Best Practices to Improve Your Company’s Safety Culture

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Westex by Milliken

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Agenda

• Best Practices to Improve Your Company’s Safety Culture
• NFPA 70E Risk Assessment Procedure – Human Error
• Annex Q – Human performance and improved Safety Culture
• PPE Program Types and Best Practices
• NFPA 70E – key PPE changes
• Burn Injury and Cost
• Comfort and Heat Stress
• Summary
• Questions

Changes to NFPA 70E

2018 edition released in Fall 2017

• Several significant changes related to the risk assessment procedure and AR/FR clothing that affect PPE Best Practices

Changes affecting arc flash PPE
For Reference of NECA Now 2019
Attendees Only

NFPA 70E  110.1 (H) Risk Assessment Procedure

New: (2) Human Error
“The risk assessment procedure shall address the potential for human error and its negative consequences on people, processes, the work environment, and equipment.”

“Informational Note: the potential for human error varies with factors such as tasks and the work environment. See Informative Annex Q.”

New: (3) 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:
  ▪ (1) Elimination
  ▪ (2) Substitution
  ▪ (3) Engineering controls
  ▪ (4) Awareness
  ▪ (5) Administrative controls
  ▪ (6) PPE

No control is infallible. All of the risk controls are subject to errors in human performance.
Info. Annex Q - Human Performance and Electrical Safety

- Human Performance: aspect of Risk Management that addresses organizational and individual performance as factors that either lead to or prevent errors and their events
- Human performance addresses human error as a unique control that is complementary to the hierarchy of risk controls

Principles of Human Performance
1) People are fallible
2) Error-Likely situations/conditions are predictable, manageable and preventable
3) Individual performance is influenced by organizational processes and values
4) People achieve high levels of performance from encouragement from leaders and peers
5) Incidents can be avoided by understanding reasons mistakes occur and lessons learned

Annex Q: Human Performance Modes and Assoc. Errors

- Human Performance Modes – 3 modes
- Rule Based Mode: Person trained to use, covered by a procedure
  Follows, IF (symptom X), THEN (situation Y) logic, most desirable human performance mode, since person can think, challenge proposed solution as appropriate. Conscious thinking/challenging can add to error prevention.
  
  Common Error in Rule Based Mode: Misinterpretation

  Since using IF-THEN logic; misinterpretation can happen, errors involve deviation from approved procedure, applying incorrect response to a work situation
Annex Q: Human Performance Modes and Assoc. Errors

• Human Performance Modes – 3 modes

• Knowledge Based Mode - worker operates in mode when there is uncertainty about what to do, no rule or skill based mode identifiable.

Person relies on their understanding and knowledge of the situation. The uncertainty creates need for more information, forces individual attentional resources to become more focused, and can take more time and energy to select an appropriate response.

Common Error: Inaccurate mental picture of situation. Stress, unfamiliar situations without rules, procedures tend to lead people to use only readily available information and focus on only one aspect of problem. Incomplete or inaccurate info.= Erroneous decision making!

• Skill Based Mode – person in this mode is usually executing a task that has been practiced, in a very familiar, common situation/environment.

Time devoted to processing information is usually milliseconds.

Example: writing one’s signature, doing a very familiar workplace task

Common Errors: Inattention- execution errors involving omissions and/or not recognizing changes in task requirements or work conditions

Perceived reduction in risk, Over confidence, complacency
Info. Annex Q - Human Performance and Electrical Safety

• Error Precursors

• Error Precursors are situations when the demands of the task and the environment it is performed in exceed the capabilities of the worker or the limitations of human nature.

• Also, precursors can be unfavorable conditions that increase the probability for error during a specific work task

• Grouped in four broad Categories

<table>
<thead>
<tr>
<th>Error Precursors</th>
<th>Optimal Tool(s)</th>
<th>Human Performance Tool(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task Demands</td>
<td>Time Pressure (In a Hurry)</td>
<td>Pre-Job Briefing</td>
</tr>
<tr>
<td>Work Environment</td>
<td>Distractions / Interruptions</td>
<td>Self Check with Verbalization (STAR)</td>
</tr>
<tr>
<td>Individual Capabilities</td>
<td>Lack of knowledge (Faulty Mental Model)</td>
<td>Stop when unsure</td>
</tr>
<tr>
<td>Human Nature</td>
<td>Complacency / Overconfidence</td>
<td>Job site review</td>
</tr>
</tbody>
</table>
Human Performance Warning Flags

• Warning flags for Performance-workers, supervisors, org.

Organizational Performance Flags

• Engage in consensus or group thinking, without counter view pts.
• Personnel over defer to managers and perceived experts
• Activities with high risk are not assigned clear owners
• The organization assumes risk mgmt. is healthy because a program or process was established (i.e. complacency exists)
• Past success without adverse outcomes becomes the basis for continuing current practices. (i.e. complacency)

Info. Annex Q - Human Performance and Electrical Safety

• Workplace Culture
• Promote open communication
• Foster a culture that values error prevention and the use of human performance tools
• Identify and prevent the formation or error-likely conditions
• Support continuous improvement and learning across organization
• Establish a blame-free culture that supports incident reporting and proactively identifies and reacts appropriately to risk
PPE Culture: Top Reasons Employees Fail to Don PPE

- Forgetfulness: “I just forgot”
- Misunderstanding: “I didn’t know”
- Fearlessness, Overconfidence, Complacency: “I won’t get in an accident”, “I’ve gone my entire career without an accident”, “that only happens to other people”
- Time Constraints: “I didn’t have time”, “it takes too much time”
- Discomfort: “It doesn’t fit right”, “it’s not comfortable”

Types of AR/FR Clothing/PPE Programs

“Task Based”
- Proper AR/FR clothing is put on to perform a specific task

“Daily Wear”
- Proper AR/FR clothing is worn at all times during work hours
Cultural Risk with Task Based PPE Programs

A significant amount of arc flash incidents occur involving either brand new employees or the most experience employees.

Task based PPE Cultural Risk

Low Energy Tasks and Complacency

• PPE Category 1 and 2 type tasks-Will workers consistently don PPE at the appropriate time? Complacency!

• Normalization of Deviance- The gradual process through which unacceptable practices and standards become acceptable. As the deviant behavior is repeated without catastrophic results, it becomes the social norm of the organization.

• Complacency is usually one of the root causes of electrical incidents at 480V. Considered low voltage, but it is the #1 killer in the electrical industry in terms of fatal incidents.

• AR/FR clothing is a SEAT BELT!
Task based vs. Daily wear: Upfront Cost Comparison

(number of employees) \times (cost of the garments per employee) = total initial cost of program

Cost Comparison

Upfront Cost

Long term cost
- effected by potential liability, medical costs and decreased productivity
Upfront and Long Term Cost Comparison

Task based programs have less upfront cost but may have significantly higher long term costs

<table>
<thead>
<tr>
<th>Level of Risk</th>
<th>Daily Wear</th>
<th>Task Based</th>
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<tbody>
<tr>
<td>Low</td>
<td><img src="images/natural_fiber_uniforms.png" alt="Natural fiber uniforms" /></td>
<td><img src="images/natural_fiber_uniforms.png" alt="Natural fiber uniforms" /></td>
</tr>
<tr>
<td>Medium</td>
<td><img src="images/natural_fiber_uniforms.png" alt="Natural fiber uniforms" /></td>
<td><img src="images/natural_fiber_uniforms.png" alt="Natural fiber uniforms" /></td>
</tr>
<tr>
<td>High</td>
<td><img src="images/potential_costs.png" alt="Potential liability, medical &amp; productivity costs" /></td>
<td><img src="images/natural_fiber_uniforms.png" alt="Natural fiber uniforms" /></td>
</tr>
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Level of Risk

Task based program increases risk of catastrophic burn injury due to human error

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<td><img src="images/low_risk.png" alt="Low Risk" /></td>
<td><img src="images/high_risk.png" alt="High Risk" /></td>
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<tr>
<td>Medium</td>
<td><img src="images/medium_risk.png" alt="Medium Risk" /></td>
<td><img src="images/high_risk.png" alt="High Risk" /></td>
</tr>
<tr>
<td>High</td>
<td><img src="images/low_risk.png" alt="Low Risk" /></td>
<td><img src="images/high_risk.png" alt="High Risk" /></td>
</tr>
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</table>
### Risks Associated with Daily Wear FR Clothing Programs

<table>
<thead>
<tr>
<th>Risk</th>
<th>Liability Concern</th>
<th>Productivity Inhibitor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improper wear</td>
<td>🚫</td>
<td></td>
</tr>
<tr>
<td>Non-FR clothing overtop AR/FR clothing</td>
<td>🚫</td>
<td></td>
</tr>
</tbody>
</table>

### Risks Associated with Task Based FR Clothing Programs

<table>
<thead>
<tr>
<th>Task</th>
<th>Liability Concern</th>
<th>Productivity Inhibitor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Will the employee recognize the hazard? Complacency?</td>
<td>🚫</td>
<td></td>
</tr>
<tr>
<td>Do they have the clothing they are supposed to have with them? Will they put it on?</td>
<td>🚫</td>
<td></td>
</tr>
<tr>
<td>Put on over natural fiber clothing? Comfort = Protection = Productivity</td>
<td>🚫</td>
<td></td>
</tr>
<tr>
<td>If the clothing is out in the truck or in their locker, will they take the time necessary to go get it? Inconvenient?</td>
<td>🚫</td>
<td>🚫</td>
</tr>
<tr>
<td>Do other people who are assisting with electrical maintenance or working near where combustible dust is being cleaned up have the proper AR/FR clothing on?</td>
<td>🚫</td>
<td></td>
</tr>
<tr>
<td>Is the employee in a hurry because it is lunch time, the end of the day or they are on a tight job schedule? If so will they take the extra time to put on their AR/FR clothing?</td>
<td>🚫</td>
<td>🚫</td>
</tr>
</tbody>
</table>
Level of Risk Recap

- Risk associated with both types of FR clothing programs
- Significantly larger amount of risk associated with task based because of possibility of human error

Task based FR clothing programs chance of exposing flammable clothing to thermal hazard which can result in significant burn injury or even death

Dangers of Non-FR Clothing
AR/ FR Clothing – Westex UltraSoft®

Changes to NFPA 70E

2018 edition released in Fall 2017

• Several significant changes related to risk assessment procedure and AR/FR clothing

Changes affecting arc flash PPE
Employer and Employee Responsibilities

Employer Responsibility

• Requires safety related work practices and procedures- established, documented, and implemented and shall provide training in these practices.

Employee Responsibility

• Need to comply with the practices and procedures provided by employer

105.4 Priority in implementation- hazard elimination! De-energize!
Work energized only if de-energizing is
1) Infeasible, not inconvenient.
2) Creates greater hazards, more risk

Article 110
General Reqs. for Electrical Safety Related Work Practices

110.3 Host Employer and Contractor Employer Responsibilities

Examples of host employer in informational note helps provide clarity of who is truly responsible

Informational note:
Examples of a host employer can include owner or their designee, construction manager, general contractor or employer
New 130.5 (A) General

1) Identify arc flash hazards
2) Estimate the Likelihood of occurrence of injury and potential severity of injury
3) Determine if additional protective measures are required, including the use of PPE

Use of Table 130.5 (C) which was formerly Table 130.7 (C) (15) (A) (a)

Table 130.7 (C)(15)(A)(a) Now Table 130.5(C)

2015 Edition
- Table 130.7 (C)(15)(A)(a)
- Arc Flash Hazard Identification

2018 Edition
- Table 130.5(C)
- Estimate of the Likelihood of Occurrence of an Arc Flash Incident for ac and dc systems
Standards for PPE – 130.7 (C)(14)

Article 130 Work Involving Electrical Hazards

Conformity assessment requiring “All suppliers and manufactures of PPE shall demonstrate conformity with an appropriate product standard by one of the following methods.”

3 ways to comply:
1. Self declaration with supplier’s declaration of conformity - used today by PPE mfg. primarily
2. Self declaration under a registered quality management system, with accredited testing
3. Accredited, independent, third-party organization

ANSI ISEA 125  2014

<table>
<thead>
<tr>
<th>Level 1</th>
<th>Level 2</th>
<th>Level 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supplier testing</td>
<td>Supplier testing, ISO 17025-accredited lab</td>
<td>Independent third-party testing and certification</td>
</tr>
<tr>
<td>Quality management system tied to manufacture of the specified product</td>
<td>ISO 9001 registered quality management system tied to manufacture of the specified product</td>
<td>Quality management system as determined by the third-party certifier</td>
</tr>
<tr>
<td>Supplier declaration of conformity</td>
<td>Supplier declaration of conformity</td>
<td>Third-party mark, certification</td>
</tr>
</tbody>
</table>
Burn Injuries

The ATPV (Arc Thermal Performance Value) of arc rated clothing is the incident energy (cal/cm²) that produces a 50% of a 2nd degree burn through the fabric.

**FIRST-DEGREE BURNS**
- **DEPT**: Includes only outermost layer of skin, the epidermis.
- **H. OF LK**: No blisters, very pink or red.
- **H. OF FEL**: Very painful, tender and sore.
- **T. OF TAK**: 2-6 days with skin peeling.
- **SAR**: No major scaring, may have discoloration.

**SECOND-DEGREE BURNS**
- **DEPT**: Includes entire epidermis, upper layers of the dermis.
- **H. OF LK**: Pink or red in color; moist, oozing blisters.
- **H. OF FEL**: Painless.
- **T. OF TAK**: Less severe second-degree wound, 9-21 days, severe wound, 21-35 days.
- **SAR**: Minimal scaring, may have discoloration.

**THIRD-DEGREE BURNS**
- **DEPT**: Includes entire epidermis, dermis and extends into subcutaneous tissues.
- **H. OF LK**: Charred, leathery appearance.
- **H. OF FEL**: Very little pain or no pain.
- **T. OF TAK**: Small wounds, several months; large wounds may require skin grafting.
- **SAR**: Scarring present.

**FOURTH-DEGREE BURNS**
- **DEPT**: Includes all skin layers and subcutaneous tissues, extends into muscle and bone.
- **H. OF LK**: Black, charred, dry, crisp.
- **H. OF FEL**: Permanent nerve endings are destroyed.
- **T. OF TAK**: Burns in the affected area is lost or severely limited.
- **SAR**: Excision or amputation is typically needed.

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<table>
<thead>
<tr>
<th>Age</th>
<th>% of 2nd &amp; 3rd degree burns</th>
<th>Risk of death</th>
<th>Avg. hospital stay for survivor</th>
<th>Avg. cost per day</th>
<th>Total avg. cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>40- to 49 year old</td>
<td>50%</td>
<td>Almost 40%</td>
<td>3 days per % of body burn</td>
<td>$7,791</td>
<td>$1,168,650</td>
</tr>
</tbody>
</table>

- The risk increases with smoke inhalation.
- This does not include rehabilitation or reconstruction, which can be necessary years after injury.
- For people over 50, the risk of morbidity (illness) and mortality (death) from their injury increases.

References:
- hospitals.unm.edu/burn/classification.shtml
- healthresearchfunding.org/difference-between-3rd-and-4th-degree-burns/
- The University of Texas Medical Branch Blocker Burn Unit
Comfort

Innovative FR/AR fabrics

Daily wear is a single layer clothing
Task based is double layer clothing (layering AR/FR coverall over non-FR, natural fiber clothing)
The flame resistant engineering of AR/FR fabrics has advanced to make AR/FR clothing almost indistinguishable from regular street clothing

Comfort

Comfort is inherently subjective

- Not linked to weight across fiber types
- Not linked to weight within fiber type until >30% delta
- Wear tests are the only way to judge
- Account for shrinkage over time

Comfort & Heat Stress
Heat Stress

No single layer, breathable woven/knit fabric (FR or not) causes heat illness

Heat illness causes:

- Poor hydration
- Lack of rest breaks
- Lack of shade
- Poor health

The Fabric Brand is Important

Specify the AR/FR Fabric

 ✓ Do Your Homework
  • Find fabrics that meet your performance needs
  • Review independent test reports, i.e. UL certified for NFPA 2112, Kinectrics arc rating test report
  • Ask: Does the fabric perform to all of your hazards?

 ✓ Evaluate viable options
  • Don't settle for minimum performance, i.e. ASTM F1506
  • Because data does not exist to evaluate comfort, conduct wear trials to assess it
  • Look for market-proven performance

 ✓ Specify by brand name
  • Know what brand you are getting
  • For example, “88/12” is not a brand
  • There are large differences in how “similar” fabrics perform
For Reference of NECA Now 2019
Attendees Only

Upfront and Long Term Cost Comparison

Task based programs have less upfront cost but may have significantly higher long term costs

<table>
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<tr>
<th></th>
<th>Upfront Cost</th>
<th>Long-term Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily Wear</td>
<td>Low</td>
<td>Natural fiber uniforms</td>
</tr>
<tr>
<td>Task Based</td>
<td>Medium</td>
<td>Natural fiber uniforms</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Potential liability, medical &amp; productivity costs</td>
</tr>
</tbody>
</table>

Summary

- Task based programs have less upfront cost but potential for significantly higher long term costs.
- Daily wear programs reduce the chance of human error exposing non-FR clothing (FUEL) to a thermal hazard and catastrophic burn injuries.
- The cost of treatment, length of recovery, and chances of mortality increase significantly with the increase in % of body burn (Extent).
- With both Daily Wear and Task Based programs, always make sure your AR/FR clothing provides the required level of protection against your specific hazard(s).
- There are many different options of AR/FR fabric on the market that all perform differently. Specifying the AR/FR fabric brand(s) is essential. Three Daily wear program decisions: Fabric(s), Garment design, Service Provider.
Summary

NFPA 70E consensus standard focus: how to reduce the likelihood of incident occurrence and mitigate the severity of burn injury from arc flash hazards and have shed new light on PPE program best practices.

The Daily wear programs, with innovations in fabric and garment technology, now provide a comfortable, “want to wear”, “best practice” program that further reduces the burn injury risk and increases an organization’s Safety Culture.

Potential Task based Scenario - Bank Arc Flash
Why FR/AR

Real Life Arc Flash Caught on Surveillance Camera: Daily wear - Westex UltraSoft®

Questions? Thank you!

Up Next:
3:00-4:00 pm
Interactive break in Canyon 1-6

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