Understanding The Electric Arc Flash Hazard and PPE

Bulwark Protective Apparel
Derek Sang
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• Involved with the Flame Resistant Clothing market from the service, manufacturing and garment sides for over 15 years.

• Over the past 8 years worked closely with fortune 1000 companies as they look develop PPE programs within their Electrical Safe Work Practices to comply with NFPA70E/NESC and also Flash Fire programs for NFPA 2113.

• Developed and conducted over 150 educational and informational seminars on the Hazards of Arc Flash and Flash Fire for NSC, ASSE, VPPPA, NJATC, NECA, CAER and numerous other associations.
• This seminar will cover many of the latest topics and information on the performance of the latest fabrics available today. This is a noncommercial presentation designed to inform the safety community on the FR market utilizing state of the art video and up to date information on the standards and regulations. The presentation will be specifically focusing on “everyday work clothing” clothing for HRC 0, 1 & 2 compliance.
Content

• What is an Arc Flash?
• Why Arc Resistant Clothing?
• NFPA 70E Standard – focus on PPE
• Creating and AR Clothing Program
• Cost?
Get Out Your Industry Update!
70E HRC 2 Arc Flash (480v)
Arc Flash Event
Arc Flash Event

- A dangerous release of energy created by an electrical fault - Arc temp can reach **35,000 F**

- Release will contain:
  - Thermal energy
  - Acoustical energy
  - Pressure wave
  - Debris - Copper expands **67,000 times** when vaporized

- Fatal burns can and do occur at >10 feet

- Per OHSA, **80%** of electrically related accidents, incidents and fatalities among qualified workers are caused by - **Arc Flash**
The Arc Flash Hazard

Shock Wave

Radiation Wave

< 740 mph (<1,191 kph)
Copper Particles

15,000+ °C
(27,032+ °F)

1,000 °C

2,000 psf
(0.977 kg/cm²)

50 cal/cm²

IR

Visible

UV

165 db
Variables that effect the size and energy of an electric arc flash are:

- Amperage
- Voltage
- Arc Gap
- Closure time
- Distance away from arc
- 3 phase v single phase
- Confined space
Arcs can be initiated many different causes, including...

- **Dust and impurities** on insulating surfaces can provide a path for current, allowing it to flash over and create arc discharge across the surface.
- **Corrosion of equipment parts** can create impurities on insulating surfaces which may also provide a path for current, allowing it to flash over and create arc discharge across the surface.
- **Condensation of vapor and water dripping** can cause tracking on the surface of insulating material, which can create flashover to ground and potential escalation to phase to phase arcing.
- **Spark discharge** resulting from accidentally touching live exposed parts or dropping tools on or near equipment may initiate arcs.
- **Over-voltages across narrow gaps** such as those that occur when the air gap between conductors of different phases is very narrow (due to poor workmanship or damage to insulating materials) in which case arcs may strike during over-voltages.
- **Failure of insulating materials**

Electric arcs are also caused by improperly designed or utilized equipment and improper work procedures.
What Equipment can Cause Arcs?

• Typical equipment can be:
  – Motor Control Centers (MCC’s)
  – Circuit Breakers
  – Disconnects
  – Metering Devices (remove – install)
  – Panel Boards
  – Switchgear (low and high voltage)
  – Transformers
Arc Energy Basics

• Exposure energy expressed in cal/cm²
• \( \frac{1}{2} \) to 1 cal/cm² = hottest part of lighter in 1 sec
• An exposure of only 1-2 calories will cause second degree burn on human skin
• Typical non-FR work wear can ignite @ 4-5 cals
• Reports indicate that 80-90% of job tasks have hazards with the potential to release up to 8 cal/cm²
• Arcs typically release 5-30 cals, and energies of 30-60 cals are not uncommon
Why is FR Needed?

- Most severe burn injuries and fatalities are caused by non-flame resistant clothing igniting and continuing to burn.
- Flame resistant clothing will self-extinguish, thus limiting the injury.
- Body area under non-FR clothing is often burned more severely than exposed skin.
Live Arc Flash Testing

480V Test Gear
Kinectrics
Test #10-3641
10 kA, 10 Cycles
Bulwark
Nomex FR shirt over
Arc Flash Slo Mo
HRC 2 Arc with FRC
CLOTHING ON MANIKIN
Pant = 100% Cotton
Shirt = 100% Cotton

NON-FR EQUIPMENT
200 Amp Disconnect

TEST PARAMETERS
Voltage = 480
Amperage = 12.5 kA
Cycles = 10
Distance = 12"
"Arc in a Box"

CALculated ENERGY
Per IEEE 1584
8.4 cal/cm²

MAIN MENU
Top 10 Video Clips
No Manikin Clips
NON-FR Clips
INDURA Ultra Soft Clips

Return to Top 10 Index
Test 4B  (11/5/02)

Dickies Work Pants
  35% Cotton / 65% Polyester
Fruit of the Loom Sweatshirt
  50% Cotton / 50% Polyester
Hanes Underpants & Shirt, 100% Cotton
Cotton Socks
Buckingham Harness
3 Way 1 Way Raychem Aerial Splice
Single Phase Short
What is Flame Resistant Clothing?

- Clothing made from fabrics that self-extinguish
- Fabrics may be natural or synthetic
- Designed to limit (not eliminate) burn injury
- Survival, extent of injury, recovery time and quality of life are all dependent on FRC performance
“Primary” vs. “Secondary”

- **Primary Protective Clothing**
  - Definition; “Clothing that is designed to be worn for work activities where significant exposure to molten substance splash, radiant heat, and flame is likely to occur.” Example - Firefighter Turnout Gear

- **Secondary Protective Clothing**
  - Definition; “Clothing that is designed for continuous wear in designated locations where intermittent exposure to molten substance splash, radiant heat, and flame is possible.”
What Flame Resistant Clothing is Not!
Standards are the Minimum

Performance Standards

• ASTM 1506 – 25 launderings
• NFPA 2112 – 100 Launderings

Test Methods

• ASTM 1959 – 3 Launderings
• ASTM 1930 – 1 Laundering
Engineered Flame Resistant Fabrics

• Natural fibers
• Synthetic fibers
• Natural / synthetic blends

NOTE: Flame resistance must be durable to launderings, wear, the environment, etc. for the service life of the garment

All – FR fabrics are engineered do not let marketing terms confuse you – inherent – treated etc.

Look for proven products!
Flame-Resistant Fabrics

• Treated vs. Inherent
  - Flame resistant fabrics can generally be divided into two groups:
    Treated: Applied chemical treatment
    Inherent: Essential characteristic
  - Advantages/Disadvantages
Consistent quality by a superior provider

Vertical integration

- conversion of fiber to yarn
- weaving and dyeing
- finishing and treating
- inspection
- all from a single source
Treated or Inherently FR?

Both FR treated and inherently FR fabrics from Bulwark provide superior flame-resistant protection. The choice between treated or inherently FR fabrics should be made based on the use environment, wearer preference, and cost to value equation.
Test #08-2008
8kA, 16 cycles
Rasco no-burn black knit Polo Shirt
Do not confuse the data

• Do not mix Arc Flash and Flash Fire Data – there is no correlation between performance in one vs the other

• For example Nomex has been a proven performer in Flash Fire for decades –

• Some fabrics perform well in Arc Flash and poorly in Flash Fire and visa versa
Flash Fire vs Arc Flash
Sample Fabric Offerings – Application / Industry

- Welding, Arc Flash, Flash Fire, Molten Red Metal
  Utilities, Steel, PetroChemical, Oil, and Gas Industries

- Flash Fire, Arc Flash
  Utilities, Steel, PetroChemical, Oil, and Gas Industries

- Molten White Metal (Aluminum)
  Aluminum Companies
What Is a Burn?

A chemical process which progressively injures skin; severity relates to depth

- 1st: redness, pain – not permanent
- 2nd: blistering – skin will regenerate
- 3rd: total skin depth destroyed. Will not regenerate – requires grafting
- 4th: Underlying muscle damaged
Burn Survival

• Burn percentage, more than severity, predicts survival because skin is infection barrier

• 2nd and 3rd degree break skin, providing an infection pathway

• Most hospital deaths 2-4 weeks post-exposure are infection (gram-neg staph)
Burn Survival

Chances of Survival from Burn Injury

Source: American Burn Association (1991 - 1993 Study)
Break For LUNCH
ARC Flash does happen.
Man working at school dies of injuries from fire

April 18, 2004 — A Berwyn man is dead six days after being burned in a fire at Chicago's Wright Elementary School. Pedrag Djakovic, 34, was doing electrical work at the school on North Harding Avenue.

According to the Cook County medical examiner, the wire he was working on sparked setting his clothing on fire. He died at Stroger Hospital yesterday afternoon.

Wright will remain closed for repairs for the rest of the school year.
Non-FR Garment Ignition
The details of injury and long term effects

- 2 workers suffered more than 60% 2nd and 3rd degree body burn.

- One subjected to induced coma for 60 day period

- 3rd worker treated and released, today experiencing long term neurological problems – “similar to shaking a baby”

- Worker pulling off hard hat – mesh liner and helmet plastic harness melted – requiring surgical removal

- Incident energy calculated to approx. 22.7 cal/cm²
Equipment Failure

- Higher amperages, failed breakers, adjacent gear, try-backs, internal contact of energized parts, etc

  - When any piece of the equipment or system fails, *all calculations and predictions fail with it*. By definition, one can no longer be certain of maximum possible incident energy, or, by extension, probability of ignition of non FR cotton.
NFPA 70E

- Standard for Electrical Safety in the Workplace
- Covers industrial personnel
  - Electricians
  - Maintenance workers
  - Operators
NFPA 70E defines 2 new terms……

**ATPV (Arc Thermal Protective Value):**

The incident energy that results in a 50% probability of the onset of 2\textsuperscript{nd} degree burn
NFPA 70E defines 2 new terms......

HRC (Hazard/Risk Category):

Schedule of ATPV ranges associated with common workplace tasks
NFPA 70E

- NFPA 70E, Standard for Electrical Safety in the Workplace, developed by the National Fire Protection Association, is one of the foremost consensus standards for electrical safety. It covers employee protection from the electrical hazards of shock, arc flash and arc blasts.

- Although it is only referenced in OSHA 29 CFR Part 1910 Subpart S, Appendix A, NFPA 70E is considered by OSHA to be the recognized industry practice for electrical safety.

- In its standard interpretation of the relevance of NFPA 70E, OSHA states: Industry consensus standards, such as NFPA 70E, can be used by employers as guides to making the assessments and equipment selections required by the standard. Similarly, in OSHA enforcement actions, they can be used as evidence of whether the employer acted reasonably.

- And while the 2012 edition of NFPA 70E emphasizes that working on live parts is "the last alternative work practice," it contains extensive requirements for "working on or near electrical conductors or circuit parts that have not been put into an electrically safe work condition." When such work is to be performed, the required electrical hazard analysis has specific requirements for analysis of shock and flash hazards. Other sections provide guidance on selecting the proper PPE.
Changes for 2012

• The 2012 Edition of NFPA 70E has been published and there are a large number of changes. There are a few key changes related to arc flash protective apparel. The three most notable are:

• First the terms Arc Rated & AR have replaced Flame-Resistant & FR. This is an attempt to prevent the use of garments using fabrics that use the term FR but have not actually been tested to establish an arc rating. This was done because there are flame-resistance tests used for products like draperies that are not suitable of arc protection but have been sold as “FR.” Users therefore assumed they provide protection against electric arc flashes. The change does not require a garment be labeled as AR versus FR but does require the garment to have been arc tested and adhere to ASTM F1506 which requires it to be labeled with the arc rating (cal/cm² or EBT.)

• Second is the consolidation of Hazard Risk Categories 2 and 2*. By doing this, HRC 2 now requires the use of either an arc rated wrap-around face shield and arc rated balaclava, or an arc rated flash suit hood. Previously only an arc rated face shield was required. This was done to provide full head protection. With the face shield alone the sides and back of the head were not protected.

• The standard now states that flammable synthetic fabrics, zipper tape and findings shall not be used. Previously it only referred to synthetic fabrics, not findings. This was done to specifically address the use of none FR zipper tape and other findings that could fail in an arc flash event.
NFPA 70E Hazard Analysis: Three Options Available

- Calculate specific equipment hazard and match Arc Rating of clothing to hazard
- Use task based matrix to determine hazard risk category of job
- Simplified two category approach in Annex H
<table>
<thead>
<tr>
<th>Hazard/Risk Category</th>
<th>Clothing Description</th>
<th>Req’d Min ATPV (cal/cm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Arc-rated FR shirt and FR pants or FR coverall</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>Arc-rated FR shirt(s) and FR pants or FR coverall</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>Arc-rated FR shirt and pants or FR coverall and arc flash suit selected so that the system arc rating meets the required minimum</td>
<td>25</td>
</tr>
<tr>
<td>4</td>
<td>Arc-rated FR shirt and pants or FR coverall and arc flash suit selected so that the system arc rating meets the required minimum</td>
<td>40</td>
</tr>
</tbody>
</table>
Comparison of Hazard Categories

**HRC1**
- FR Shirt (4 cal/cm²)
- FR Pants (4 cal/cm²)
- Arc-Rated Hard Hat
- Arc-Rated Faceshield
- Voltage-Rated Gloves
- Leather Gloves
- Leather Footwear
- Safety Glasses
- Hearing Protection

**HRC2**
- FR Shirt (8 cal/cm²)
- FR Pants (8 cal/cm²)
- (or FR Coverall of 8 cal/cm²)
- FR Balaclava (8 cal/cm²)
- Arc-Rated Hard Hat
- Arc-Rated Faceshield
- Voltage-Rated Gloves
- Leather Gloves
- Leather Footwear
- Safety Glasses
- Hearing Protection

**HRC3**
- FR Hood (25 cal/cm²)
- FR Suit (25 cal/cm²)
- worn over
- HC2 Shirt (8 cal/cm²)
- HC2 Pants (8 cal/cm²)
- Voltage-Rated Gloves
- Leather Gloves
- Leather Footwear
- Safety Glasses
- Hearing Protection

**HRC4**
- FR Hood (40 cal/cm²)
- FR Suit (40 cal/cm²)
- worn over
- HC2 Shirt (8 cal/cm²)
- HC2 Pants (8 cal/cm²)
- Same as HRC 3
Simplified Two-Category Clothing Approach
page 83-87:

• H.2 – For use with the Tables
  – Everyday Work Clothing
    • Min arc rating of 8
  – Arc Flash Suit
    • Min arc rating of 40

• H.3 – For use with a Hazard Analysis
CATEGOR 2

- Arc Rated Hard Hat and Face Shield/Chin Cup
- Standard Safety Glasses (Z 87.1)
- Flame Resistant (FR) Shirt 8 cal/cm²
- Flame Resistant (FR) Pant 8 cal/cm²
- Flame Resistant (FR) Balaclava 8 cal/cm
- Voltage Rated Gloves appropriate to the environment
- Leather Protector Gloves
- Leather Footwear
- Hearing Protection
CATEGORY 4

- Flame Resistant (FR) Flash Hood 40 cal/cm\(^2\)
- Flame Resistant (FR) Flash Suit Jacket 40 cal/cm\(^2\)
- Flame Resistant (FR) Flash Suit Pants 40 cal/cm\(^2\)

*Worn over the*

- Flame Resistant (FR) Shirt 8 cal/cm\(^2\)
- Flame Resistant (FR) Pant 8 cal/cm\(^2\)
- Hearing Protection (ear plugs)
- Safety Glasses (Z 87.1)
- Voltage Rated Gloves appropriate to the environment
- Leather Protector Gloves
- Hearing Protection
- Leather Footwear

or FR Coverall of 8 cal/cm\(^2\)
OSHA Requirements

• The General Duty Clause requires work places free from recognized hazards
• The general Duty Clause requires employees to comply with the rules pursuant to the Act.
• The specific Duty Clause requires employers to comply with OSHA Standards
OSHA Requires

• Basic list for electrical safety compliance
• OSHA requires employers to provide the following:
  – Written Electrical Safety Program
  – Hazard Analysis (Arc Flash and Shock Hazard Analysis)
  – Labeling Electrical Equipment
  – Specific hazard Training for workers in order for workers to be considered “qualified” by OSHA
  – PPE for Electrical Workers
  – Tools (Insulated hand tools and other specific electrical safety tools for workers)
  – A preventative maintenance program for electrical equipment
• OSHA is the “SHALL”
• NFPA 70E is the “HOW”
  – Industry consensus standards, such as NFPA 70E, are used in OSHA enforcement actions as evidence as to whether the employer acted reasonably
Rotterdam firm faces fine

By BRIAN NEARING, Staff writer
First published in print: Sunday, May 3, 2009

- ROTTERDAM — A rubber recycling company has been hit with $14,600 in government fines after an investigation into an electrical explosion Feb. 28 that injured two workers. New York Rubber Recycling was cited for six safety violations by the U.S. Labor Department's Occupational Safety and Health Administration.
- The violations stemmed from an accident at the company's facility in the Rotterdam Corporate Park, where two unidentified workers were severely burned in an explosion while trying to replace a circuit breaker without turning off the power to the panel box.
- OSHA found the two workers were not qualified to change the breaker. Other violations included an uncovered main power panel that exposed live electrical parts, an ungrounded extension cord being used to power lighting equipment and incomplete accident and safety logs for 2007 and 2008.
- The company has 15 days to contest the fines or seek an informal conference with OSHA.
- In September 2007, a fire broke out at the plant in a pile of shredded rubber. The company recycles tires into a mulch material that is used to surface playgrounds and sports fields.
— Brian Nearing
OSHA alleges safety violations at MillerCoors 08/04/2009

• (AP) – 19 hours ago
• DENVER — Regulators have proposed fining MillerCoors $128,500 over alleged safety violations at its brewery in Golden.
• The Occupational Safety and Health Administration said Monday a maintenance electrician who was missing for several hours was found dead outside an open, energized electrical panel Feb. 2, and two others were burned by an electrical arc flash April 9.
• OSHA investigators in the fatal accident found inadequate safety measures for electrical hazards, but coroner's officials couldn't determine if that led to the death, said John Healy, OSHA's area director in Englewood.
• OSHA cited MillerCoors LLC for 10 alleged violations of rules for electrical hazards.
• That included one alleged willful violation over allegations that MillerCoors failed to ensure employees used proper protective equipment when working near energized electrical parts. OSHA also alleged nine serious violations over work practices and protective equipment.
• A MillerCoors spokesman didn't immediately return a phone message seeking comment.
• MillerCoors received the citations Friday and has 15 business days to contest the findings, Healy said.
• "We found dangerous conditions that existed at MillerCoors in the area of electrical work," Healy said. "The company does need to take necessary steps to mitigate workplace threats to ensure the safety of the work force."
Lowes Home Centers Inc. was cited $55k for safety violations at the Killeen, TX, retail store. The serious violations were cited for failing to illuminate exit signs, protect exposed lamps from possible breakage or contact and guard electrical receptacles with exposed current-carrying parts. The repeat violations were for failing to mount fire extinguishers and guard or cover exposed live parts on fluorescent lamp holders.
Fiberglass Structures Inc. of Laurel, MT, a subsidiary of Texas-based LF Manufacturing Inc., was cited

- 12/19/12

Fiberglass Structures Inc. of Laurel, MT, a subsidiary of Texas-based LF Manufacturing Inc., was cited $75.6 by OSHA for safety violations. Fiberglass Structures received one repeat violation for not containing energized wires with covers in a flammable area, which carries a $12,600 penalty. Inspectors found 11 serious violations, with a $63,000 penalty, which involve exposing workers to fire and explosion hazards in spray booths; various electrical hazards; improper storage of chemicals; confined space deficiencies; inadequate eyewash facilities; failure to use and require personal protective equipment; and provide adequate training for confined space and personal protective equipment.
Bender Enterprises Inc. of Union, NJ, was cited

- 12/27/12
- Bender Enterprises Inc. of Union, NJ, was cited $41.58k by OSHA for electrical hazards at a Fort Lee worksite. Violations include failing to protect workers from contact with live electrical parts, provide eye and face protection from electric arcs, flashes or flying objects, and provide insulated tools and equipment for workers exposed to energized conductors or circuit parts.
Creating an FRC Program

- Hazard Assessment
- PPE Selection
  - Protection
  - Comfort
  - Value
- Care and Maintenance
The Next Step

- Already performed hazard analysis
- Decided level of protection needed, i.e. Arc Ratings
- Clothing must be chosen
  - Everyday garments
  - Arc flash suits
  - Outerwear?
  - Layering to meet levels
Comfort – The Bottom Line

• Never make comfort decisions from graphs, data, office samples or appearance

• There is simply no substitute for a wear test
Proper Use

• FRC should be appropriate to hazard
• Always the outermost layer
• Worn correctly; zipped, buttoned, etc
• All natural, non-melting undergarments
• Clean, no flammable contaminants
• Repaired correctly and removed from service when needed
Don’t let this be your Legacy
Maintenance of FRC

• Garments should be cleaned to maximize performance
• Contaminants can “mask” or negate flame resistance
• Care choices
  – Home laundry
  – Industrial Laundry
  – Dry-cleaning
How large is the problem?

- According to CapSchell, Inc., a Chicago-based research and consulting firm that specializes in workplace injury prevention, there are five to 10 arc flash explosions every day in the United States, resulting in 1 to 2 deaths.

- Moreover, over the course of a seven-year study tracking electrical accidents conducted by the U.S. Department of Labor’s Bureau of Labor Statistics, 2,576 U.S. workers died and another 32,807 were injured -- losing an average of 13 days away from work -- due to electrical shock or burn injuries.

- A second study involving more than 120,000 employees determined arc flash injuries accounted for 77% of all recorded electrical injuries -- The final cost to employers and their insurers for a single, serious injury can approach $10 million. (CapSchell) -- 2,000 workers are admitted annually to burn centers for extended injury treatments caused by arc flash, according to the U.S. Department of Labor.

- A recent study from the National Institute for Occupational Safety and Health (NIOSH) determined 17,101 injuries were caused by electric arc flash burns between 1992 though 2001.
• Five to 10 arc flash explosions occur in electric equipment every day.
  – 2000 Victims sent to special burn facilities (1 an hour, 1 fatality a day)

• This number doesn't even include cases in which the victim is sent to an ordinary hospital or clinic for medical treatment.

• Unreported cases and “near misses” are estimated to be many times this number.

• Approx 200 fatalities per year - CapSchell
Burn Injury Costs

• Burn treatment requires approx. 1.5 days hospitalization per % burn
• Average hospitalization is 19 days, at costs exceeding $18,000/day
• Total hospitalization cost typically ranges from $200,000 to $750,000, with many over $1,000,000 USD
### Burn Costs: FR vs Non-FR

<table>
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<tr>
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<th>Accidents Before FR</th>
<th>Accidents After FR</th>
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<tr>
<td></td>
<td>Paid</td>
<td>Reserve</td>
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<tr>
<td>Medical</td>
<td>562,677.78</td>
<td>250,000.00</td>
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<tr>
<td>Indemnity</td>
<td>52,182.14</td>
<td>721,431.00</td>
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<tr>
<td>Vocational Expenses</td>
<td>2510.36</td>
<td>7,438.00</td>
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<tr>
<td></td>
<td>931.53</td>
<td>0.00</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>$618,301.81</strong></td>
<td><strong>$978,928.00</strong></td>
</tr>
<tr>
<td>Medical</td>
<td>184,572.12</td>
<td>124,999.00</td>
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<tr>
<td>Indemnity</td>
<td>30,143.43</td>
<td>19,226.00</td>
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<td>Vocational Expenses</td>
<td>2,393.43</td>
<td>7,606.00</td>
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<tr>
<td></td>
<td>20.00</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>$217,128.98</strong></td>
<td><strong>$151,863.00</strong></td>
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</table>

Source: PECO Presentation by Bill Mattiford, PES-IEEE Seminar.
IBEW States:
$.25/hour X 8 hours a day =
$10 a week
or $600 a person
Summary

• Objections to FR are usually based on either cost or comfort…

• Durability, productivity and liability issues reduce real over-time cost of FR to, or below, non FR cotton in energized environments

• Wear tests and current programs clearly show comfort of newer generation FR clothing is equal to like weights of non FR cotton clothing

• Get your assessment done – know your hazard

• Any FR is better than No FR

• Get your layering solutions tested
The Bottom Line

Incidents & Accidents Happen

“Street Clothing” can and does worsen injury

You Can’t Rely on “It’s Not Going to Happen to Me”

You Can Do Something About Your Clothing
Thank You!
Questions & Discussion

Bulwark Protective Apparel

Derek Sang
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Technical Bulletins
Use of DEET Insect Repellant

- DEET is the active ingredient in many insect repellent products
- Used to repel biting insect
- DEET can be highly flammable in concentrated forms
- Spray DEET on skin only, never on garments
Application of non flame-resistant emblems and embroidery

- Nothing on an article of clothing may increase the extent of wearer injury in case of garment ignition
- Emblems and embroideries should be limited in number and surface area
- End user must weigh the benefits of identification and personalization against the potential risk from using non-flame-resistant materials
Contact Sensitivity of FR Cotton & Nomex

- No occupational injury or illness has ever been linked to FR fabrics
- In isolated cases, consider:
  - Has the garment been laundered?
  - Can another fabric be tolerated?
- Millions of yards of fabric have been handled by our employees
Layering & Undergarments

- Non-FR undergarments must be made of non-melting fibers
- An incidental amount of elastic is permitted in socks and underwear
- Any garment worn as the outer layer, including rainwear, must be flame resistant
- Non-FR garments cannot be used to increase the arc rating of a garment or clothing system
- ATPV rating of individual layers $\neq$ ATPV rating of the clothing system
Removal of Stains

- If flammable soils are not completely removed, the protective qualities of the garment may be compromised
- Petroleum odor indicates that a flammable contaminant may still be present
- Discoloration alone is not an indicator of reduced protection
- Pre-treatment of stains is OK; follow with laundering process
Maintenance of FR Apparel

• It is essential to keep FR clothing clean – use either a home or industrial laundering process.

• Do not use these products in process of cleaning/caring for your FR clothing:
  – Bleach
  – Fabric softeners
  – Starch
  – Other topical treatments
Repairing FR Clothing

• ASTM F 1449, covers care and maintenance as well as repairs of flame-resistant protective garments

• Repair small rips, tears, holes using materials equivalent to those used in the original manufacture of garment

• Repair kit lot #EM0344
Static Electricity

- The primary hazard from static charges is stored energy on the body of an ungrounded person
- Some FR fabrics contain static dissipative fibers
- Others must rely on moisture in the air to help dissipate static from fabric
- Never don or doff protective clothing in hazardous environments
Use of Conductive Components

• Metal zippers, snaps, etc

• ASTM F1506 requires that a layer of FR fabric cover any metal components that could contact the wearer's skin