



Reviewing How NFPA 70E (2024) Changes Impact Sustainable PPE Best Practices

Scott Francis, Technical Sales Manager | April 2024

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Agenda

- + Arc Flash Basics
- + Review NFPA 70E Risk Assessment Procedure - Condition of Equipment!
- + Protection - Condition of FR/AR PPE Program?
- + Comfort - Innovative FR/AR Fabric Blends
- + Sustainability + Durability + Comfort
- + Trust - PPE Selection - Best Practices

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Arc Flash Basics

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NFPA 70E PPE Cat 2 Arc Flash Scenario



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Arc Flash Hazard

- + A dangerous release of energy created by an electrical fault
- + Release will contain:
 - Thermal energy
 - Acoustical energy
 - Pressure wave
 - Debris



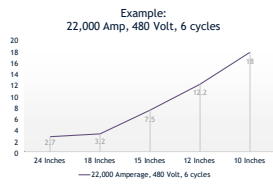
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Intensity of an Arc Flash

Variables that effect the incident energy of an electrical arc flash:

- + Amperage
- + Voltage
- + Arc gap
- + Cycle time
- + Distance away from arc
- + 3 phase vs. single phase
- + Confined space



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Arc Energy Basics

- + Incident energy expressed in cal/cm²
- + Arc rating of clothing/PPE expressed in cal/cm²
- + Approx. 1 cal/cm² = hottest part of lighter in 1 sec
- + An exposure of only 1.2 calories/cm² will cause second-degree burn on human skin
- + Typical non-FR workwear can ignite @ 4-5 calcs

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Dangers of Non-FR Clothing



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Review NFPA 70E Risk Assessment Procedure

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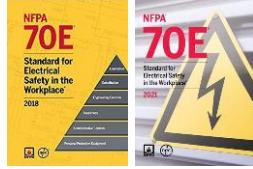
Risk Assessment Review

When?

- + Data reviewed every 5 years or when changes occur to the system. Equipment label updated, if needed.

Impacts

1. Incident energy or PPE category
2. Arc flash boundary
3. PPE selection
4. OSHA compliance - CFR 1910.132
5. Electrical safety program



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Equipment Labels - PPE Category or Incident Energy



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Article 130.5 Arc Flash Risk Assessment - Review

New 130.5 (A) General



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Estimate of Likelihood and Severity

- + Consider design of electrical equipment - overcurrent protective device and operating time
- + Consider electrical equipment operating condition and maintenance condition, assess the preventative maintenance program (Informative Annex 5)
- + Use of Table 130.5 (C) can be used to estimate likelihood of arc flash occurrence



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Likelihood of Occurrence of an Arc Flash - Task, Condition

TABLE 130.5(C) Estimate of the Likelihood of Occurrence of an Arc Flash Incident For arc and dc Systems

Equipment Condition	Likelihood of Occurrence*	
	Yes	No
Any	Yes	No

*Footnote: *The likelihood of occurrence is based on the probability of occurrence of an arc flash incident in the equipment condition listed in the table. It is not based on the probability of occurrence of an arc flash incident in the equipment condition listed in the table. It is not based on the probability of occurrence of an arc flash incident in the equipment condition listed in the table. It is not based on the probability of occurrence of an arc flash incident in the equipment condition listed in the table.*



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70E Notes Table 130.5 (C) - Assessing Maintenance



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Table 130.5 (C) Likelihood of Occurrence of an Arc Flash

+ Yes/No answer for likelihood of occurrence

- Yes means arc flash is likely to occur, so additional protective measures like PPE are required

+ Use arc flash PPE category and PPE tables

- Tables 130.7 (C) (15) a, b, and c, if using PPE category method
- OR use incident energy analysis method



Arc Flash PPE Category Method/NFPA 70E Tables Method

+ Changes: Do the electrical changes/additions impact the equipment parameters such as available fault current and clearing time? Do the changes still meet the parameter criteria listed for that equipment type in the PPE category table? If parameter criteria are not met, use the incident energy analysis method.

ARTICLE 130 — WORK INVOLVING ELECTRICAL HAZARDS			
Table 130.7(C)(15)(a) Arc-Flash PPE Categories for Alternating Current (ac) Systems			
Equipment	Arc Flash PPE Category	Arc Flash Boundary	
Faultwork or other equipment rated 240 volts and below. Parameters: Maximum of 20 kA available fault current; maximum of 0.05 sec. (2 cycles) fault clearing time; minimum working distance 10 ft (3.0 m).	1	405 mm (15.9 in.)	
Faultwork or other equipment rated greater than 240 volts and up to 600 volts. Parameters: Maximum of 20 kA available fault current; maximum working distance 4.5 m (15 ft).	2	900 mm (35.4 in.)	
Faultwork or other equipment rated greater than 600 volts and up to 800 volts. Parameters: Maximum of 20 kA available fault current; maximum of 0.05 sec. (2 cycles) fault clearing time; minimum clear access control circuit (MCC)	3	1.5 m (5.0 ft)	
Faultwork or other equipment rated greater than 800 volts and up to 15 kV. Parameters: Maximum of 20 kA available fault current; maximum of 0.05 sec. (2 cycles) fault clearing time; minimum clear access control circuit (MCC)	4	4.5 m (14.8 ft)	

+ Every 5 years: The data supporting the information on the electrical equipment label (regardless of method) must be reviewed for accuracy at intervals not exceeding 5 years



PPE Selection via 2 Methods

+ OR via incident energy analysis method - simply select arc-rated clothing with an arc rating equal to or greater than the estimated incident energy determined by methods in Annex D

ARTICLE 130 — WORK INVOLVING ELECTRICAL HAZARDS	
Table 130.7(C)(15)(c) Personal Protective Equipment (PPE)	
Arc-Flash PPE Category	PPE
1	Arc-Rated Clothing, Minimum Arc Rating of 4 cal/cm ² (16.79 J/cm ²) Arc-rated long-sleeved shirt and pants or equivalent ensemble Arc-rated face shield or eye, face and head Arc-rated gloves, gauntlet, high-voltage-appeared, insulative, or hard hat liner (ANSI) Protective Equipment Hard hat Hearing protection (ear, canal inserts) ¹ Heavy-duty leather gloves, met-crated gloves, or rubber insulating gloves with leather protectors (SRP) ² Leather footwear (ANSI)
2	Arc-Rated Clothing, Minimum Arc Rating of 8 cal/cm ² (33.6 J/cm ²) Arc-rated long-sleeved shirt and pants or equivalent ensemble Arc-rated face shield or eye, face and head Arc-rated gloves, gauntlet, high-voltage-appeared, insulative, or hard hat liner (ANSI) Protective Equipment Hard hat Hearing protection (ear, canal inserts) ¹ Heavy-duty leather gloves, met-crated gloves, or rubber insulating gloves with leather protectors (SRP) ²





Protection - Condition of FR/AR Program?

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Additional Protective Measures

Hierarchy of Risk Control Methods

The risk assessment procedure shall require that preventative 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

PPE usually seen as a protective measure, preventative measure?



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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 information Annex Q."
- + Hierarchy of Risk Controls: No risk control infallible. All of the controls are subject to errors in human performance!



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PPE Culture: Top Reasons Employees Fail to Wear 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 the time" or "It takes too much time"
- + Discomfort: "It doesn't fit right" or "It's not comfortable"

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Condition of AR/FR Clothing-PPE Program?

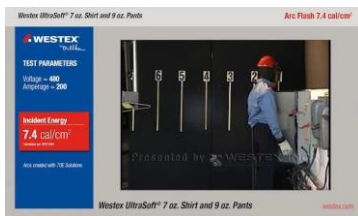
<p>TASK-BASED</p> <ul style="list-style-type: none"> + Proper FR/AR clothing is put on to perform a specific task. 		<p>DAILY WEAR</p> <ul style="list-style-type: none"> + Proper AR/FR clothing is worn at all times during work hours. 	
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FR/AR Clothing: Self Extinguish Westex® UltraSoft®



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Two Key FR/AR PPE Roles

Self Extinguish

- + FR Mechanisms - No Fuel, Free Radical Scavengers

Insulate

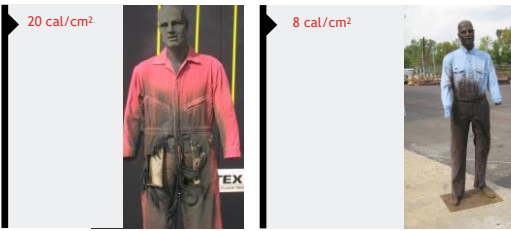
- + Arc Flash - Arc Rating

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FR/AR Clothing



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Layered Arc Ratings (ATPV)

- + UltraSoft 8.7 cal/cm² over 8.7 cal/cm² = 26.8 cal/cm²
- + UltraSoft 8.7 cal/cm² over 8.9 cal/cm² knit = 29 cal/cm²
- + DH Air 9.1 cal/cm² over 6 cal/cm² base layer = 18 cal/cm²
- + UltraSoft 8.7 cal/cm² over 8.2 cal/cm² iQ knit = 27 cal/cm²
- + Layered arc ratings are usually more than additive, need to be determined experimentally

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Garment Labels



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Garment Labels



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Comfort - Innovative FR/AR Fabrics

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PPE Culture: Top Reasons Employees Fail to Wear PPE

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Comfort is Inherently Subjective

- + Not linked to weight across fiber types
- + Not linked to weight within type until >30% delta
- + Wear tests are the best way to judge
- + Wear tests will help develop consensus on FR/AR clothing options
- + Employee engagement opportunity

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Heat Stress

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

Examples of heat illness causes:

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

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Why FR/AR Blends? Comfort = Protection

The market was asking for solutions in protective apparel that addressed the following criteria:

Comfort	Excellent breathability for comfort in hot environments, moisture management and soft feet
Protection	Cat 2 arc protection, NFPA 2112 certified with low body burn % and minimal thermal shrinkage
Value	Provides lifelong protection, cost effectiveness and shrinkage control
Appearance	Wash and wear ability, improved appearance after laundering with stylish look
Confidence	Lifelong protection

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Comfort - Innovative FR/AR Fabrics

The latest FR/AR fabrics are blends and are deemed more comfortable.

Why? Lighter weight, air permeability and moisture management.

Fabric brands:

- + Westex® DH and DH Air™
- + Knit FR fabrics
- + Glenguard
- + Tencate Tecasafe One
- + Arvind - Carhartt FR Force

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Westex® DH Air

Westex® DH Air™ is comprised of a patent-pending fiber blend of 47% TENCEL™ Lyocell, 38% Modacrylic and 15% Aramid.



47% TENCEL™ Lyocell

- + Cellulosic fiber - provides comfort and performance similar to cotton, but stronger
- + Fabric performance - moisture wicking and breathable fiber, wide range of dyeing options, comfortable



38% Modacrylic

- + FR protection - provides protection to the fabric structure
- + Fabric performance - abrasion resistance, ability to dye into solid colors



15% Aramid

- + FR protection - provides thermal stability, improved arc flash
- + Fabric performance - enhances fabric strength and durability

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FR/AR Fabric Blend Competitive Landscape

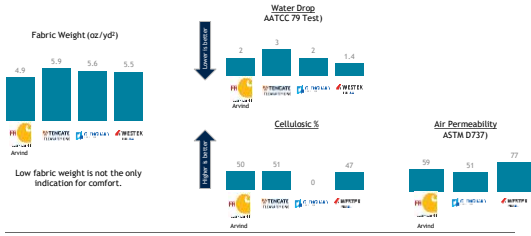
Product	Published Weight (oz/yd ²)	Composition	FR Durability	ATPV / NFPA 70E Category	NFPA 2112
Westex® DH Air™	5.5	4% TENCEL™ Lyocell 38% Modacrylic 1% Aramid	Inherently FR	9.1 cal/cm ² Category 2	Yes
Anvind / Carhartt FR Force	4.7	50% Lenzing FR 38% Aramid 10% Polyamide 2% Antistat	Inherently FR	8.6 cal/cm ² Category 2	Yes
TecasaOne	5.5	5% Lyocell 39% Modacrylic 10% Aramid	Inherently FR	8.2 cal/cm ² Category 2	Yes
Glenguard	5.5	74% Kermel 20% Modacrylic 5% Twaron 1% Antistat	Inherently FR	9.5 cal/cm ² Category 2	Yes

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Blended Fabrics Attributes - Comfort



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Note: Water drop testing is performed as received.



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Sustainability

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Sustainability Key Questions

- 1. Material selection: Durable? Comfortable? Fibers utilized are sustainable from renewable or recycled sources?
- 2. Manufacturing processes: GHG emission reductions? (net zero?)
- 3. Fabric finishes and certifications? PFAS?

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Textile Durability

+ By using materials that are designed to last longer, companies can reduce the need for disposable FR/AR clothing and lower the amount of waste that is sent to landfills.



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REPREVE® Fibers

Transforming plastic bottles into certifiable, traceable high-performance yarn.

- + Recycled bottles and post-industrial waste collected worldwide
- + Waste material is chopped, ground, washed and turned into flake to remove contaminants
- + Waste flake is melted and reformulated into high-quality resin
- + Resin is melted into liquid polymer and extruded to form fiber, which is spun and air-jet textured into yarn found in our Westex® Indigo® style 329 denim



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Why do we use TENCEL™ Lyocell

- + Sustainable product - wood
 - + This is a sustainable raw material - the raw material pulp is derived from the renewable resource, wood.
 - + TENCEL standard fibers are certified with the EU Ecolabel, a verified third-party label of environmental excellence that is awarded to products and services meeting high environmental standards throughout their life-cycle.



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The Path to Net-Zero

Does your manufacturing partner have plans to achieve net-zero targets approved by SBTi; they align to meet the goals of the Paris Climate Agreement and Sustainable Development Goals.

According to a recent report from the International Panel on Climate Change, it is still possible to limit global temperature rise 1.5°C, which climate scientists believe is the necessary threshold for human health and wellbeing.



SCIENCE BASED TARGETS

DRIVING AMBITIOUS CORPORATE CLIMATE ACTION

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Manufacturing Processes

Milliken's Approved SBTi Net-Zero GHG Targets to meet 1.5 C.



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Lowering GHG Emissions Through Cogeneration

Magnolia Finishing Plant now creates energy using steam to run its operation.

- + Reduces greenhouse gas (GHG) emissions
- + Eliminates coal as the primary steam fuel source

1000
tons of coal diverted from disposal after useful life

20%
increase in energy efficiency



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Manufacturing Processes

NEAR-TERM TARGETS (2030)

Milliken & Company commits to reduce absolute scope 1 and scope 2 GHG emissions 50.4% by 2030 from a 2018 base year.

Milliken & Company also commits to reduce absolute scope 3 GHG emissions 30% by 2030 from a 2018 base year.

LONG-TERM TARGETS (2050)

Milliken & Company commits to reduce absolute scope 1, scope 2 and scope 3 GHG emissions 90% by 2050 from a 2018 base year.

These SBTi targets are set (50% reduction by 2030 and net zero by 2050) to meet the Paris Climate Agreement goal of limiting Temperature change to 1.5 C.

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OEKO-TEX 100 Certified - Non-PFAS

- + Do your products carry the OEKO-TEX 100 certification, one of the world's best-known labels for textiles?
- + This certification signifies that products have been tested and found to contain no harmful substances, including PFAS chemicals.
- + Effective Jan. 1, 2023, all textile products developed by Milliken & Company will not contain any intentionally added PFAS chemistries, and other companies will likely follow.



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Sustainability Summary

The sustainability of FR clothing is an important issue that needs to be considered. By using comfortable, more sustainable (durable) materials, eco-friendly manufacturing methods (GHG emission reduction) and more closely evaluating the materials used on a molecular level (non PFAS), companies can greatly improve the sustainability of their FR clothing program.

Working with credible, eco-friendly FR/AR fabric/clothing manufacturer also impacts your organization's Scope 3 GHG Emission reduction efforts.

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Trust: PPE Best Practices

Types of AR/FR Clothing and PPE Programs

<p>TASK-BASED</p> <ul style="list-style-type: none"> Proper FR/AR clothing is put on to perform a specific task. 		<p>DAILY WEAR</p> <ul style="list-style-type: none"> Proper AR/FR clothing is worn at all times during work hours. 	
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Risk Assessment / Risk Management

- + **Risk:** Hazard(s), consequences, likelihood of consequences
- + **Risk Management:** Reduce risk to "ALARP" (as low as reasonably practicable)

Likelihood of Consequences:

1. Qualified person
2. Human error - NFPA 70E - "state" of qualified person - human performance
3. History and current status of equipment

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Routine Tasks and Complacency

A significant amount of arc flash incidents occur involving either brand-new employees or the more-experienced employees.



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Cultural Risk with Task Based PPE Programs

- + Routine tasks - 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.

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Cultural Risk with Task Based PPE Programs (Cont.)

- + Complacency is usually one of the root causes of electrical incidents at 480V
- + Although it is considered low voltage, 480V equipment is a leading killer in the electrical industry
- + FR/AR daily wear clothing is a SEAT BELT

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Potential Task-Based Scenario—Bank Arc Flash



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Real Life Arc Flash Caught on Surveillance Camera:
Daily Wear—Westex UltraSoft®



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Thank you.
Questions?
