



Canadian  
Utilities Equipment  
& Engineering Show



INTERNATIONAL CENTRE, TORONTO, ON - SEPTEMBER 14-15 | 2010

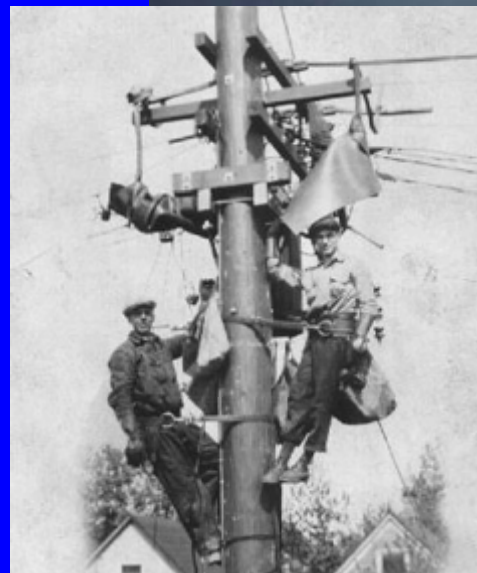
# ARC FLASH HAZARDS & STANDARDS IN ELECTRICAL UTILITIES

MIKE DOHERTY

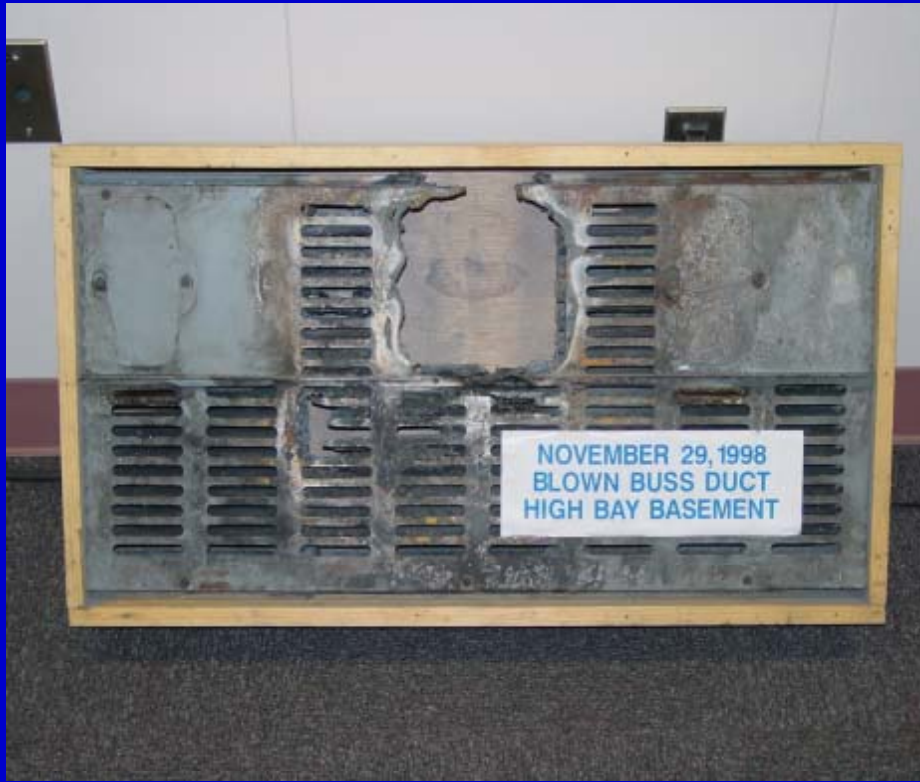
INFRASTRUCTURE HEALTH and SAFETY  
ASSOCIATION

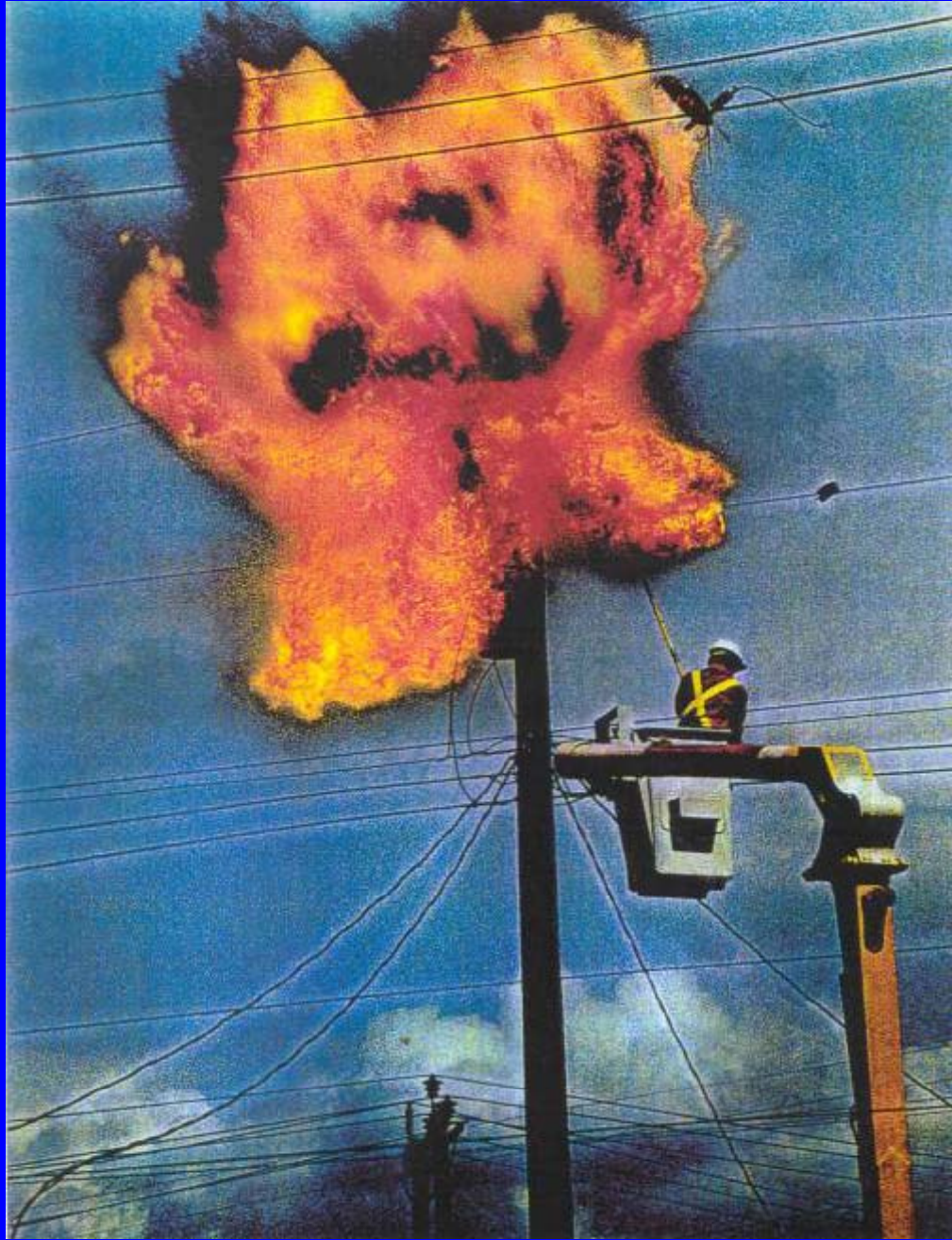
[moherty@ihsa.ca](mailto:moherty@ihsa.ca)

1-800-263-5024 X 8479



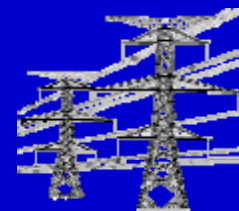








# Injuries From Arc Exposure



Electrical flash burns. Mills, Morton, Page.  
A Color Atlas of Accidents and Emergencies, 1984.





**480 VOLTS**







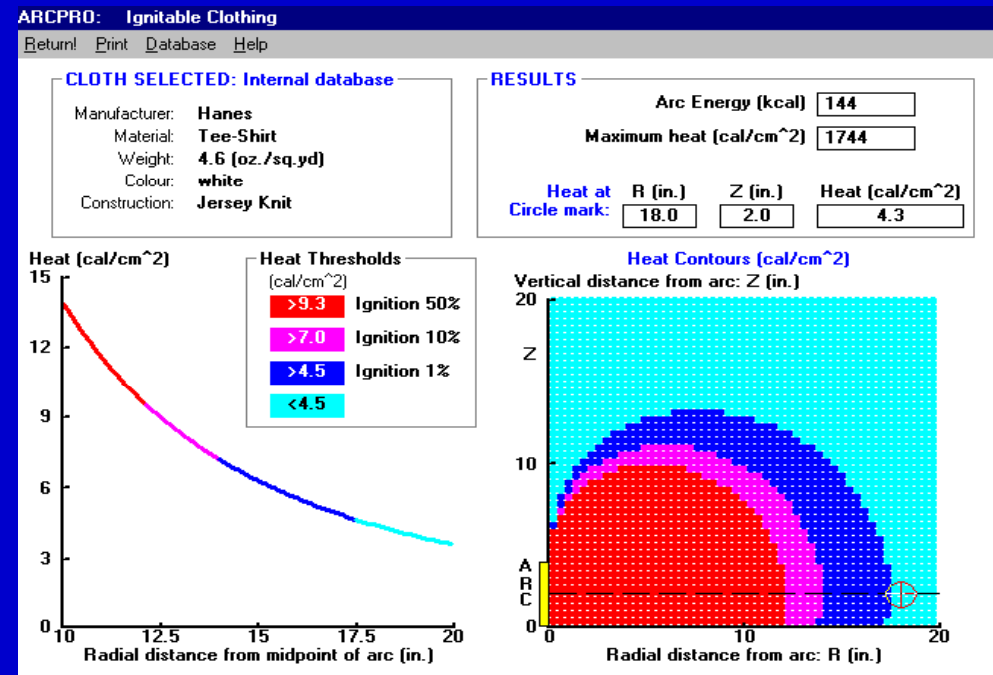
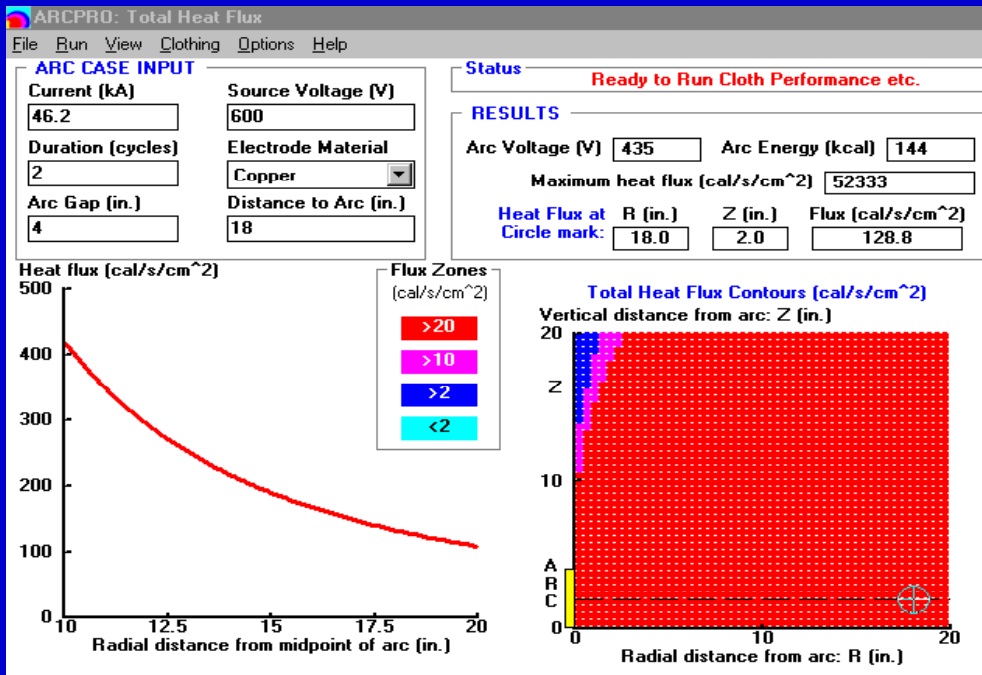
ARC FLASH

TESTING

KINECTRICS  
LAB

05-26-2003 01:06:53

05/27/03 M01 C47 10:51:24



**Factors which when Multiplied by Arcpro Single-Arc Incident Energies Produce Incident Energies in the Range of Those Measured in the IEEE 1584 Tests with 3 Vertical Electrodes in a Flat Plane at Voltages of 13.8 kV and Below**

(CONTACT KINECTRICS INC. FOR ALL INFORMATION)

Voltage	<1kV		=>1 kV to 13.8kV					
	Current		Current		Current		Current	
	<=10kA		>10kA to 30kA		<=10kA		>10kA to 40kA	
Arc Length	=<1"	>1" to 1.5"	=<1"	>1" to 1.5"	=<1"	>1" to 6"	=<1"	>1" to 6"
Open	6.5	3	4.5	2	4	2	2.5	2
In-Box	10	10	6	4.5	5.5	3.5	4	3.5

The worker was in the bucket of a truck when a non-energized conductor wire came in contact with an energized 16,000-volt conductor wire.

The victim is listed in serious condition with burns to his hands, arms, shoulders and upper back.

An electric arc flash,  
rather than a jolt of  
current, was the probable  
cause of injury.

He was injured while working to replace old 4,000-volt power lines with upgraded 16,000-volt lines.

He was taking out some  
old under build 4 kv from  
under the 27.6 kv  
distribution system.

The bucket of the hydro truck was lowered and he was removed.

Employees who were in the  
area at the time of the  
incident and may have  
witnessed it were  
interviewed by police.

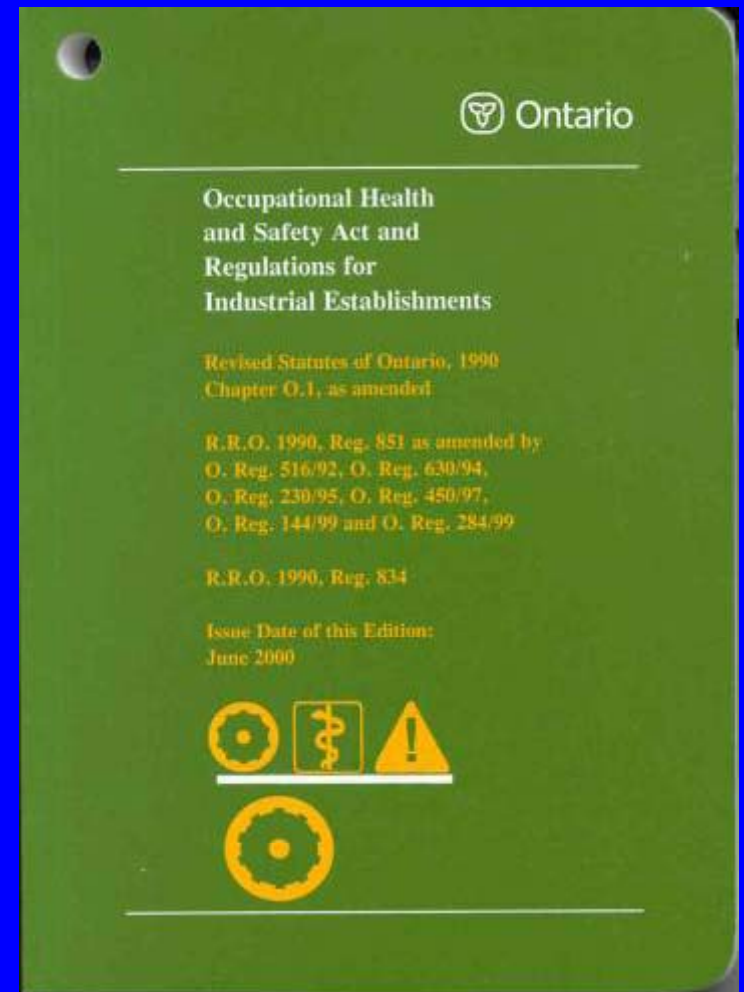
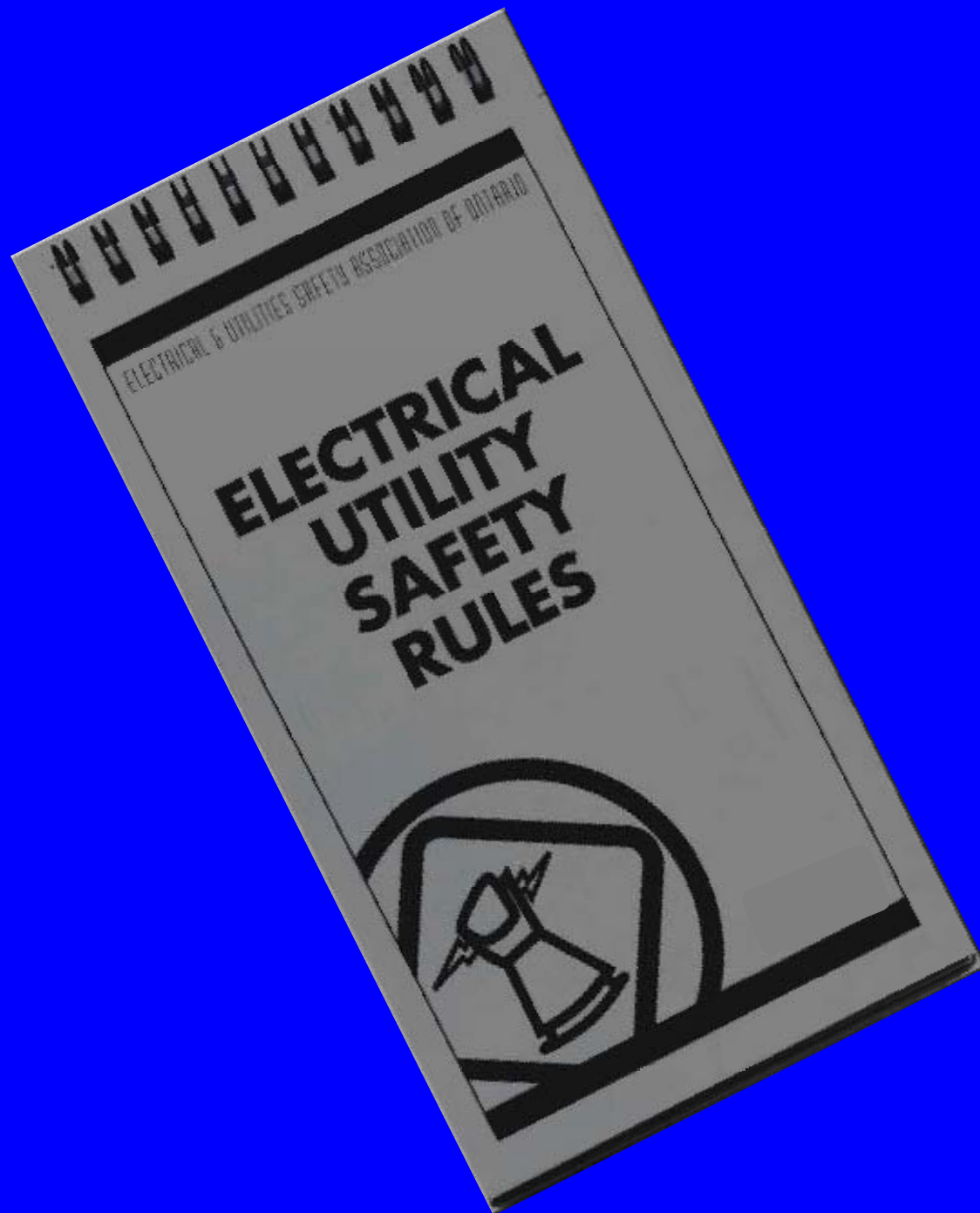
There were power outages in portions of the city and traffic lights were reported to be malfunctioning throughout the central core.

Winds were gusting to  
around 55 km/h at the time  
of the incident, which may  
have been a factor

The arcflash occurred about 8 – 10 inches from his shoulder.

He had a ATPV 46 cal  
winter jacket and cotton tee  
shirt and FR (with no ATPV  
rating or reference to ASTM  
1506) and an FR bib  
coverall

Between his winter jacket  
and the cotton tee shirt he  
was wearing a mixed nylon  
hooded sweat shirt, 80%  
nylon & mixed cotton and  
20% poly





# Rule 135 – Rubber Glove Work

# Electrical Utility Safety Rules (Jan 2009)

(Reference Only – Use E&USA Rule Book)

## 113 Arc Flash, Flame Resistant Protective Equipment

When *workers* are required to perform work on exposed *energized apparatus* or where exposure to an *arc flash* hazard exists, all practical measures shall be taken to protect *workers* against the effects of electric *arc flash*.

### 1. When working on or in *proximity* to exposed *energized apparatus*,

a) The *arc flash, flame resistant* clothing and *approved* protective equipment selected must provide an adequate level of protection to protect the *worker*.

b) The outer layer of clothing must be made of *arc flash, flame resistant* material.

c) Clothing worn in conjunction with *arc flash, flame resistant* clothing must not contribute to increased *worker* injury.

d) *Arc flash, flame resistant* clothing, foul-weather clothing and protective equipment must be manufactured, tested and maintained to current recognized industry standards.

e) *Workers* shall wear *approved* eye protection in all circumstances where there is a possibility of an electrical flash or



# CSA Z 462-08

## Workplace Electrical Safety

- Develop and implement a national safety standard for electrical safety
- Chapter 1 Safety Related Work Practices
- Chapter 2 Safety Related Maintenance Requirements
- Chapter 3 Safety Requirements for Special Equipment
- Annexes



# CAN/ULC S-801-10

## Standard on Electrical Utility Workplace Electrical Safety For Generation, Transmission, And Distribution

### **CAN/ULC-S801-10 ADDRESSES:**

- Fundamental requirements
- Minimum approach distances for working near or on energized electrical lines or equipment
- Protective tools, equipment & devices
- Working on energized electrical lines and equipment
- Arc flash protection
- Radio frequency hazards
- Working on isolated electric utility systems
- Working near electric utility systems

Note: See Page #1 to access the “complete Scope” Section for S801

# CAN/ULC S-801-10

11 Sections

5 Annexes

## Section 8. Arc Flash Protection (page 50)

8.1 Fundamental Requirements

8.2 Arc Flash assessments

8.3 Engineering and Control

8.4 Arc-Rated Clothing and Other Arc Rated Personal Protective Equipment (PPE)

8.5 Care and Maintenance of Arc-Rated Clothing and PPE

# CAN/ULC S-801-10

## Section 8. Arc Flash Protection (page 50)

### 8.1 Fundamental Requirements

8.1.1 When workers are required to work on or near energized equipment above 50 V a.c., all practicable measures shall be taken to protect workers from the harmful effects of electric arc flash.

These measures shall include one or a combination of the following:

- A) Engineered controls (i.e., minimized fault currents, reduced clearing times, arc-resistant switchgear, remote equipment operation, barrier boards, arc-flash blankets, etc.);
- B) Administrative controls (i.e., electrically safe work zones, increased working distance, specific safe work methods, etc.); and/or
- C) The use of arc-rated clothing and associated arc-rated PPE.

# CAN/ULC S-801-10

## Section 8. Arc Flash Protection (page 50)

### 8.2 Arc Flash assessments

8.2.1 When workers are required to work on or near energized equipment above 240 V a.c. and sources greater than 125 kVA, an arc flash assessment should be performed in order to determine the potential incident energy of an arc flash for the specific equipment (see Appendix C).

8.2.2 A professional engineer shall approve the arc flash assessment for generation, transmission and distribution systems. The calculations and methodology used shall be documented.

8.2.3 A process for informing workers of arc flash hazards shall be in place.

# CAN/ULC S-801-10

## Section 8. Arc Flash Protection (page 50)

8.2.4 Potential incident energy shall be determined using formulae and methods appropriate for the voltage level and the nature of the installation, such as:

A) IEEE 1584, IEEE Guide for Performing Arc Flash Hazard Calculations;

B) IEEE C2, National Electrical Safety Code, Part 4; or

C) SaskPower TS&R Report Number 05-345, Arc Protection Recommendations for SaskPower Transmission and Distribution;

D) Other applicable engineering analyses and calculations.

# CAN/ULC S-801-10

## Section 8. Arc Flash Protection (page 50)

8.2.5 Parameters to consider when performing an arc flash assessment shall include, but are not limited to the following:

A) Fault current;

B) Fault clearing time;

C) Arc length; the length of the arc is related to the amount of heat that can be radiated to the worker;

D) Distance to the arc;

E) System voltage;

# CAN/ULC S-801-10

## Section 8. Arc Flash Protection (page 51)

8.2.6 When performing arc flash assessments, consideration shall be given to very low fault energy areas as well as very high. Low fault currents can result in very long clearing times and may give higher total incident energies than high fault currents with very fast clearing times.

8.2.7 Arc flash assessments shall be reviewed periodically, and as a minimum, when design changes intended to be permanent occur to electrical system parameters that affect the assessment. (e.g., when changing protection settings, changing power transformer size, or power source configuration, etc.).

8.2.8 Arc flash assessments shall be reviewed when work on the system results in temporary changes to electrical system parameters that affect the assessment.

# CAN/ULC S-801-10

## Section 8. Arc Flash Protection (page 51)

### 8.3 Engineering and Control

8.3.1 Arc flash hazards should be eliminated or controlled through engineered solutions.

8.3.2 Where the hazard cannot be eliminated or controlled through the use of engineered solutions alone, then engineered and administrative controls shall be used to minimize the potential incident energy to the lowest practicable level for the specific apparatus.

8.3.3 Notwithstanding Clauses 8.3.1 and 8.3.2, when the incident energy cannot be reduced to below  $1675 \text{ kJ/m}^2$  ( $40 \text{ cal/cm}^2$ ) at the expected working distance (e.g., during switching and grounded to establish an electrically safe work zone), arc-rated clothing and PPE with an adequate incident energy rating shall be worn and the work should be planned to minimize worker exposure.

# CAN/ULC S-801-10

## Section 8. Arc Flash Protection (page 51)

### 8.4 Arc-Rated Clothing and Other Arc Rated Personal Protective Equipment (PPE)

8.4.1 Where there is a risk of arc flash, only workers wearing appropriate arc-rated clothing and arc-rated PPE shall be allowed in an area where there is an identifiable risk that an arc flash is present.

8.4.2 In selecting arc-rated clothing and arc-rated PPE, the arc rating as derived from the Arc Thermal Performance Value (ATPV) shall be evaluated.

8.4.3 The arc-rated clothing and associated arc-rated PPE shall provide protection for a worker. The level of protection required is determined by calculating the potential incident energy at the expected working distance.

8.4.4 Arc-rated clothing and arc-rated PPE shall provide a minimum Arc Thermal Performance Value (ATPV) of 335 kJ/m<sup>2</sup> (8 cal/cm<sup>2</sup>). If layered clothing is used to achieve the 335 kJ/m<sup>2</sup> (8 cal/cm<sup>2</sup>), it shall be tested to confirm that the minimum ATPV is met.





# CAN/ULC S-801-10

## Section 8. Arc Flash Protection (page 51/52)

8.4.5 Arc-rated clothing may be layered when necessary to increase the level of protection. Refer to clothing manufacturer's information concerning protection levels of layered arc-rated clothing.

8.4.6 All clothing worn under the outer layer of arc-rated clothing shall be made of non-melting fabric.

# CAN/ULC S-801-10

## Section 8. Arc Flash Protection (page 51/52)

8.4.7 Arc-rated clothing shall be constructed of inherently flame resistant fabric or fabric treated for permanent (normal life of the garment) flame resistance, and shall be in compliance with or tested in accordance with the following standard(s), or an industry standard(s) of equivalent or greater worker protection:

A) CAN/ULC-61482-1, Live Working – Flame-Resistant Materials for Clothing for Thermal Protection of Workers – Thermal Hazards of an Electric Arc – Part 1: Test Methods;

B) IEC 61482-1-1, Live working – Protective clothing against the thermal hazards of an electric arc – Part 1: Test methods – Method 1 – Determination of the arc rating (ATPV or EBT50) of flame resistant materials for clothing;

C) IEC 61482-2, Live working – Protective clothing against the thermal hazards of an electric arc – Part 2: Requirements;

D) ASTM F 1506, Standard Performance Specification for Textile Material for Wearing Apparel for Use by Electrical Workers Exposed to Momentary Electric Arc and Related Thermal Hazards;

E) ASTM F 1891, Standard Specification for Arc and Flame Resistant Rainwear; and

F) ASTM F 1959, Standard Test Method for Determining the Arc Rating of Materials for Clothing.

## CAN/ULC S-801-10

### Section 8. Arc Flash Protection (page 52)

8.4.8 When the use of the arc-rated clothing and associated arc-rated PPE required by the arc flash assessment introduces additional hazards to the worker, the safe work plan shall be reviewed and revised as appropriate to ensure that the overall hazard to the worker is reduced to the lowest risk level.

8.4.9 When worker visibility is a safety concern, the outer layer of arc-rated clothing shall meet the requirements of CAN/CSA-Z96, High Visibility Safety Apparel, or an industry standard(s) equivalent or greater in worker protection.

8.4.10 Arc-Flash blankets shall be in compliance with ASTM F 2676, Standard Test Method for Determining Protective Performance of an Arc Protective Blanket for Electric Arc Hazards, or an industry standard of equivalent or greater worker protection.

# CAN/ULC S-801-10

## Section 8. Arc Flash Protection (page 50)

### 8.5 Care and Maintenance of Arc-Rated Clothing and PPE

8.5.1 Arc-rated clothing shall be cleaned in accordance with the manufacturer's recommendations.

8.5.2 Tears and holes in arc-rated clothing shall be repaired with like materials to maintain the original ATPV.

8.5.3 In order to ensure the intended protection level of arc-rated clothing and associated arc-rated PPE, workers shall inspect and maintain the clothing and equipment to protect the integrity of the arc-rating.

# SUMMARY

- ENSURE THAT ALL APPLICABLE LEGISLATION IS COMPLIED WITH
- PLAN YOUR ELECTRICAL WORK
- PERFORM COMPREHENSIVE HAZARD / RISK ASSESSMENTS INCLUDING ARC FLASH / BLAST
- USE BEST CASE PRACTICE CONSENSUS STANDARDS TO EXECUTE DUE DILLIGENCE

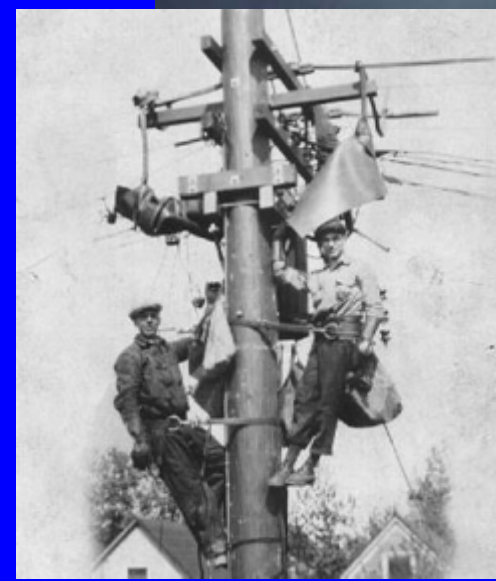


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# Thank You



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