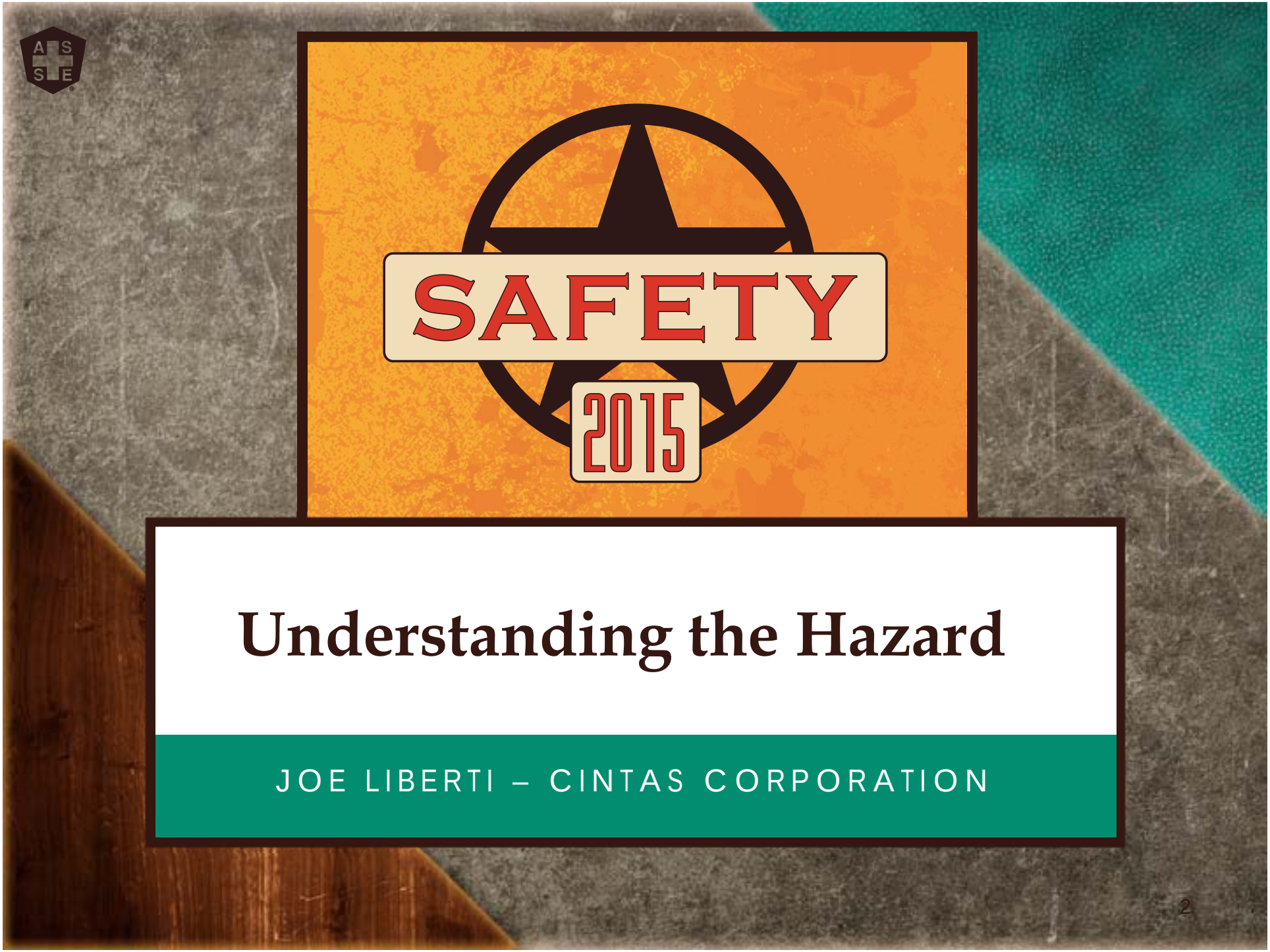
Protective Apparel for the Trades
Electrical Safety for NFPA 70E - 2015

- Understanding the Hazards
- Donnie's Video
- Evolution of NFPA 70E
- 3 Key Changes to 2015 Edition
- Annex H – Group Exercise
- Care, Maintenance, & Proper Use
- Conclusions & Next Steps
- Questions



Understanding the Hazard

JOE LIBERTI – CINTAS CORPORATION

Video Clip shown here.

See Recorded Version of this presentation

Understanding the Hazards

- **Arc Flash Hazard**:
  - A dangerous condition associated with the possible **release** of energy caused by an electric arc.

- **Shock Hazard:**
  - A dangerous condition associated with the possible release of energy caused by **contact** or approach to energized electrical conductors or circuit parts.

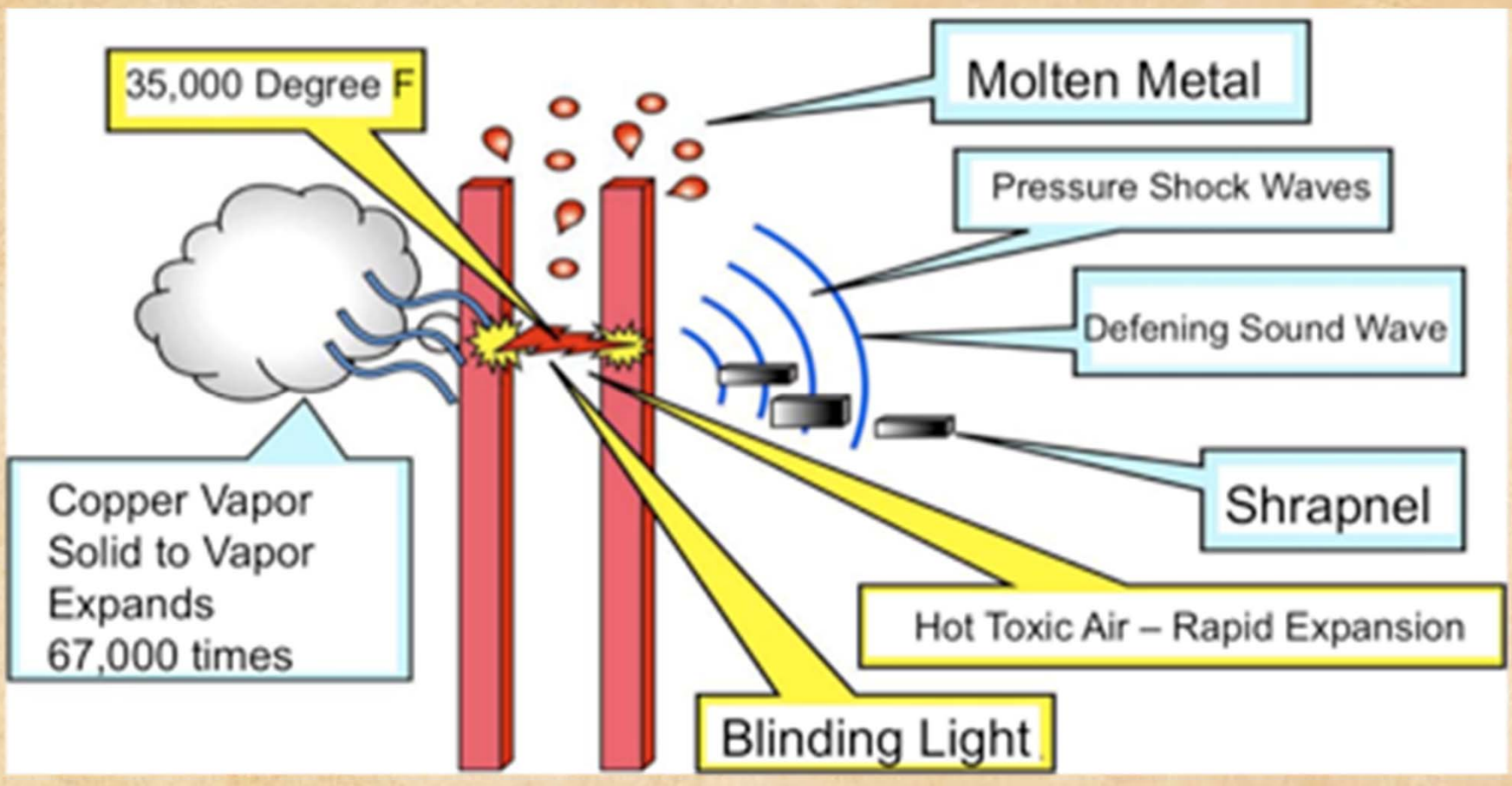
Sources: NFPA 70E, 2015 Edition, pages 10 & 17

Why Should You Care About Arc Flash?

- 5-10 arc explosions occur in electric equipment every day in the United States
- Medical costs for severe electrical burns can exceed $4M per person
- 2,287 U.S. workers died and 32,807 U.S. workers sustained lost time injuries due to electrical shock or burn injuries over a seven year period starting in 1992.
- 38% were classified as electrical burns.
- Electrical injuries each caused an average of 13 days away from work and nearly one fatality every day of the year.

Sources: Capshell, Inc., National Safety Council, Dept. of Labor Bureau of Labor Statistics, I& EEE

What makes Arc Flash dangerous?



Sources: PowerSource, LLC – What is Arc Flash?

In Other Words….

Arc Flash Facts

- Electrical arcs produce some of the highest temperatures known to occur on earth, up to 35,000°F (19,426 °C).

- This is 4 times the temperature of the surface of the sun which is about 9000°F (4982°C).

Sources: National Fire Protection Association (NFPA), ESA's Practical Solution Guide to Arc Flash Hazard, and an article in EC&M magazine (Electrical Construction & Maintenance) Preventing Arc Flash Incidents in the Workplace, by George Gregory, 2003.

What Causes an Arc Flash?

- Lack of properly de-energizing equipment
- Uninsulated Tools
  - Phase to Phase Contact
  - Phase to Ground Contact
- Rodents, Bees, Reptiles
- Any element in a breaker or service area, that could compromise the distance between energized components

Arc Flash Live Camera

Sources: YouTube: https://www.youtube.com/watch?v=dPJtknGmsys

Fire Exposure Energy

- One cal/cm2 per second…
- can be equal…
- to holding your finger…
- over the tip of the flame…
- of a cigarette lighter for ***one second!***

Sources: National Fire Protection Association (NFPA), ESA's Practical Solution Guide to Arc Flash Hazard, and an article in EC&M magazine (Electrical Construction & Maintenance) Preventing Arc Flash Incidents in the Workplace, by George Gregory, 2003.

Understanding Body Burn

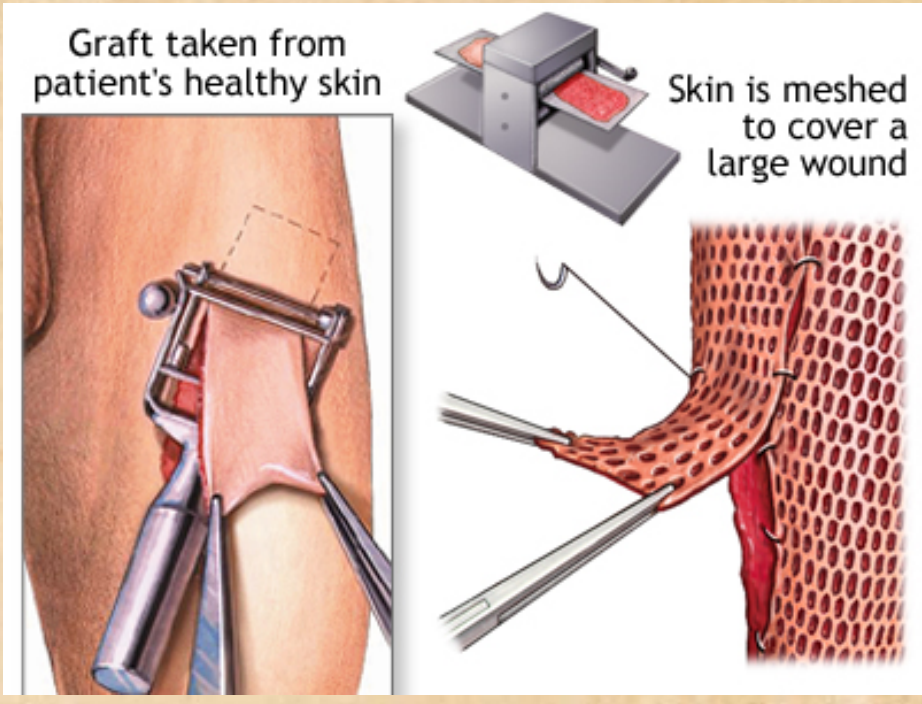
- 1st Degree
  - Red skin, no blister
- 2nd Degree
  - Blisters, Epidermis must regenerate
- 3rd Degree
  - Full thickness burn, skin cannot regenerate, & scar tissue forms
- 4th Degree
  - Damage to muscle & bone

- Inhalation Injuries

Sources: Burn Survivor Resource Center: http://burnsurvivor.com/burn_types_first

Understanding Body Burn

- Surgical Procedures
  - Dermabrasion
  - Skin Grafts
- Skin Substitutes
  - Cadaver or Animal Skin
  - Dermagraft-TC
  - Integra Artificial Skin
  - BioBrane
- Nutrition
  - Harris-Benedict Equation
- Medications
- Pressure Garments
- Scars

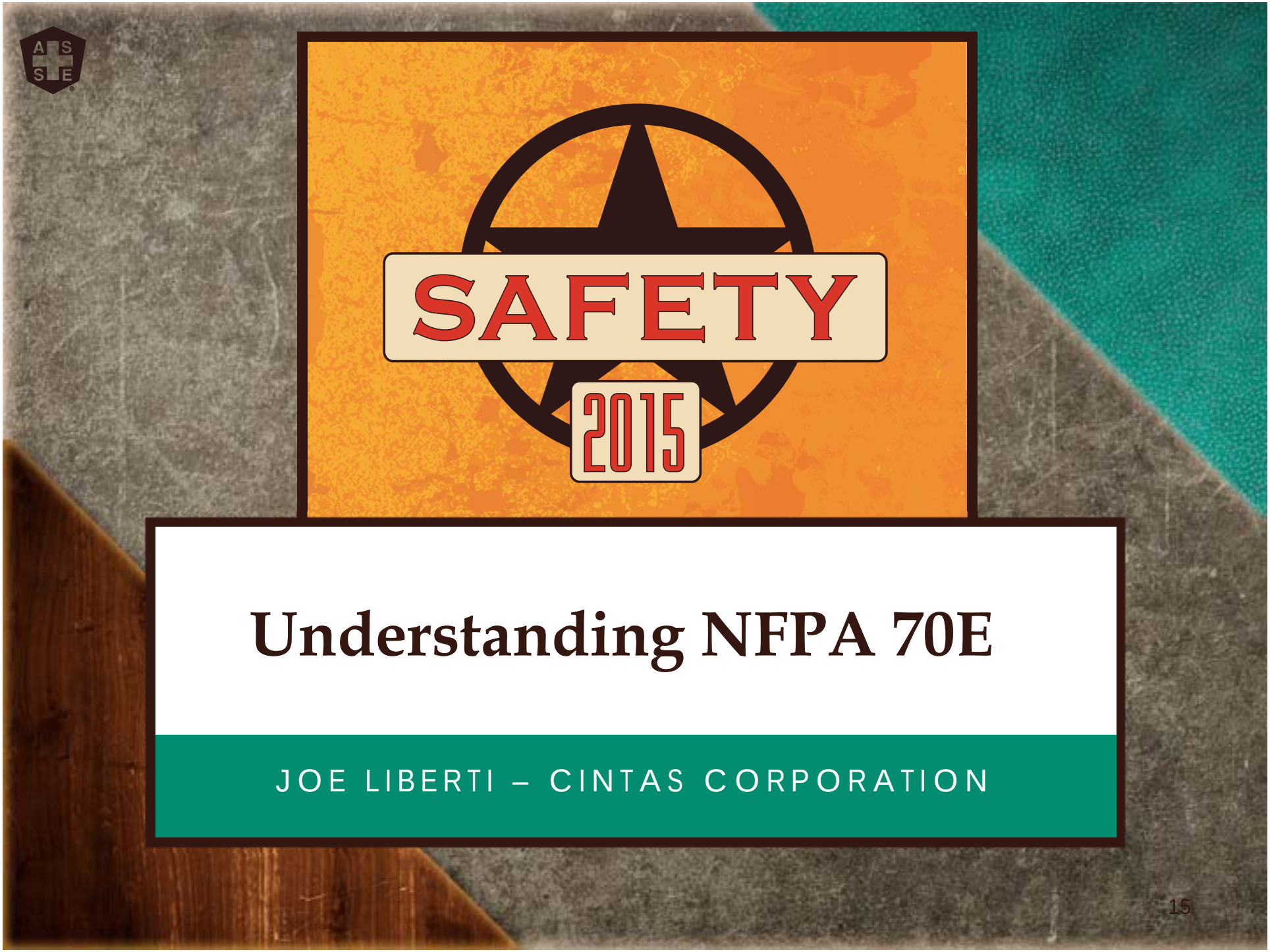


Sources: Burn Survivor Resource Center: http://burnsurvivor.com/burn_types_first

The Cost of Body Burn

- Direct Costs:
  - Medical
  - Wage Indemnity
  - Claims & Admin Fees
- Additional Costs:
  - General Liability Costs & Litigation
  - Lost Productivity & Quality
  - Insurance Premiums
  - Damage to Public Image
  - Potential OSHA Fines
  - Opportunity Costs

Sources: International Association of Oial & Gas Producers, Liberty Mutual Safety Index



Understanding NFPA 70E

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Evolution of NFPA 70E

- 1979 – Part I
- 1981 – Part II
- 1983 – Part III
- 1988 – Minor revisions
- 1995 – Limits to approach & arc are introduced
- 2000 – Use of PPE
- 2004 – Safe Work practices
- 2009 – Chpt 4 deleted
- 2012 – FR to AR
- 2015 – How stakeholders evaluate electrical risk

Sources: NFPA 70E, 2015 Edition, pages 1-5

#1 – Key Changes to Terminology, Tables, & Labels

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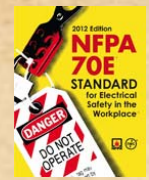
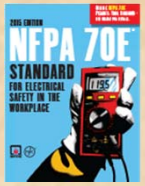
2015 – Terminology Changes



Out with the old…

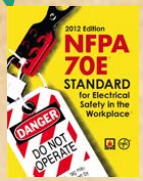
- *"Arc Flash Hazard Analysis"*
- *"Shock Hazard Analysis"*
- *"Hazard/Risk Category"*



In with the new…

- *"Arc Flash Risk Assessment"*
- *"Shock Risk Assessment"*
- *"PPE Category"*

2015 – Table Changes



Out with the old…

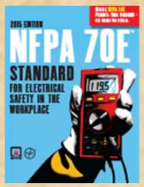
130.7(C)(15)(a)

Hazard/Risk Category Classifications

Table 130.7(C)(15)(a) Hazard/Risk Category Classifications and Use of Rubber Insulating Gloves and Insulated and Insulating Hand Tools-Alternating Current Equipment (Formerly Table 130.7(C)(9)

Tasks Performed on Energized Equipment	Hazard/Risk Category	Rubber Insulating Gloves	Insulated and Insulating Hand Tools
Panelboards or other equipment rated 240 V and below Parameters: Maximum of 25 kA short circuit current available; maximum of 0.03 sec (2 cycle) fault clearing time; minimum 18 in. working distance Potential arc flash boundary with exposed energized conductors or circuit parts using above parameters: 19 in.			
Perform infrared thermography and other non-contact inspections outside the restricted approach boundary	0	N	N
Circuit breaker (CB) or fused switch operation with covers on	0	N	N
CB or fused switch operation with covers off	0	N	N
Work on energized electrical conductors and circuit parts, including voltage testing	1	Y	Y

2015 – Table Changes



In with the new…

Task Based

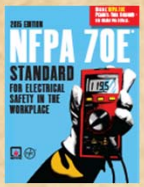
130.7(C)(15)(A)(a)

Arc Flash Hazard Identification for AC and DC Systems

Table 130.7(C)(15)(A)(a) Arc Flash Hazard Identification for Alternating Current (ac) and Direct Current (dc) Systems

Task	Equipment Condition*	Arc Flash PPE Required
Reading a panel meter while operating a meter switch	Any	No
Normal operation of a circuit breaker (CB), switch, contactor, or starter	All of the following: The equipment is properly installed The equipment is properly maintained All equipment doors are closed and secured All equipment covers are in place and secured There is no evidence of impending failure	No
	One or more of the following: The equipment is not properly installed The equipment is not properly maintained Equipment doors are open or not secured Equipment covers are off or not secured	Yes

2015 – Table Changes



In with the new…

Equipment Based

130.7(C)(15)(A)(a)

Arc Flash Hazard Identification for AC and DC Systems

Table 130.7(C)(15)(A)(b) Arc-Flash Hazard PPE Categories for Alternating Current (ac) Systems

Equipment	Arc Flash PPE Category	Arc-Flash Boundary
Panelboards or other equipment rated 240 V and below Parameters: Maximum of 25 kA short-circuit current available; maximum of 0.03 sec (2 cycles) fault clearing time; working distance 455 mm (18 in.)	1	485 mm (19 in.)
Panelboards or other equipment rated >240 V and up to 600 V Parameters: Maximum of 25 kA short-circuit current available; maximum of 0.03 sec (2 cycles) fault clearing time; working distance 455 mm (18 in.)	2	900 mm (3 ft)
600-V class motor control centers (MCCs) Parameters: Maximum of 65 kA short-circuit current available; maximum of 0.03 sec (2 cycles) fault clearing time; working distance 455 mm (18 in.)	2	1.5 m (5 ft)
600-V class motor control centers (MCCs) Parameters: Maximum of 42 kA short-circuit current available; maximum of 0.33 sec (20 cycles) fault clearing time; working distance 455 mm (18 in.)	4	4.3 m (14 ft)

2015 – Labels Changes

THE NEW 2015 NFPA 70E 130.5(D) STATES WARNING LABELS MUST NOW INCLUDE:

(1) Nominal system voltage
(2) Arc flash boundary
(3) At least one of the following:

a. Available incident energy and the corresponding working distance, or the arc flash PPE category in Table 130.7(C)(15)(A)(b) or Table 130.7(C)(15)(B) for the equipment, but not both
b. Minimum arc rating of clothing
c. Site-specific level of PPE

Exception: Labels applied prior to September 30, 2011 are acceptable if they contain the available incident energy or required level of PPE.

Sources: NFPA 70E, 2015 Edition, pages 28

#2 – Elimination of HRC 0

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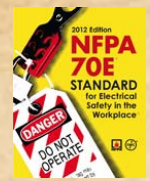
2015 – Elimination of HRC 0



Out with the old…

- **HRC 0 has been removed from Table 130.7(C)(16)**
- **Hazard/risk category 0 was deleted because the new PPE table only specifies PPE for work within the arc flash boundary.**
- **No arc flash hazard, then no arc flash PPE is required.**

Table 130.7(C)(16) Personal Protective Equipment (PPE)

PPE Category	PPE
1	**Arc-Rated Clothing, Minimum Arc Rating of 4 cal/cm²** (see Note 1) Arc-rated long-sleeve shirt and pants or arc-rated coverall Arc-rated face shield (see Note 2) or arc flash suit hood Arc-rated jacket, parka, rainwear, or hard hat liner (AN) **Protective Equipment** Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Heavy duty leather gloves (see Note 3) Leather footwear (AN)
2	**Arc-Rated Clothing, Minimum Arc Rating of 8 cal/cm²** (see Note 1) Arc-rated long-sleeve shirt and pants or arc-rated coverall Arc-rated flash suit hood or arc-rated face shield (see Note 2) and arc-rated balaclava Arc-rated jacket, parka, rainwear, or hard hat liner (AN) **Protective Equipment** Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Heavy duty leather gloves (see Note 3) Leather footwear
3	**Arc-Rated Clothing Selected so That the System Arc Rating Meets the Required Minimum Arc Rating of 25 cal/cm²** (see Note 1) Arc-rated long-sleeve shirt (AR) Arc-rated pants (AR) Arc-rated coverall (AR) Arc-rated arc flash suit jacket (AR) Arc-rated arc flash suit pants (AR) Arc-rated arc flash suit hood Arc-rated gloves (see Note 1) Arc-rated jacket, parka, rainwear, or hard hat liner (AN) **Protective Equipment** Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Leather footwear
4	**Arc-Rated Clothing Selected so That the System Arc Rating Meets the Required Minimum Arc Rating of 40 cal/cm²** (see Note 1) Arc-rated long-sleeve shirt (AR) Arc-rated pants (AR) Arc-rated coverall (AR) Arc-rated arc flash suit jacket (AR) Arc-rated arc flash suit pants (AR) Arc-rated arc flash suit hood Arc-rated gloves (see Note 1) Arc-rated jacket, parka, rainwear, or hard hat liner (AN) **Protective Equipment** Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Leather footwear

AN: as needed (optional). AR: as required. SR: selection required.

Notes:

(1) *Arc rating* is defined in Article 100.

(2) Face shields are to have wrap-around guarding to protect not only the face but also the forehead, ears, and neck, or, alternatively, an arc-rated arc flash suit hood is required to be worn.

(3) If rubber insulating gloves with leather protectors are used, additional leather or arc-rated gloves are not required. The combination of rubber insulating gloves with leather protectors satisfies the arc flash protection requirement.

(D) Other Protective Equipment.

(1) Insulated Tools and Equipment. Employees shall use insulated tools or handling equipment, or both, when working inside the restricted approach boundary of exposed energized electrical conductors or circuit parts where tools or handling equipment might make accidental contact. Insulated tools shall be protected from damage to the insulating material.

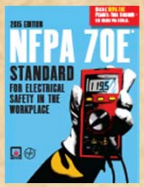
Informational Note: See 130.4(B), Shock Protection Boundaries.

(a) Requirements for Insulated Tools. The following requirements shall apply to insulated tools:

(1) Insulated tools shall be rated for the voltages on which they are used.

(2) Insulated tools shall be designed and constructed for the environment to which they are exposed and the

2015 – Elimination of HRC 0

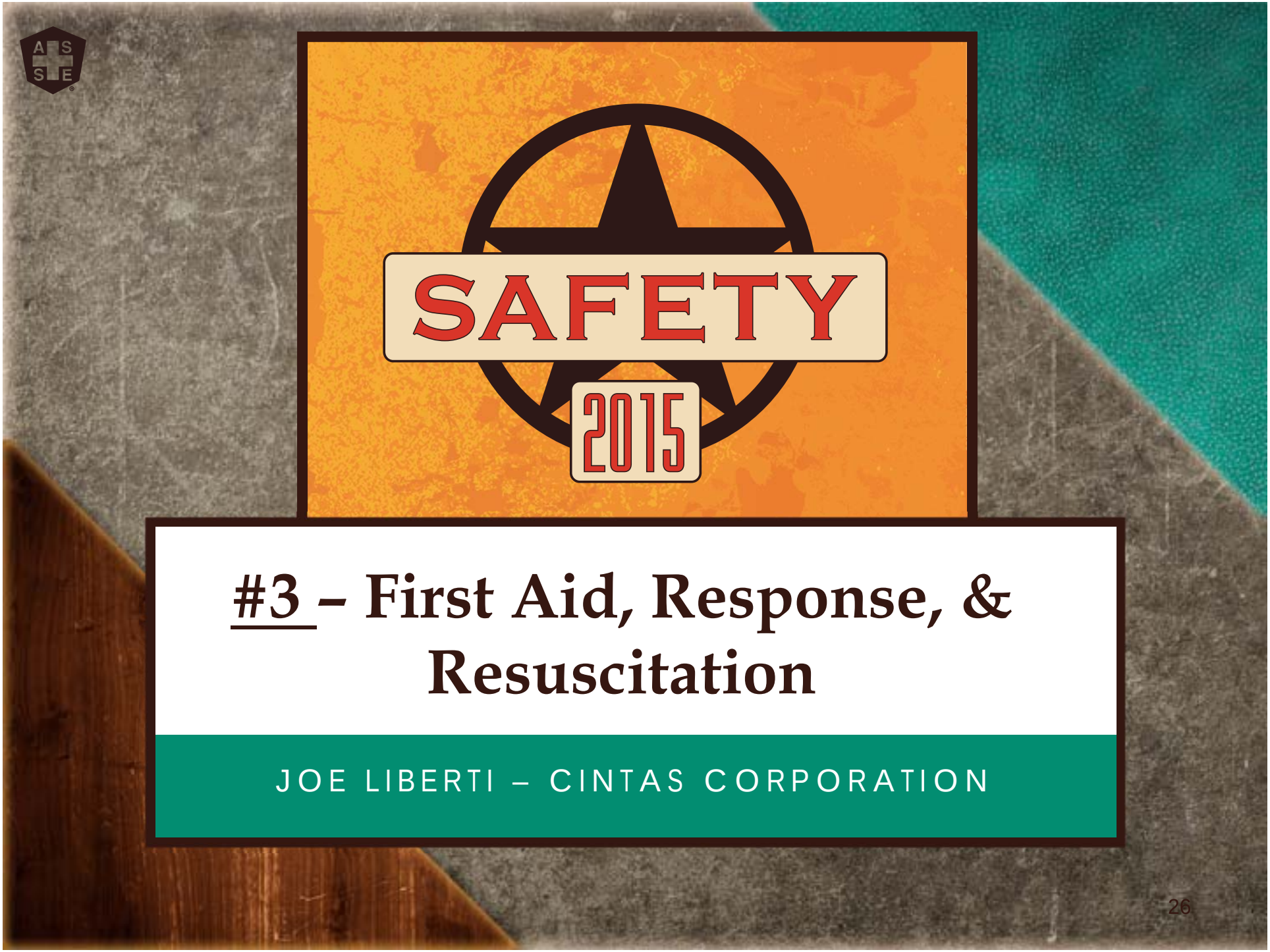


In with the new…

- When using a risk assessment….
- If no calculations are done, garments must be arc rated.

Table H.3(a) Summary of Specific Sections Describing PPE for Electrical Hazards

Arc Flash Hazard PPE	Applicable Section(s)
Incident energy exposures up to 1.2 cal/cm²	
Clothing: nonmelting or untreated natural fiber long-sleeve shirt and long pants or coverall	130.7(C)(1); 130.7(C)(9)(d)
Gloves: heavy-duty leather	130.7(C)(7)(b); 130.7(C)(10)(d)
Hard hat: class G or E	130.7(C)(3)
Face shield: covers the face, neck, and chin (as needed)	130.7(C)(3)
Safety glasses or goggles	130.7(C)(4); 130.7(C)(10)(c)
Hearing protection	130.7(C)(5)
Footwear: heavy-duty leather (as needed)	130.7(C)(10)(e)
Incident Energy Exposures ≥ 1.2 cal/cm²	
Clothing: arc-rated clothing system with an arc rating appropriate to the anticipated incident energy exposure	130.7(C)(1); 130.7(C)(2); 130.7(C)(6); 130.7(C)(9)(d)
Clothing underlayers (when used): arc-rated or nonmelting untreated natural fiber	130.7(C)(9)(c); 130.7(C)(11); 130.7(C)(12)
Gloves:	130.7(C)(7)(b); 130.7(C)(10)(d)



#3 – First Aid, Response, & Resuscitation

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2015 – Emergency Response Changes

Under the Contact Release section:

- **All qualified-level employees** are required to be trained on how to safely "release" a victim from contact with an electrical circuit.
- Trainees should be trained on the process of utilizing a **"body rescue hook"** to safely pull the victim from the circuit
- ***Refresher Required Annually***

Sources: NFPA 70E, 2015 Edition, pages 16

2015 – Emergency Response Changes

All employees responsible for responding to a medical emergency are required to be trained in....

- First Aid and CPR
  - *(Particularly those who would be responding to an electrical shock and/or electrical burn injury)*
- ***Refresher Required Annually***

Sources: NFPA 70E, 2015 Edition, pages 16

2015 – Emergency Response Changes

If an Automated External Defibrillator (**AED**) is part of the employer's safety program…

- AED Training Required
- Same Employees as CPR
- ***Refresher Required Annually***

Sources: NFPA 70E, 2015 Edition, pages 16

SAFETY 2015

Informative Annex H

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Informative Annex H

Guidance on Selection of Protective Clothing and Other Personal Protective Equipment (PPE)

- 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

Table H.2 Simplified Two-Category, Arc-Rated Clothing System

Clothing[a]	Applicable Tasks
Everyday Work Clothing Arc-rated long-sleeve shirt with arc-rated pants (minimum arc rating of 8) *or* Arc-rated coveralls (minimum arc rating of 8)	All arc flash PPE category 1 and arc flash PPE category 2 tasks listed in Table 130.7(C)(15)(A)(a), Table 130.7(C)(15)(A)(b), and Table 130.7(C)(15)(B)[b]
Arc Flash Suit A total clothing system consisting of arc-rated shirt and pants and/or arc-rated coveralls and/or arc flash coat and pants (clothing system minimum arc rating of 40)	All arc flash PPE category 3 and arc flash PPE category 4 tasks listed in Table 130.7(C)(15)(A)(a), Table 130.7(C)(15)(A)(b), and Table 130.7(C)(15)(B)[b]

[a]Note that other PPE listed in Table 130.7(C)(16), which include arc-rated face shields or arc flash suit hoods, arc-rated hard hat liners, safety glasses or safety goggles, hard hats, hearing protection, heavy-duty leather gloves, rubber insulating gloves, and leather protectors, could be required. The arc rating for a garment is expressed in cal/cm^2.

Sources: NFPA 70E, 2015 Edition pages 84-86

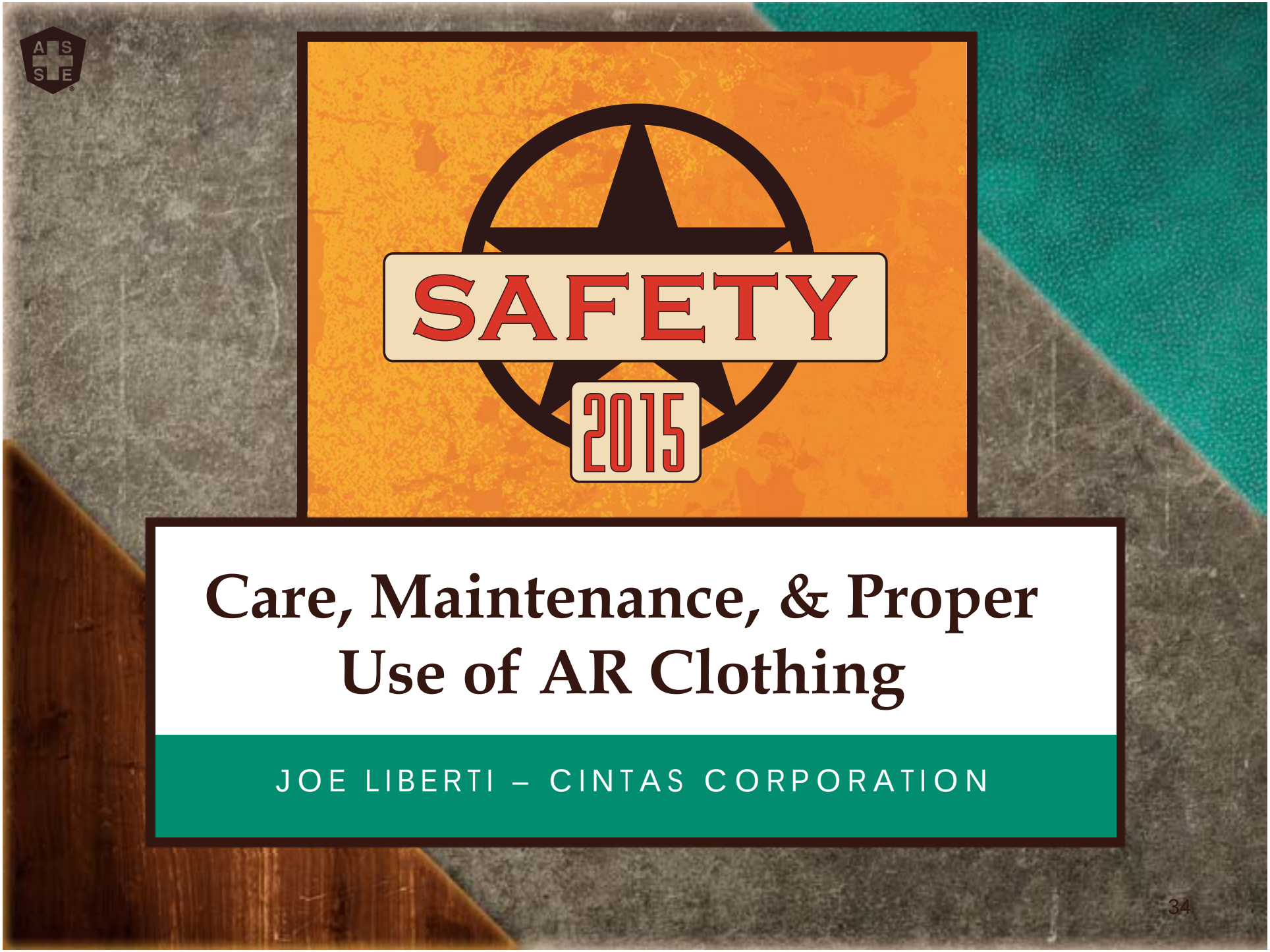
PPE CATEGORY 2

- Arc Rated (AR) Shirt (*tucked in*) 8 cal/cm^2
- Arc Rated (AR) Pant 8 cal/cm^2
- Leather Footwear
- Ear Canal Inserts
- Arc Rated (AR) Balaclava 8 cal/cm
- Standard Safety Glasses (Z 87.1)
- Arc Rated Hard Hat and Face Shield/Chin Cup
- Voltage Rated Gloves (Class 0)
- Leather Protector Gloves

Sources: Burn Survivor Resource Center: http://burnsurvivor.com/burn_types_first

Daily wear vs. Task Wear

- **Program design risks:**
  - Employees elect to not protect themselves
  - Company & Management must police task wear
  - Cannot wear synthetics under Arc Rated Coveralls



Care, Maintenance, & Proper Use of AR Clothing

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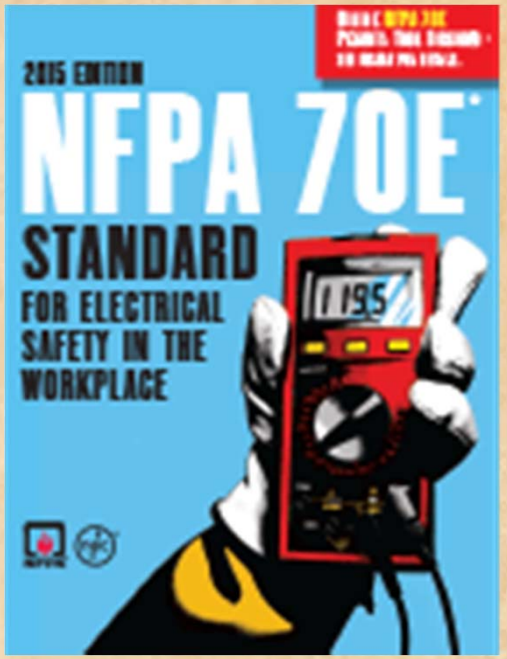
NFPA 70E – 130.7 (13)

A. Inspection
B. Manufacturers Instructions
C. Storage
D. Cleaning, Repairing, and Affixing Items.

- Key word is **SHALL**!



Sources: NFPA 70E, 2015 Edition page 33

ASTM F-2757

- **Guidelines for companies who mandate home laundry of AR Clothing:**

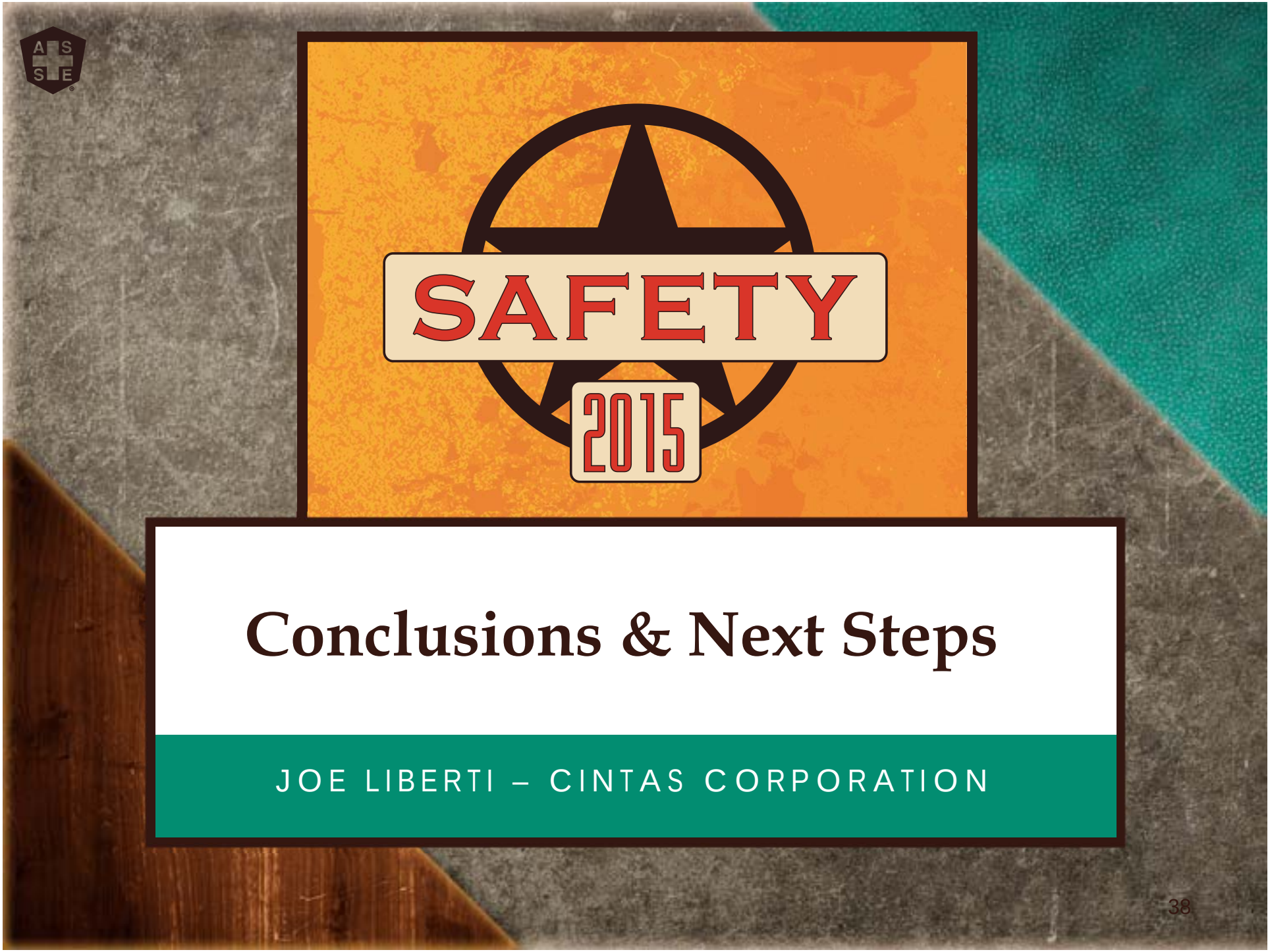
- ***Do not use*:**
  - chlorine bleach
  - hydrogen peroxide
  - Starch
  - fabric softeners,
  - pretreatment products
- Use ***soft water***
- Launder AR and arc rated garments ***separately***.

Sources: ASTM 2757, pages 1-6

Arc Rated Clothing - Proper Use

- Always the outermost layer
- All natural, non-melting undergarments
- Clean, no flammable contaminants
- Repaired correctly and removed from service when needed

Sources: NFPA 70E, 2015 Edition page 31



Conclusions & Next Steps

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www.Bandicam.com
The Hilgeman Group Accident Investigation
File #418
Video Clip. See recording.

Thank you!

Joe Liberti

Cintas Corporation

FRC Regional Director

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