and the utilization of *human performance tools and principles*



Workplace Culture

- **The Organization.**
- It is important that an organization's procedures, processes, and values recognize and accept that people make mistakes. The policies and goals of an organization influence worker and supervisor performance.



Workplace Culture

- **The Organization.**
- Five general practices that should be consistently demonstrated by an organization include the following:
 - (1) Promote open communication
 - (2) Foster a culture that values error prevention and the use of human performance tools
 - (3) Identify and prevent the formation of error-likely situations and conditions
 - (4) **Support continuous improvement** and learning across the entire organization
 - (5) **Establish a blame-free culture** that supports incident reporting and proactively identifies and reacts appropriately to risk



Questions?

- Thanks!
- Jim Dollard



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