

# **CHES Manitoba Education Day 2018**

## **Electrical Safety Program**

### **CSA Z462-2018**

## **Changes & Updates**

**April 24, 2018**

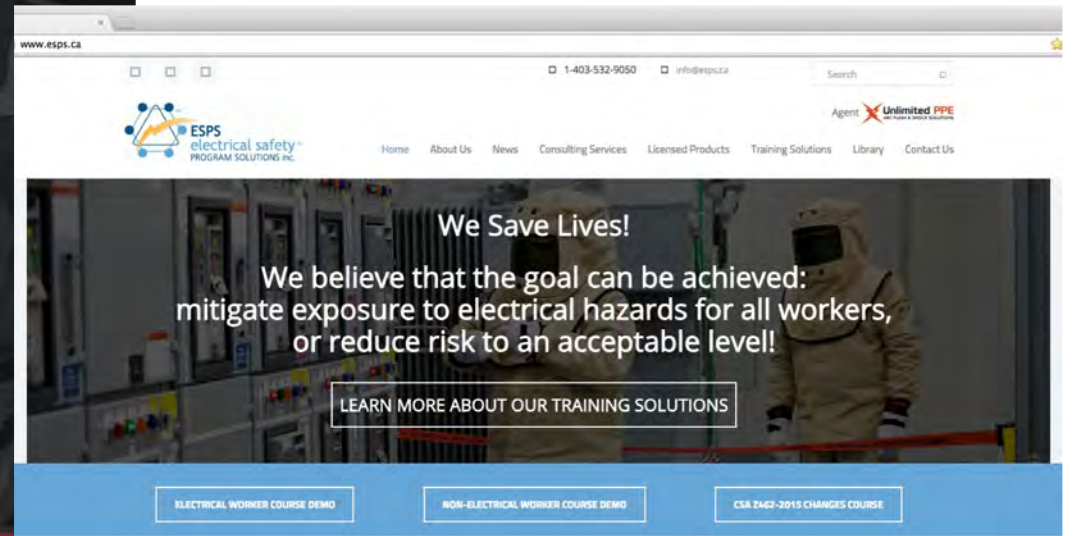
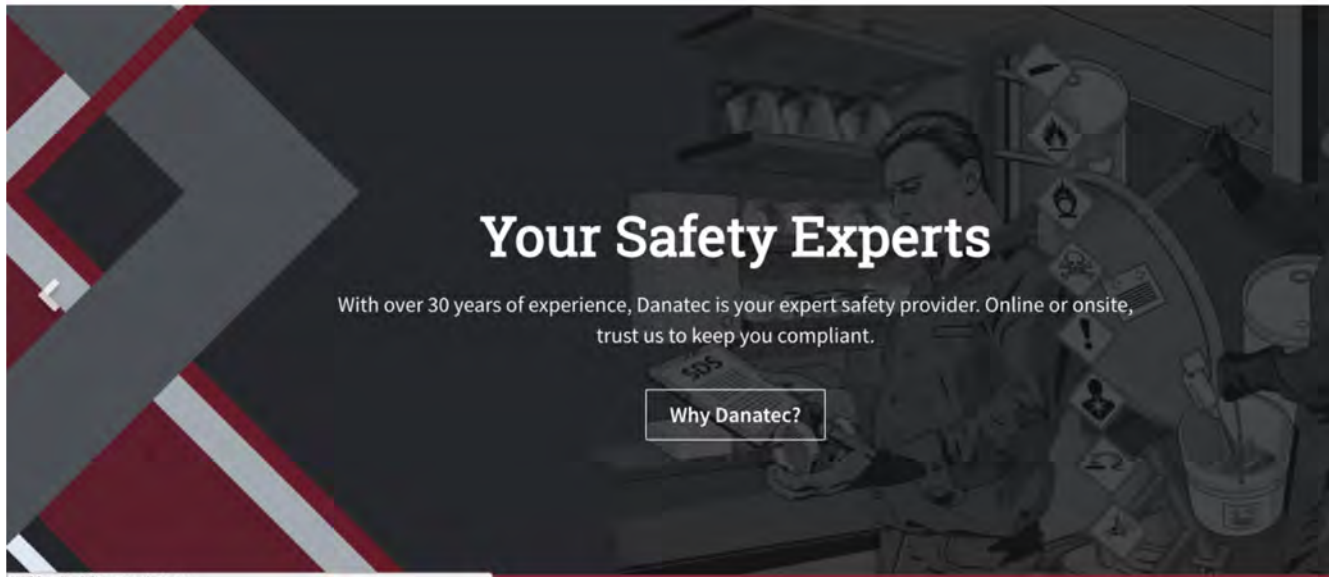
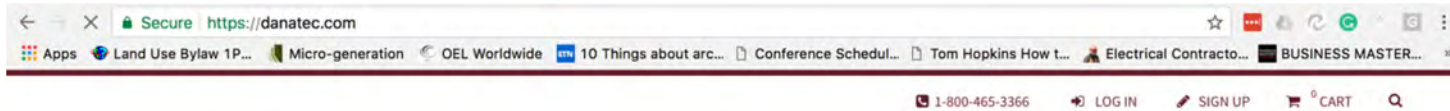
Terry Becker, P.Eng., CESC, IEEE Senior Member  
Senior Vice President, Electrical Safety  
Danatec Educational Services Ltd.

[www.danatec.com](http://www.danatec.com)

- **Terry Becker, P.Eng., CESC, IEEE Senior Member, Senior VP, Electrical Safety, Danatec Educational Services Ltd.:**
  - Mobil Oil Canada, DPH Engineering, PanCanadian/EnCana, ESPS, Danatec
  - CSA Z462 1<sup>st</sup> Past Vice-Chair
  - CSA Z462 Voting Member & Annexes Working Group Leader
  - NFPA 70E Technical Committee Annexes Working Group
  - IEEE 1584 Technical Committee Voting Member
  - CSA Z463 Guideline for Maintenance of Electrical Systems, Associate Member
  - Electrical Safety Audit Process
  - Electrical Safety Program Licensed Product, and Consulting
  - Low & High Voltage Arc Flash & Shock Training Solutions, Blended Training
  - Electrical Safety Training System (ESTS), eLearning LMS Based Training - Subject Matter Expert & Visionary



- Danatec Educational Services purchased ESPS effective August 1, 2017.

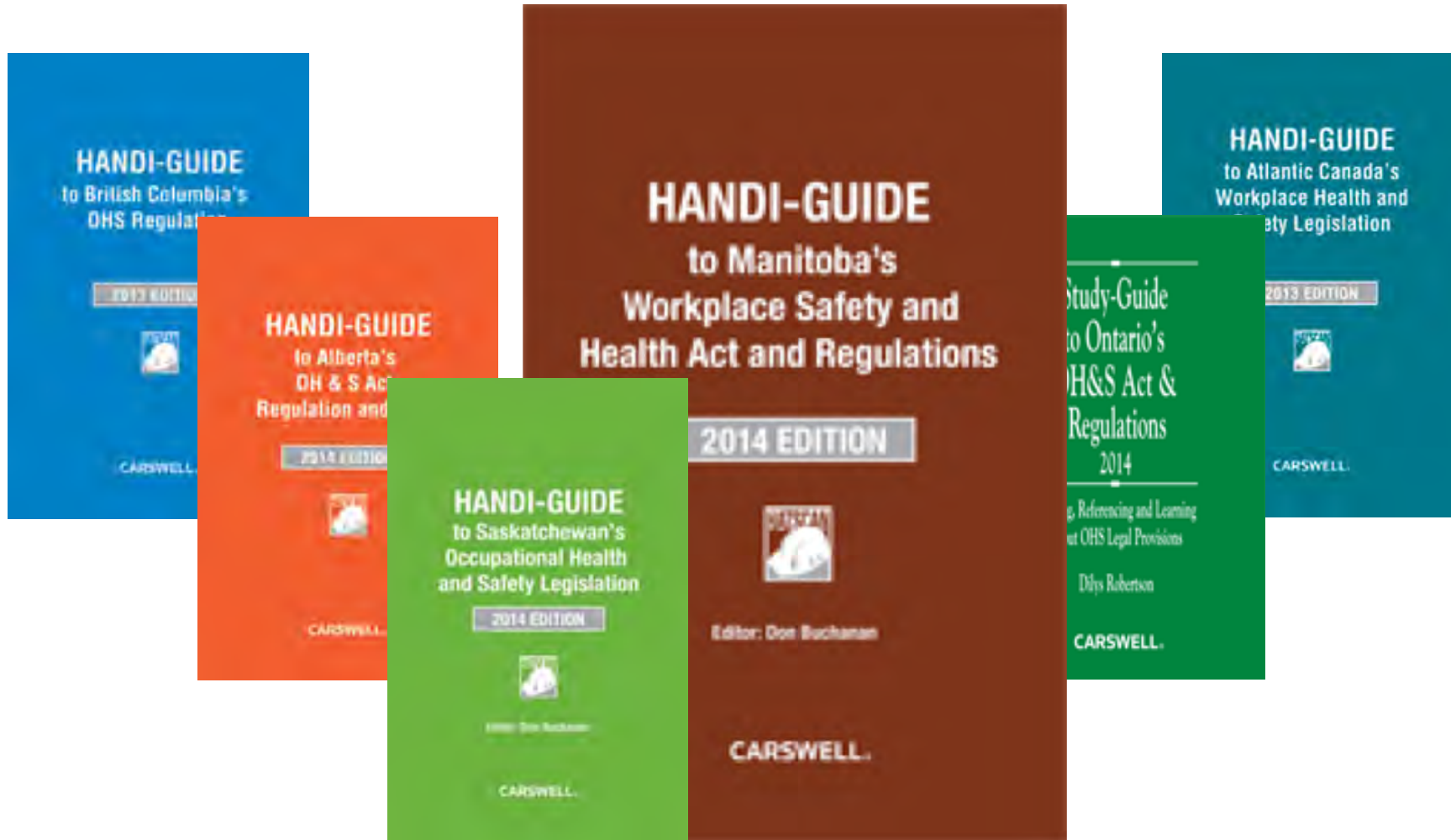


Who, What and Where We Are?

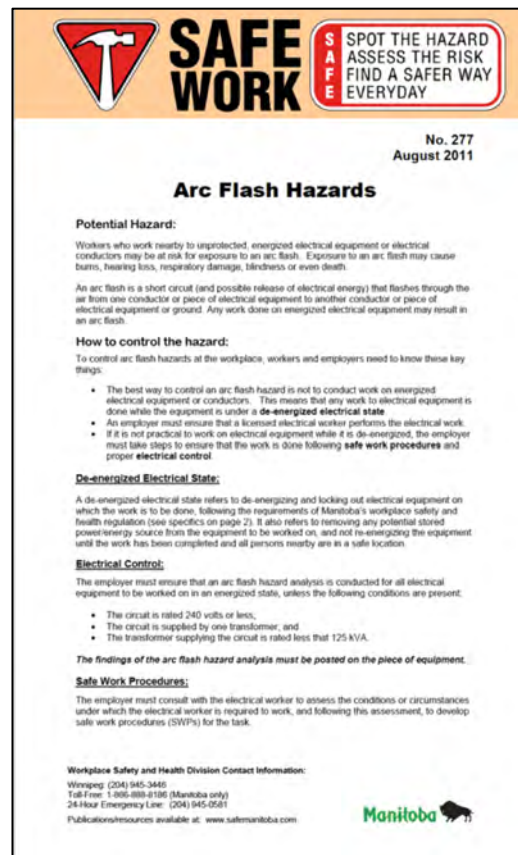
- UPDATES:
- MN SafeWork / WorkSafeMN Part 38 Electrical Safety.
- CSA Z462 & NFPA 70E Relationship.
- NFPA Electrical Incident Statistics.
- CSA Z463 Maintenance of Electrical System Standard (2018).
- IEEE 1584 2018-2019 Release.

- Electrical Safety Program and CSA Z462-2018 Changes & Updates:
- CSA Z462 Clause 4.1.6 Electrical Safety Program Requirements.
- CSA Z462 Clause 4.2 Establishing an Electrically Safe Work Condition.
- CSA Z462 Clause 4.3 Work Involving Electrical Hazards..
- CSA Z462-2018 Changes & Updates, Key Changes Review.
- Closing Remarks.
- Q & As.

# Manitoba OH&S Regulations



- Are you aware of these electrical safety specific OH&S Regulations?



**SAFE WORK** SPOT THE HAZARD  
ASSESS THE RISK  
FIND A SAFER WAY  
EVERYDAY

No. 277  
August 2011

### Arc Flash Hazards

**Potential Hazard:**  
Workers who work nearby to unprotected, energized electrical equipment or electrical conductors may be at risk for exposure to an arc flash. Exposure to an arc flash may cause burns, hearing loss, respiratory damage, blindness or even death.

An arc flash is a short circuit (and possible release of electrical energy) that flashes through the air from one conductor or piece of electrical equipment to another conductor or piece of electrical equipment or ground. Any work done on energized electrical equipment may result in an arc flash.

**How to control the hazard:**  
To control arc flash hazards at the workplace, workers and employers need to know these key things:

- The best way to control an arc flash hazard is not to conduct work on energized electrical equipment or conductors. This means that any work to electrical equipment is done while the equipment is under a **de-energized electrical state**.
- An employer must ensure that a licensed electrical worker performs the electrical work.
- If it is not practical to work on electrical equipment while it is de-energized, the employer must take steps to ensure that the work is done following **safe work procedures** and proper **electrical control**.

**De-energized Electrical State:**  
A de-energized electrical state refers to de-energizing and locking out electrical equipment on which the work is to be done, following the requirements of Manitoba's workplace safety and health regulation (see specifics on page 2). It also refers to removing any potential stored power energy source from the equipment to be worked on, and not re-energizing the equipment until the work has been completed and all persons nearby are in a safe location.

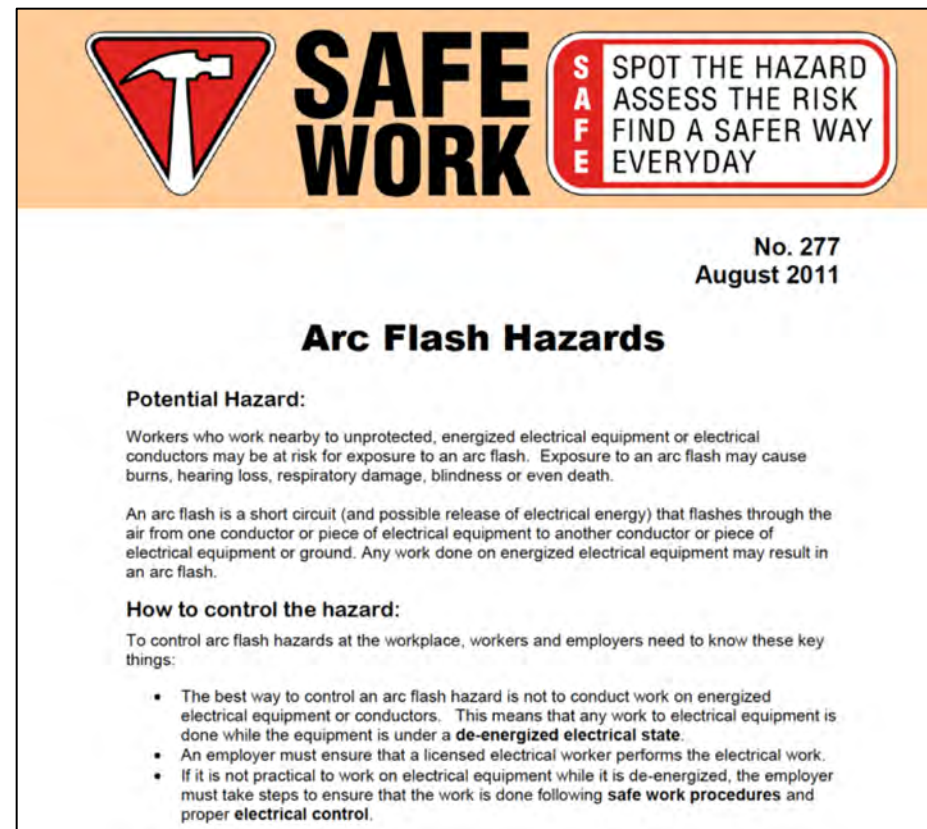

**Electrical Control:**  
The employer must ensure that an arc flash hazard analysis is conducted for all electrical equipment to be worked on in an energized state, unless the following conditions are present:

- The circuit is rated 240 volts or less,
- The circuit is supplied by one transformer, and
- The transformer supplying the circuit is rated less than 125 kVA.

*The findings of the arc flash hazard analysis must be posted on the piece of equipment.*

**Safe Work Procedures:**  
The employer must consult with the electrical worker to assess the conditions or circumstances under which the electrical worker is required to work, and following this assessment, to develop safe work procedures (SWPs) for the task.

Workplace Safety and Health Division Contact Information:  
Winnipeg: (204) 945-3446  
Toll Free: 1-866-888-8195 (Manitoba only)  
24-Hour Emergency Line: (204) 945-0581  
Publications/resources available at: [www.safemanitoba.com](http://www.safemanitoba.com)



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- Are you aware of these electrical safety specific OH&S Regulations?

**WSH REGULATION** *Summary Sheet*

**PART 38**  
**Electrical Safety**

Previous Regulation(s): NEW - Previously enforced through other regulatory requirements.

Summary of requirements:

- **Application** – applies to workplaces where electrical work is performed.
- **Safe work procedures** must be developed, implemented, and workers trained.
- **Emergency procedures for contact with energized electrical equipment** must be developed, implemented and workers trained.
- **Only electrical workers may do electrical work.**
- **Other requirements to be met:** (1) The Electricians' Licensing Act; (2) The Manitoba Electrical Code; and (3) Municipal by-laws, where applicable.
- **Energized electrical equipment** must be suitably located and guarded so that it is not contacted by a worker.
- **Work being done near exposed, energized electrical equipment** must be done in a manner to prevent a worker from contacting the equipment.
- **Defect or unsafe condition** – workers must be protected and the unsafe condition must be corrected as soon as possible.
- **Electrical equipment to be protected and properly installed** – each electrical panel and switch controlling a service supply, feeder or branch circuit must be protected from physical or mechanical damage and electrical distribution switches, including main circuit breakers, must have a suitable means for being locked-out in the open or de-energized position.
- **Temporary electrical equipment** must be adequately guarded or securely suspended overhead to provide adequate clearance for workers and material.
- **Work at a damp location** – electrical circuits must be protected by a class "A" ground fault circuit interrupter.
- **High voltage switch gear** must be restricted to persons authorized by the employer and warning signs posted.
- **Switch not to be locked in closed or energized position** unless the design specifications of the switch require it to remain in this position.
- **Electrical equipment must be de-energized and locked out** when an electrical worker is doing electrical work. This does not apply to Manitoba Hydro or an electrical worker employed by Manitoba Hydro where Manitoba Hydro complies with the appropriate CSA Standard.

**WSH REGULATION** *Summary Sheet*

**PART 38**  
**Electrical Safety**

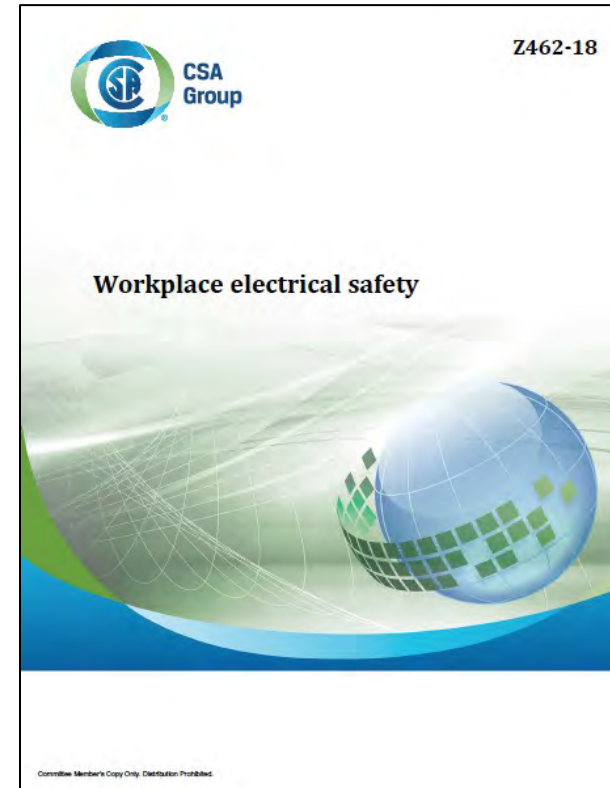
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- 2018 Editions, still technically harmonized. Z462 some subtle differences specific to Canada (e.g. Z462 now 30V threshold, 70E changed back to 50V, OSHA).



- 20 Years Data.
- 5527 fatalities.
- 99% of Fatalities Are Electrocutions.
- 1% Arc Flash Fatalities (56).
- No recorded fatalities due to Arc Blast Pressure.

**Occupational Injuries**  
**From**  
**Electrical Shock and Arc Flash Events**

*Final Report*

Prepared by:

Richard B. Campbell, ScD.  
Fire Analysis and Research Division  
National Fire Protection Association  
Quincy, Massachusetts USA

David A. Dini, P.E.  
Commercial and Industrial R&D  
UL LLC  
Northbrook, Illinois USA

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THE  
FIRE PROTECTION  
RESEARCH FOUNDATION

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THE FIRE PROTECTION RESEARCH FOUNDATION  
ONE BATTERYMARCH PARK  
QUINCY, MASSACHUSETTS, U.S.A. 02169-7471  
E-MAIL: [Foundation@NFPA.org](mailto:Foundation@NFPA.org)  
WEB: [www.nfpa.org/Foundation](http://www.nfpa.org/Foundation)



Z463-18 (3<sup>rd</sup> Draft)

December, 2017

## ***Maintenance of Electrical Systems***

## *Contents*

Technical Committee List

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- 1** Scope
- 2** Reference publications and standards development organizations
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- 4** Electrical maintenance program
- 5** Electrical maintenance as part of workplace safety and risk reduction
- 6** Planning and development of a maintenance program
- 7** General maintenance practices
- 8** Equipment-specific maintenance practices
- 9** Specialized equipment maintenance

## **Annexes**

- A** — Making a business case for a maintenance program
- B** — Electrical maintenance management systems
- C** — Simple example for risk evaluation and assessment
- D** — Time-current curves
- E** — Maintenance programs
- F** — Failure mode analysis
- G** — Spare parts inventory — Best practices
- H** — Cable condition health index flowchart example
- I** — Power system study frequency matrix
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- K** — Sample maintenance plan for switchgear
- L** — Best practices for cleaning electrical equipment
- M** — Equipment-specific types of maintenance and maintenance priority levels
- N** — Maintenance practice for airport electrical systems
- O** — Additional definitions and abbreviations
- P** — Bibliography

P1584/D32, ~~March~~July 20187  
Draft Guide for Performing Arc-Flash Hazard Calculations

1 **P1584<sup>TM</sup>/D32**  
2 **Draft Guide for Performing Arc-Flash**  
3 **Hazard Calculations**

4 Sponsor  
5  
6 **Petroleum and Chemical Industry Committee**  
7 of the  
8 **IEEE Industry Applications Society**  
9  
10

- First Published in 2002.
- IEEE – NFPA Arc Flash Phenomenon Project, Review & Update.
- 2000 arc flashes analyzed.
- Test box configurations reviewed.
- Horz. Vs Vertical electrode configuration, if Horz. Potential 200% increase, ejected arc directs incident energy at the Qualified Electrical Worker.
- <240VAC, 125kVA Guideline removed, moves down to 2000A or approx. 45kVA transformer size.
- Updated IEEE 1584 Publish anticipated first quarter 2019.

- 2 Second Guideline:

If the total protective device clearing time is longer than two seconds; consider how long a person is likely to remain in the location of the arc-flash. It is likely that a person exposed to an arc flash will move away quickly if it is physically possible, and two seconds usually is a reasonable assumption for the arc duration to determine the incident energy. However, this also depends on the specific task. A worker in a bucket truck, or inside an equipment enclosure, may need more time to move away. Use engineering judgement when applying any maximum arc duration time for incident energy exposure calculations, since there may be circumstances where a person's egress may be blocked.

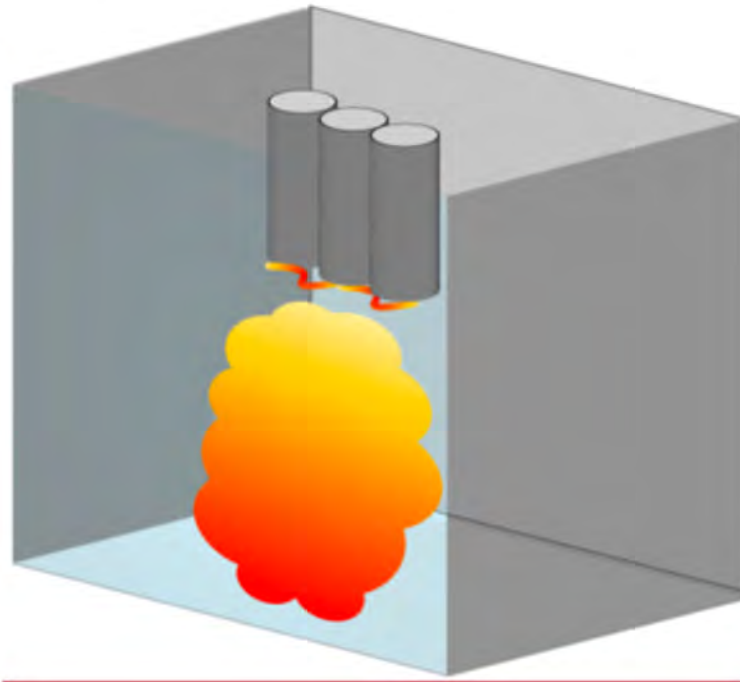


**Electrode configuration:** Electrode configuration is defined as the orientation and arrangement of the electrodes used in the testing performed for the model development. Electrodes were placed in open-air (“OA”) or enclosed (“Box”) configurations (with open front end). Electrodes were also oriented vertically and horizontally. Open-tipped and barrier-terminated electrode configurations were also used. For more details refer to Annex G. The following electrode configurations (test arrangements) are defined and listed according to their order of use within the incident energy model.

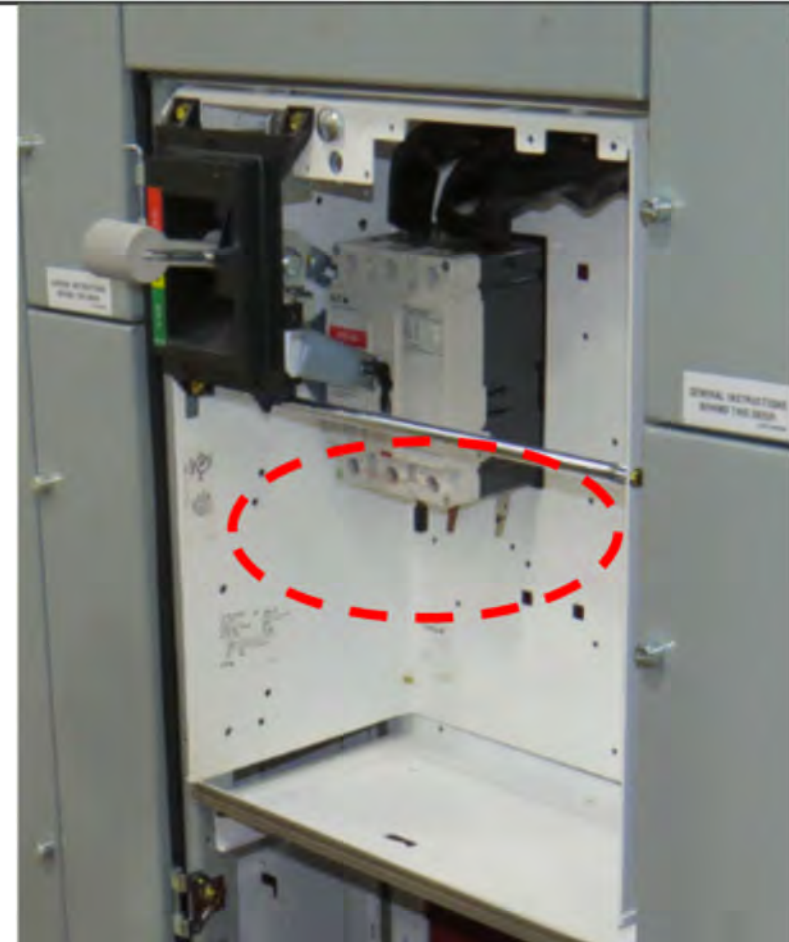
- **VCB:** Vertical electrodes inside a metal “box” enclosure.
- **VCBB:** Vertical electrodes terminated in a “barrier,” inside a metal “box” enclosure.
- **HCB:** Horizontal electrodes inside a metal “box” enclosure.
- **VOA:** Vertical electrodes in open air.
- **HOA:** Horizontal electrodes in open air.

## Electrode Configuration in Test

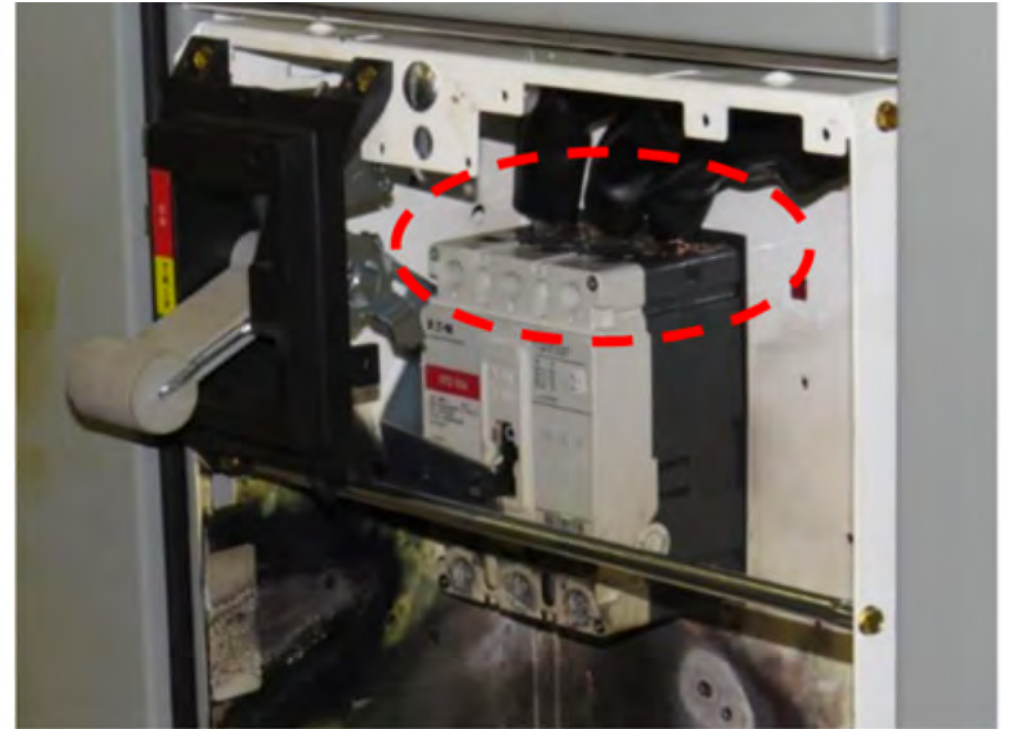
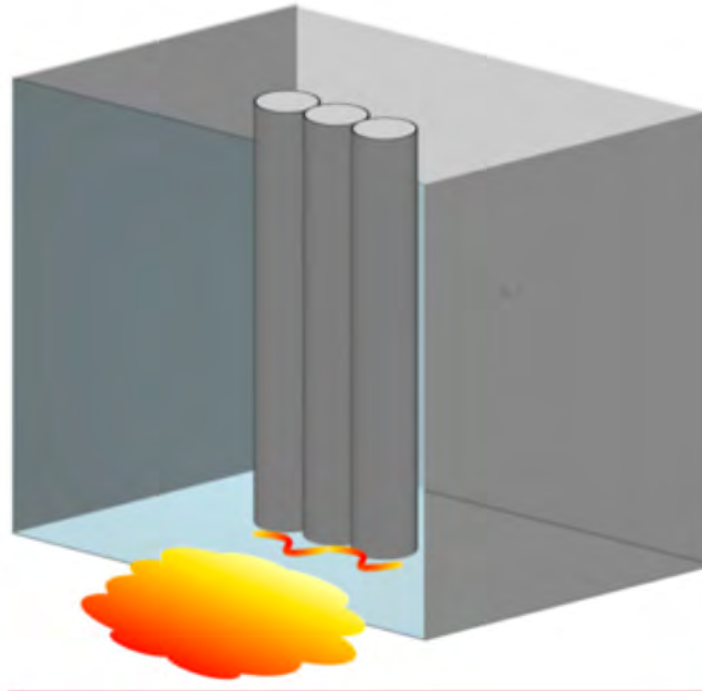
VCB



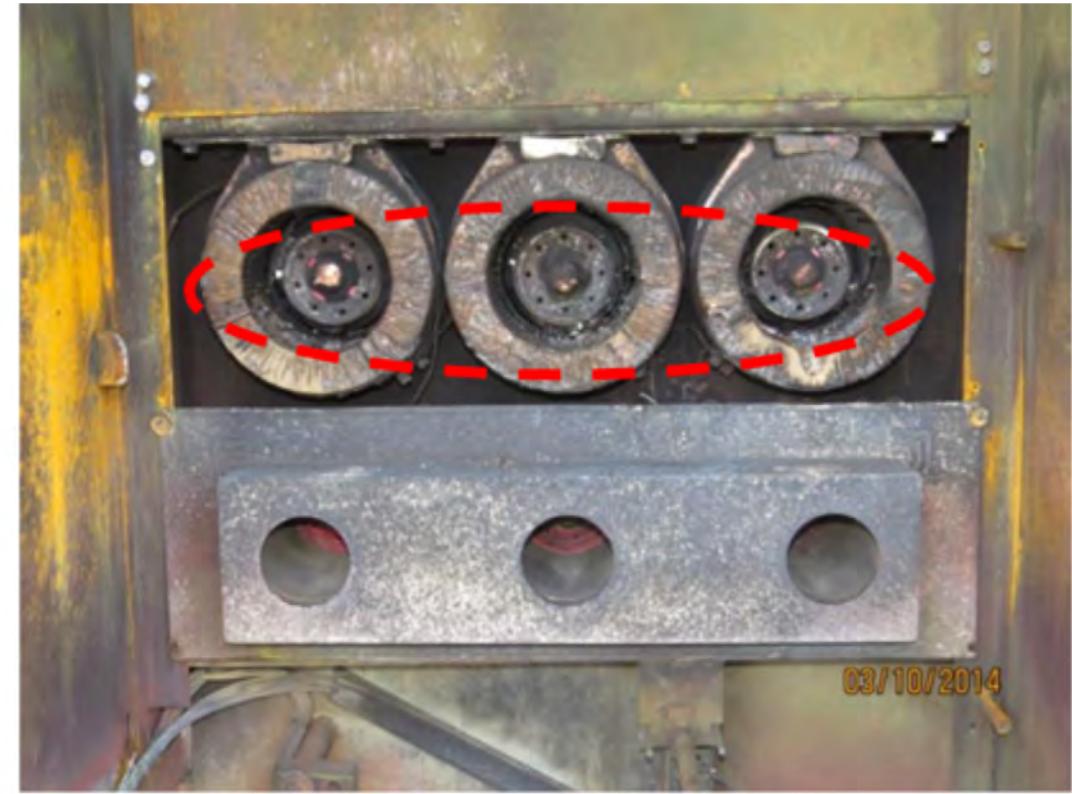
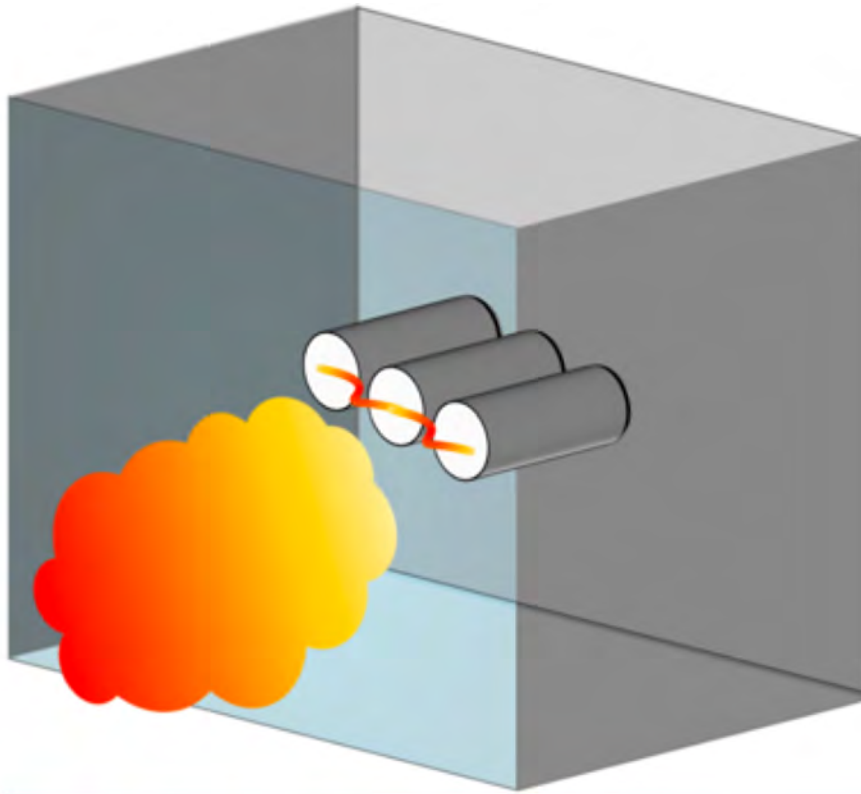
## Electrode Configuration in Equipment



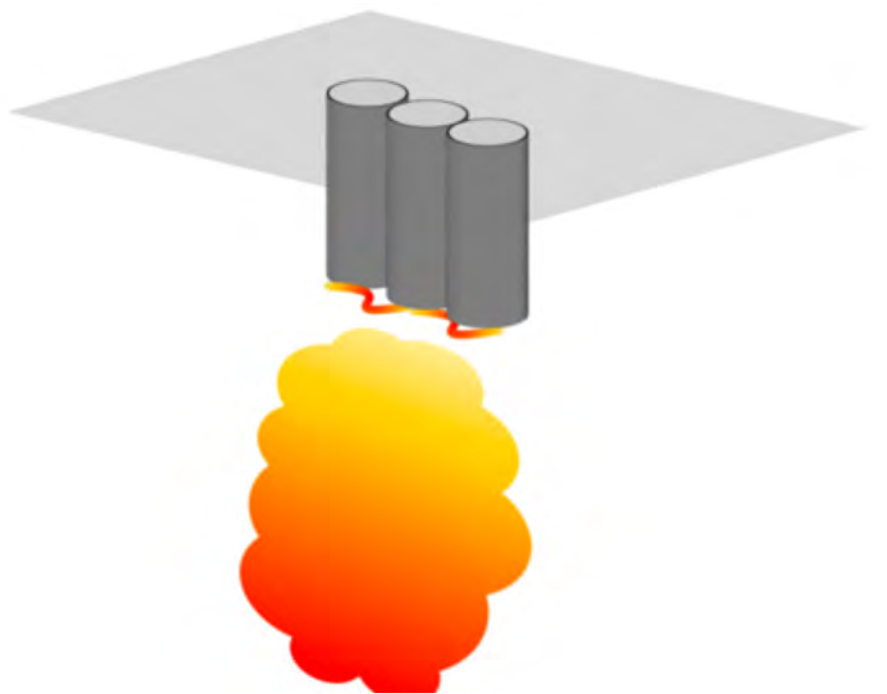
VCBB



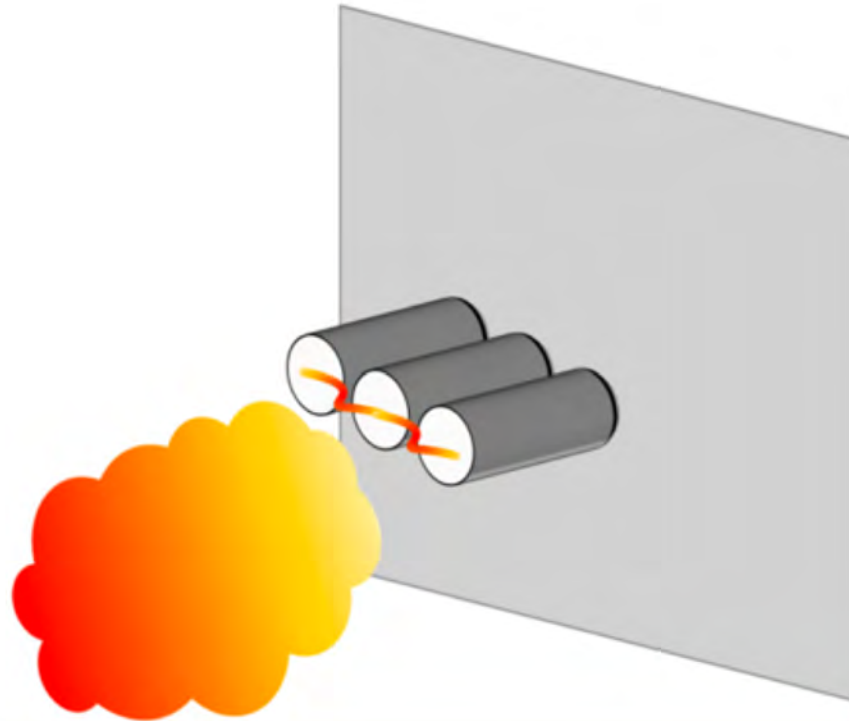
HCB



VOA



HOA



# CSA Z462 Clause 4.1.6 Electrical Safety Program Requirements



- Electrical Safety Program and CSA Z462, Clause 4.1.6 Electrical Safety Program.
- Requires that **Electrical Safety Program shall be documented and implemented** as a component of overall Occupational Health & Safety Management System.
- Electrical Safety Program **SHALL** include a Risk Assessment Procedure!!



- What is a compliant Electrical Safety Program?
- What does CSA Z462 Workplace electrical safety Standard advise us that an Electrical Safety Program should include for content and what is required to be documented?

**Electrical safety program** - a documented system consisting of electrical safety principles, policies, procedures, and processes that directs activities appropriate for the risk associated with electrical hazards.



- Employer and employee responsibilities:

## 4.1.3 Responsibility

### 4.1.3.1 Employer responsibility

The employer shall have the following responsibilities:

- (1) establish, document, and implement the safety-related work practices and procedures required by this standard; and
- (2) provide workers with training in the employer's safety related work practices and procedures.

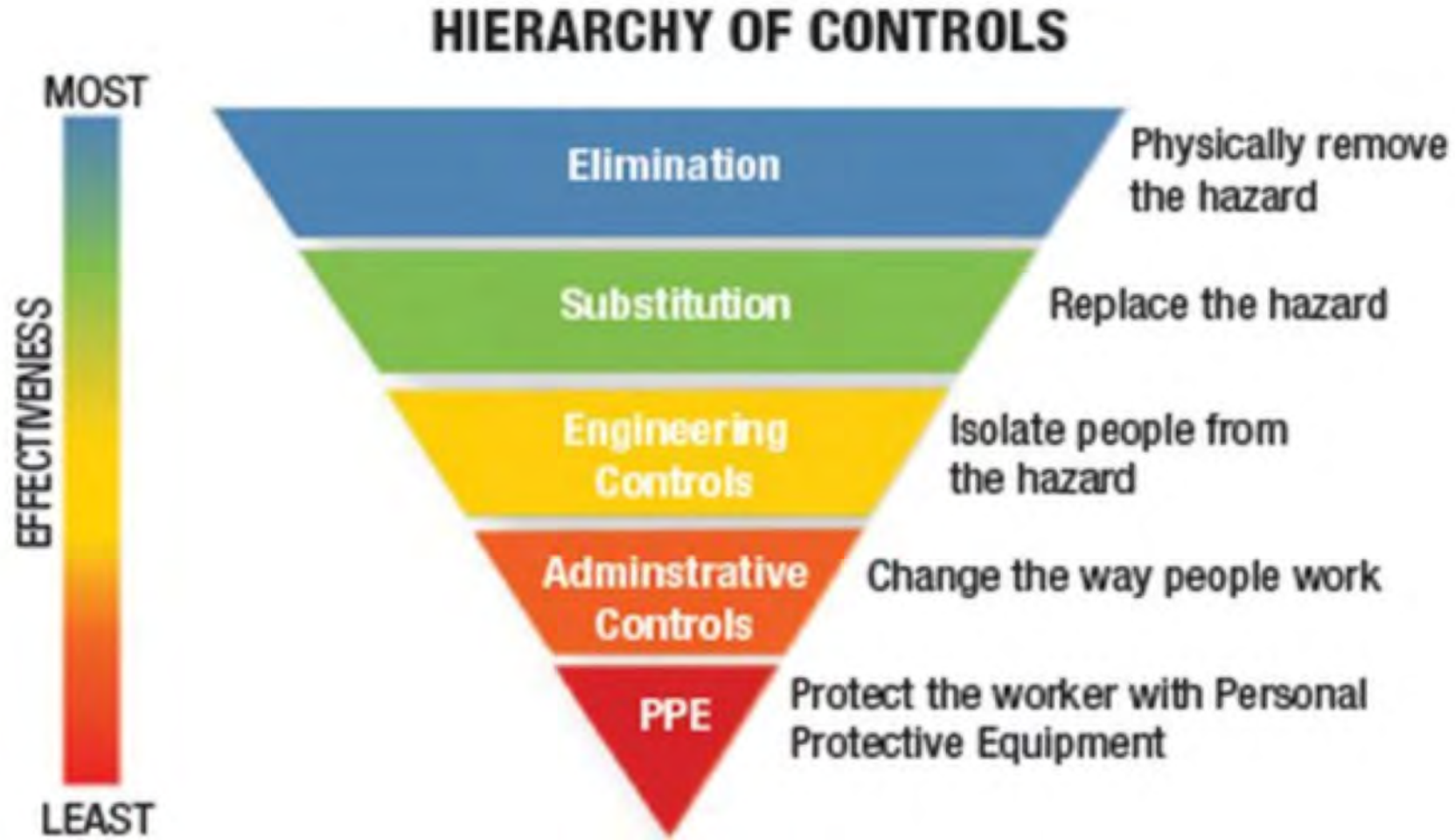
### 4.1.3.2 Worker responsibility

The worker shall comply with the safety-related work practices and procedures provided by the employer.

- Electrical Safety Program Shall include or address:
- Directing activity appropriate to the risk associated with electrical hazards.
- Shall be implemented as a part of employer's overall Occupational Health & Safety Management System.
- Inspection of electrical equipment and systems, approved and installed to CEC Part 1. [NEW]
- Include elements that consider condition of maintenance of electrical equipment and systems.
- Provide awareness to workers (e.g. Electrical and Non-Electrical) who work in presence of electrical hazards.

- Identify Principles on which it is based.
- Identify controls by which it is measured and monitored.
- Identify procedures to be utilized before work is started.
- Shall include a documented Risk Assessment Procedure that applies the Hierarchy of Risk Control Methods to reduce risk and consider human error.
- Worker in charge shall complete a Job Safety Plan and conduct a Job Briefing with other workers involved.
- Include requirements for incident investigation to closure.

# CSA Z462 Clause 4.1.6 Electrical Safety Program Requirements



# CSA Z462 Clause 4.1.6 Electrical Safety Program Requirements



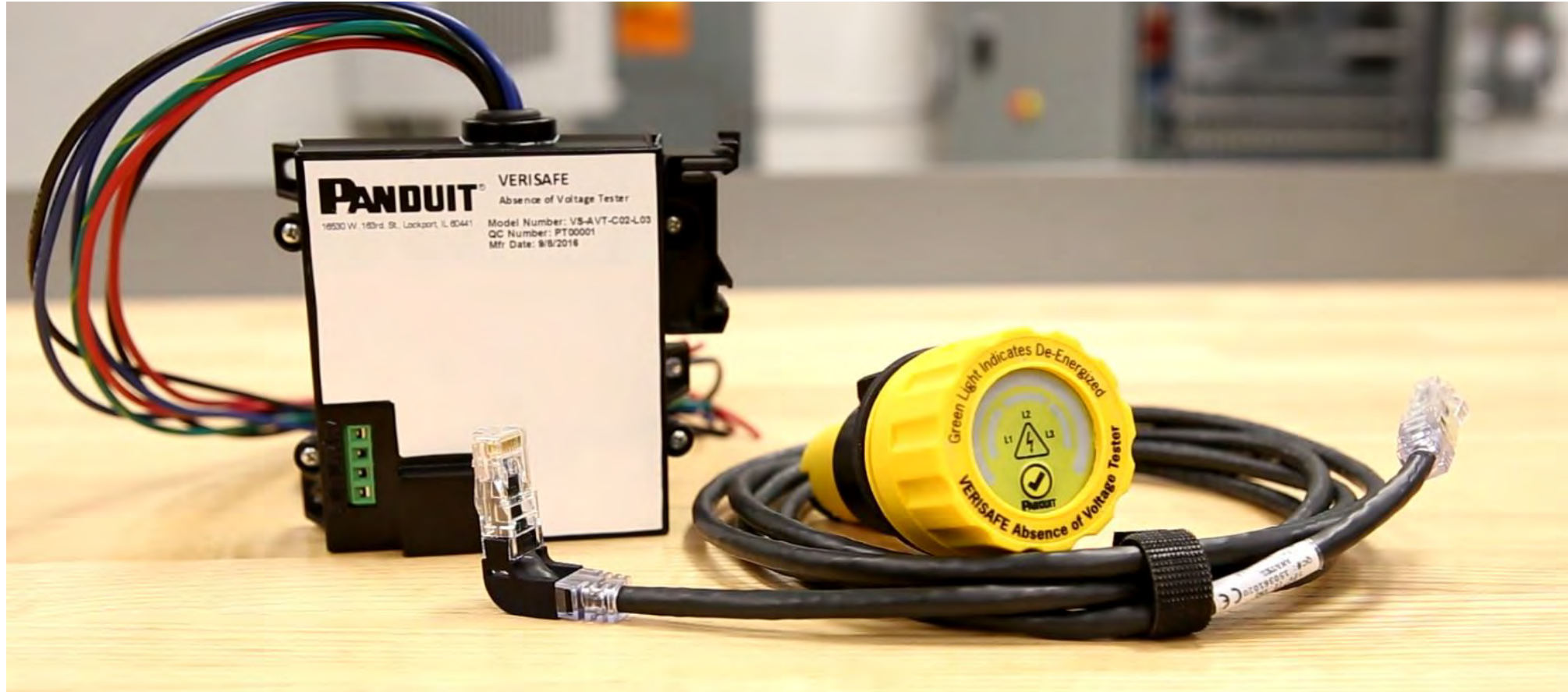
- Include requirement for ESP and field work audit.
- A separate Lockout Program and related procedures shall be audited.
- Address Electrical Safety Training with a 3 year frequency.
- Identify Roles & Responsibilities for a Qualified Person and Unqualified Person.
- Electrical Safety, Arc Flash & Shock Training provided.
- Lockout training shall be provided.
- First aid and emergency response training provided based on industry and employer requirements.
- Contact release training of a shock incident victim.

- Test instruments and equipment.
- Portable cord-and-plug connected electric equipment.
- GFCIs shall be provided.
- Include requirement for Establishing an Electrically Safe Work Condition.
- Process for Establishing and Verifying an Electrically Safe Work Condition. [NEW, updated, 8 steps now.] >1000VAC proximity non-contact test instrument identified as acceptable. Adequately rated permanent mounted test device permitted, shall be approved.
- Temporary protective grounding.

# CSA Z462 Clause 4.1.6 Electrical Safety Program Requirements



- Panduit Verisafe (Permanently Mounted Test Device):



# Clause 4.2 Establishing An Electrically Safe Work Condition



- Lockout Program.
- Lockout Principles.
  - Worker Involvement.
- Lockout Equipment.
- Lockout Procedures.
  - Individual.
  - Group.
  - Complex.
- Process For Establishing and Verifying An Electrically Safe Work Condition [2018, Eight (8) Step Process].
  - NEW - Release of stored electrical energy.
  - NEW - Release or block stored mechanical energy.



- Work involving electrical hazards.
  - Justification if an Electrically Safe Work Condition cannot be established.
  - Additional hazards or increased risk.
  - Infeasibility due to Equipment Design or Operational Limitations.
  - <30V [NEW, CEC Part 1 Definition].
- Normal Operating Condition.
- Use of Energized Electrical Work Permit (EEWP).
- Shock Risk Assessment documented. [Updated true risk assessment]
- Arc Flash Risk Assessment documented. [Updated true risk assessment]
  - Additional Protective Measures determined by Incident energy analysis or Arc Flash PPE Category “Table Method.”
  - Significant updates, complete alignment with risk assessment.

## Δ 4.3.2.2.4 Normal operating condition

Normal operation of electric equipment may be used where a normal operating condition exists. A normal operating condition exists when all of the following conditions are satisfied:

- a) the equipment is properly installed;
- b) the equipment is properly maintained;
- c) the equipment is used in accordance with instruction included in the applicable *Canadian Electrical Code, Part II* Standard and in accordance with the manufacturer's instructions;
- d) all equipment doors are closed and secured;
- e) all equipment covers are in place and secured; and
- f) there is no evidence of impending failure.

**Note:** *The phrase "properly installed" means that the equipment is installed in accordance with applicable industry codes and standards and the manufacturer's recommendations. The phrase "properly maintained" means that the equipment has been maintained in accordance with the manufacturer's recommendations and applicable industry codes and standards. The phrase "evidence of impending failure" means that there is evidence such as arcing, overheating, loose or bound equipment parts, visible damage, or deterioration.*

# Clause 4.3 Work Involving Electrical Hazards



- No Look, Listen or Smell.



# Clause 4.3 Work Involving Electrical Hazards Normal & Abnormal Conditions



# Clause 4.3 Work Involving Electrical Hazards Normal & Abnormal Conditions



# Clause 4.3 Work Involving Electrical Hazards Normal & Abnormal Conditions



# Clause 4.3 Work Involving Electrical Hazards Normal & Abnormal Conditions



# Clause 4.3 Work Involving Electrical Hazards Normal & Abnormal Conditions





# Clause 4.3 Work Involving Electrical Hazards Normal & Abnormal Conditions



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# Clause 4.3 Work Involving Electrical Hazards Normal & Abnormal Conditions





# Clause 4.3 Work Involving Electrical Hazards Normal & Abnormal Conditions



# Clause 4.3 Work Involving Electrical Hazards Normal & Abnormal Conditions



- Energized Electrical Work Permit:
- Needs to be interpreted correctly.
- Increased Risk or Hazards.
- Equipment Design.
- Infeasibility due to Operational Limitations.
- Add additional exemptions to the list of “Annualized” work tasks such as racking in and out, installing temporary protective grounds, opening a hinged door.

## 4.3.2.3 Energized electrical work permit

### 4.3.2.3.1 General

When work is performed as permitted in accordance with Clause [4.3.2.2](#), an energized electrical work permit shall be required and documented under any of the following conditions:

- a) when work is performed within the restricted approach boundary; or
- b) when the worker interacts with the equipment when conductors or circuit parts are not exposed but an increased likelihood of injury from an exposure to an arc flash hazard exists.

### 4.3.2.3.3 Exemptions to work permit


Electrical work may be performed without an energized electrical work permit if a qualified person is provided with and uses appropriate safe work practices and PPE in accordance with Clause 4 under any of the following conditions:


- a) testing, troubleshooting, or voltage measuring;
- b) thermography, ultrasound, or visual inspections if the restricted approach boundary is not crossed;
- c) access and egress to an area with energized electrical equipment if no electrical work is performed and the restricted approach boundary is not crossed; and
- d) general housekeeping and miscellaneous non-electrical tasks if the restricted approach boundary is not crossed.

- Equipment Labelling for arc flash and shock, NEW 2018 supervised industrial sites can use Results Table, include with Work Orders, or Arc Flash Single Line Diagram. Use Generic Equipment Label. [Updated]
- Other precautions:
  - Alertness.
  - Scope changes.
  - Blind reaching.
  - Illumination.
  - No jewelry policy.
  - Confined or enclosed work spaces.
  - Clear spaces.

# Clause 4.3 Work Involving Electrical Hazards Equipment Labelling



 <b>WARNING</b>			
Arc Flash and Shock Hazard			
ARC FLASH PROTECTION		SHOCK PROTECTION	
Working Distance	18 inches	Shock Hazard when covers are removed	600 VAC
Incident Energy	5.0 cal/cm <sup>2</sup>	Limited Approach	42 inches
Arc Flash Boundary	43 inches	Restricted Approach	12 inches
<Company> PPE Level =	1	Rubber Insulating Glove Class	0
Refer to <Company> Electrical Safety Program for PPE Requirements.			
Location: MCC #1 Building		Study provided by: Danatec	
Equipment: LOAD SIDE of <b>MCC #1 MAIN BREAKER</b>		Date: <b>2018-01-30</b>	
Report #: Danatec-XXX-YYY-AHA-ZZZ Rev 1.0		Label #: 1	

 <b>WARNING</b>			
Arc Flash and Shock Hazard			
ARC FLASH PROTECTION		SHOCK PROTECTION	
Working Distance	24 inches	Shock Hazard when covers are removed	600 VAC
Incident Energy	98 cal/cm <sup>2</sup>	Limited Approach	42 inches
Arc Flash Boundary	120 inches	Restricted Approach	12 inches
Maint. Mode Switch ON	39.8 cal/cm <sup>2</sup>	Rubber Insulating Glove Class	0
Arc Flash Boundary	48 inches		
<Company> PPE Level =	2		
Refer to <Company> Electrical Safety Program for PPE Requirements.			
Location: MCC #1 Building, SWGR #1		Study provided by: Danatec	
Equipment: LOAD SIDE of <b>FB-1</b>		Date: <b>2018-01-30</b>	
Report #: Danatec-XXX-YYY-AHA-ZZZ Rev 1.0		Label #: 2	

# Clause 4.3 Work Involving Electrical Hazards Equipment Labelling



## **WARNING**

### Arc Flash and Shock Hazard

#### ARC FLASH PROTECTION

Working Distance            **24 inches**  
 Incident Energy            **36 cal/cm<sup>2</sup>**  
 Arc Flash Boundary        **43 inches**  
 <Company> PPE Level =    **2**

**Arc Flash Relay Must Be On**

*Refer to <Company> Electrical Safety Program for PPE Requirements.*

#### SHOCK PROTECTION

Shock Hazard when covers are removed        **600 VAC**  
 Limited Approach                                    **42 inches**  
 Restricted Approach                                **12 inches**  
 Rubber Insulating Glove Class                **0**

Location: MCC #1 Building, SWGR #1  
 Equipment: LOAD SIDE of **FB-1**  
 Report #: Danatec-XXX-YYY-AHA-ZZZ Rev 1.0

Study provided by: Danatec  
 Date: **2018-01-30**  
 Label #: 4

## **DANGER**

### Arc Flash and Shock Hazard

#### ARC FLASH PROTECTION

Working Distance            **18 inches**  
 Incident Energy            **143 cal/cm<sup>2</sup>**  
 Arc Flash Boundary        **25 feet**

**Refer to <Company> Electrical Safety Program**

#### SHOCK PROTECTION

Shock Hazard when covers are removed        **480 VAC**  
 Limited Approach                                    **42 inches**  
 Restricted Approach                                **12 inches**  
 Rubber Insulating Glove Class                **0**

Location: MCC #1 Building  
 Equipment: LINE SIDE of **SWGR #1 Main BreakerK**  
 Report #: Danatec-XXX-YYY-AHA-ZZZ Rev 1.0

Study provided by: Danatec  
 Date: **2018-01-30**  
 Label #: 3



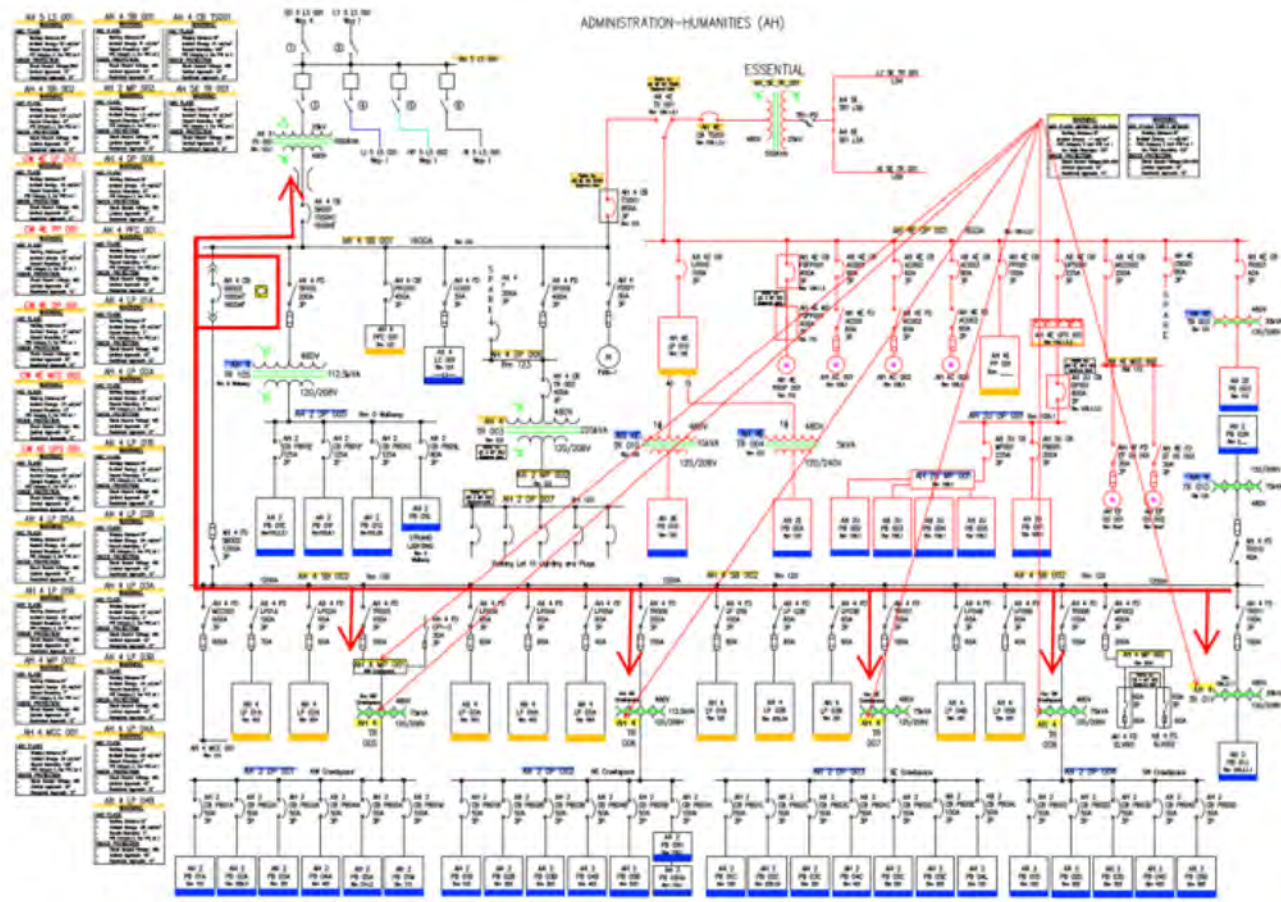
# Clause 4.3 Work Involving Electrical Hazards Equipment Labelling – NEW 2018



# **WARNING**

**Arc Flash and Shock Hazard**

**REFER TO [COMPANY]  
ELECTRICAL MAINTENANCE DEPARTMENT  
ARC FLASH INCIDENT ENERGY STUDY RESULTS  
TABLE OR CMMS ASSET RECORD FOR  
ARC FLASH & SHOCK DATA  
CONTACT PHONE: (XXX) XXX-XXXX  
Building ID, Office ID**



# Clause 4.3 Work Involving Electrical Hazards Equipment Labelling – NEW 2018





Table 6.1 – Arc-Flash Analysis Summary Table

Bus Name	Device Name	Bus kV	Bus Bolted Fault kA	Device Bolted Fault kA	Arcing Fault kA	Trip Time (s.)	Bkr. Opening (s.)	AF Boundary	Working Distance (in.)	Incident Energy (cal/cm <sup>2</sup> )
01ES-2501-A	50/51-2501-09A	25.00	6.29	1.88	1.88	1.95	0.05	28' 2"	3'	105
01ES-2501-A (Line Side)	50/51-25-26.122	25.00	6.29	4.42	4.42	1.086	0.05	27' 9"	3'	102
01ES-2501-B	50/51-2501-9B	25.00	6.29	1.88	1.88	1.95	0.05	28' 2"	3'	105
01ES-2501-B (Line Side)	50/51-25-26.122	25.00	6.29	4.42	4.42	1.086	0.05	27' 9"	3'	102
01ES-2502-A	50/51-2502-02A	25.00	5.81	1.40	1.40	1.95	0.05	23' 9"	3'	75
01ES-2502-A (LineSide)	50/51-2501-10A	25.00	5.81	4.42	4.42	0.551	0.05	20'	3'	53
01ES-2502-B	50/51-2502-02B	25.00	5.81	1.40	1.40	1.95	0.05	23' 9"	3'	75
01ES-2502-B (Line Side)	50/51-2501-10B	25.00	5.81	4.42	4.42	0.551	0.05	20'	3'	53
01ES-2503-A	50/51-2501-09A	25.00	6.29	4.42	4.42	0.231	0.05	13' 5"	3'	24
01ES-2503-A (LineSide)	50/51-01ES-2503-01A	25.00	6.29	1.88	1.88	0.77	0.05	17' 11"	3'	43
01ES-2503-B	50/51-2501-09A	25.00	6.29	4.42	4.42	0.231	0.05	13' 5"	3'	24
01ES-2503-B (LineSide)	50/51-01ES-2503-01B	25.00	6.29	1.88	1.88	0.77	0.05	17' 11"	3'	43
01ES-2504-A	50/51-2502-02A	25.00	5.81	4.41	4.41	1.086	0.05	25' 11"	3'	89
01ES-2504-A (LineSide)	50/51-2504-01A	25.00	5.81	1.41	1.41	1.95	0.05	28' 10"	3'	111
01ES-2504-B	50/51-2502-02B	25.00	5.81	4.41	4.41	1.086	0.05	25' 11"	3'	89
01ES-2504-B (LineSide)	50/51-2504-01B	25.00	5.81	1.41	1.41	1.95	0.05	28' 10"	3'	111
01ES-2505-A	50/51-2505-01A	25.00	1.40	1.40	1.40	1.95	0.05	16'	3'	34
01ES-2505-A (Line Side)	50/51-2502-06A-	25.00	1.40	1.40	1.40	1.95	0.05	16'	3'	34
01ES-2505-B	50/51-2505-01B	25.00	1.40	1.40	1.40	1.95	0.05	16'	3'	34
01ES-2505-B (Line Side)	50/51-2502-06B-	25.00	1.40	1.40	1.40	1.95	0.05	16'	3'	34

- Other precautions:
  - Housekeeping.
  - Anticipate failure.
  - Reclosing after protective device operation.
  - Look alike equipment.
  - Alerting techniques e.g. Electrical Work Zone barricading.
  - Overhead Power Lines.
- PPE, Tools & Equipment:
  - Arc flash and shock.
  - Arc flash PPE Specified by Arc Thermal Performance Value (ATPV) NOT HRC or Arc Flash PPE Category e.g. ASTM F1959.

- Some significant “Differences” between 2015 and 2018 Editions for NFPA 70E and CSA Z462.

	Document: ELECTRICAL SAFETY PROGRAM	Subject: CSA Z462 3 <sup>rd</sup> to 4 <sup>th</sup> Edition Differences Changes & Updates	
Issued By: TWB	Approved By: TWB	Rev #: 2.2	Rev Date: Oct. 12, 2017

**CSA Z462 3<sup>rd</sup> to 4<sup>th</sup> EDITION DIFFERENCES  
2015 vs. 2018 CHANGES & UPDATES**

Provided to you by:  
**Terry Becker, P.Eng., CESP,**  
IEEE Senior Member, Electrical Safety Expert  
CSA Z462 First Past Vice-Chair, Voting Member, Annexes Working Group Leader, NFPA 70E  
Technical Committee Annexes Working Group, CSA Z463 Associate Member, IEEE 1584 Voting  
Member, Senior VP, Electrical Safety Division, Danatec Educational Services Ltd.  
[www.danatec.com](http://www.danatec.com) / [www.esps.ca](http://www.esps.ca) / [www.arcflash-training.ca](http://www.arcflash-training.ca)

&

**Jim Pollard**  
Electrical Safety & Arc Flash PPE Expert  
Oberon Company Canadian Representative  
CSA Z462 Technical Committee Voting Member, CAN/ULC-S801 Voting Member, CSC/IEC/TC78,  
ULC Live Working Member, Owner/Director, Unlimited PPE Inc. [www.unlimitedppe.com](http://www.unlimitedppe.com)

<ul style="list-style-type: none"><li>• Terry Becker, P.Eng., CESP</li><li>• 1-800-465-3366</li><li>• <a href="mailto:tbecker@danatec.com">tbecker@danatec.com</a></li><li>• <a href="http://www.danatec.com">www.danatec.com</a></li><li>• <a href="http://www.esps.ca">www.esps.ca</a></li></ul>	<ul style="list-style-type: none"><li>• Jim Pollard</li><li>• Oberon 1-519-939-3204</li><li>• <a href="mailto:jim@oberoncompany.com">jim@oberoncompany.com</a></li><li>• <a href="http://www.arcflash.com">www.arcflash.com</a></li><li>• <a href="http://www.unlimitedppe.com">www.unlimitedppe.com</a></li></ul>
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Arc Flash & Shock eLearning for Electrical & Non-Electrical Workers that is affordable and high quality using the Electrical Safety Training System (ESTS).  
**Contact Danatec** for access to a free evaluation course.  
Visit [www.arcflash-training.ca](http://www.arcflash-training.ca).

- CSA Z462, 2018 includes additional modifications and content to solidify requirements for completing risk assessments of energized electrical work tasks. [see CSA Z1002 and CSA Z462-2015 Annex F]
- De-energize is the priority (e.g. repair & alteration).
- Energized electrical work justified and complete Risk Assessment Procedure (RAP).
  - Overall Risk Assessment Procedure.
  - Arc Flash Risk Assessment is a component of the RAP.
  - Shock Risk Assessment is a component of the RAP.

- Key Changes:
- 1. Low voltage threshold lowered to 30V from 50V, CEC Part 1 definition of extra low voltage for Canada. Still 50V for USA.
- 2. Clause 4.1.5.7 Risk Assessment Procedure modified.
  - Clause 4.1.6.8.3 Human error.
  - Clause 4.1.6.8.4 Hierarchy of risk control methods (moved to Clause from Notes).
- 3. Clause 4.1.6.9 Job Safety Planning added.
- 4. Shock Risk Assessment.
  - Modified to make it a true risk assessment process.
  - Determine “Additional Protective Measures.”

## Arc Flash and Shock Risk Assessments

Additional Protective Measures • Based on CSA Z462-2018 or NFPA 70E-2018 Standards



No PPE Required Outside of the Arc Flash Boundary

1.2 cal/cm<sup>2</sup>  
Onset of 2nd Degree Skin Burn



### Arc Flash Boundary

#### Qualified Electrical Worker

- Competent for Work Task
- Job Safety Plan & Job Briefing
- Risk Assessment Procedure
- Arc Flash Risk Assessment
- EEWP if Required
- EEJRA
- Approved Work Procedure
- Arc-Rated PPE (ATPV or E<sub>arc</sub>) Suitable for the Work Task

### Limited Approach Boundary for Shock

#### Qualified Electrical Worker

- Competent for Work Task
- Job Safety Plan & Job Briefing
- Risk Assessment Procedure
- Shock Risk Assessment
- EEJRA

### Restricted Approach Boundary for Shock

#### Qualified Electrical Worker

- Competent for Work Task
- Contact Work Justification
- Job Safety Plan & Job Briefing
- Risk Assessment Procedure
- Shock Risk Assessment
- EEWP if Required
- EEJRA
- Approved Work Procedure
- Shock PPE, Tools & Equipment Appropriate to the Work Task



Updated PPE requirements

- LED Lamp
- True Color
- Grey Face Shield

**Exposed Energized Electrical Equipment**

Non-Electrical Worker + Appropriate PPE + Awareness + Continuously Escorted by Qualified Electrical Worker

Non-Electrical Worker Not Authorized

Arc Flash Boundary Arc-Rated PPE Required

Higher Risk of Shock



Calgary, AB, Canada  
arcflash-training.ca | Danatec.com

Consulting Services • Licensed Products • Training Solutions

For online arc flash & shock training go to [arcflash-training.ca](http://arcflash-training.ca) or [danatec.com](http://danatec.com)

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### Detailed Arc Flash and Shock Warning Equipment Label Example

## WARNING

### Arc Flash & Shock Hazard

ARC FLASH PROTECTION		SHOCK PROTECTION	
Working Distance	18 inches	Shock Hazard when covers removed	600 VAC
Incident Energy	5.0 cal/cm <sup>2</sup>	Limited Approach	42 inches
Arc Flash Boundary	43 inches	Restricted Approach	12 inches
Company PPE Level	3	Rubber Insulating Glove Class	0

Location: MMC #1 Building Study provided by: Danatec  
Equipment: LOAD Side of MMC #1 Main Breaker Date: 2020-01-08  
Report #: Danatec000-YYV-AHA-ZZZ Rev: 1.0 Label #: 1

### CSA Z462 Table 1A / NFPA 70E Table 130.4(D)(a)

Shock Protection Approach Boundaries to Exposed Energized Electrical Conductors or Circuit Parts for AC Systems

System Voltage	Limited Approach Boundary	Restricted Approach Boundary
< 30V CAN < 50V USA	Not specified	Not specified
120V	3 ft. 6 in. / 1.0 m	Avoid contact
208V - 600V	3 ft. 6 in. / 1.0 m	1 ft. 0 in. / 0.3 m
4,160V	5 ft. 6 in. / 1.5 m	2 ft. 2 in. / 0.7 m
13,800V	5 ft. 6 in. / 1.5 m	2 ft. 2 in. / 0.7 m

This material is not all-inclusive and users shall refer to the Standards for requirements.

- Key Changes:
- 5. 40 cal/cm<sup>2</sup> Myth. Deletion of Note from Clause 4.3.7 PPE, General and Annex D. No substantiation. Incident energy doesn't correlate to arc blast pressure. ETAP/SKM/Easypower software SHALL NOT dictate PPE!!!!
- 6. Arc Flash Risk Assessment (2018).
  - Modified to make it a true risk assessment process.
  - Determine “Additional Protective Measures.”
  - CSA Z462-2015 Table 4A now CSA Z462 Table 2 and used as a part of the AFRA to determine Likelihood of Occurrence of arcing fault/arc flash, based on work task description and condition of maintenance.



Z462-18

Workplace electrical safety


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**Table 2**  
**Estimate of the likelihood of occurrence of an arc flash incident for ac and dc systems**  
 (See Clause 4.3.5.3.)

Task	Equipment condition	Likelihood of occurrence *
Reading a panel meter while operating a meter switch. Performing infrared thermography and other non-contact inspections outside the restricted approach boundary. This activity does not include opening of doors or covers.  Working on control circuits with exposed energized electrical conductors and circuit parts, nominal 125 V ac or dc, or below without any other exposed energized equipment over nominal 125 V ac or dc, including opening of hinged covers to gain access.  Examination of insulated cable with no manipulation of cable.  For dc systems, insertion or removal of individual cells or multi-cell units of a battery system in an open rack.  For dc systems, maintenance on a single cell of a battery system or multi-cell units in an open rack.	Any	No
For ac systems, work on energized electrical conductors and circuit parts, including voltage testing. For dc systems, working on energized electrical conductors and circuit parts of series-connected battery cells, including voltage testing.  Removal or installation of CBs or switches.  Opening hinged door(s) or cover(s) or removal of bolted covers (to expose bare, energized electrical conductors and circuit parts). For dc systems, this includes bolted covers, such as battery terminal covers.  Application of temporary protective grounding equipment, after voltage test.	Any	Yes

- Arc Flash Risk Assessment (2018):
- Additional Protective Measures are:
  - Appropriate safety-related work practices;
  - The Arc Flash Boundary; and
  - The PPE that personnel with the Arc Flash Boundary when an arcing fault is probably must use.
- Additional Protective Measures are determined with two Methods:
- Method 1: Incident Energy Analysis.
- Method 2: Arc Flash PPE Category Method (“Table Method”).

- Arc Flash Risk Assessment (2018):
- Method 1:

 <b>WARNING</b>			
Arc Flash and Shock Hazard			
ARC FLASH PROTECTION		SHOCK PROTECTION	
Working Distance	18 inches	Shock Hazard when covers are removed	600 VAC
Incident Energy	5.0 cal/cm <sup>2</sup>	Limited Approach	42 inches
Arc Flash Boundary	43 inches	Restricted Approach	12 inches
<Company> PPE Level =	1	Rubber Insulating Glove Class	0
<i>Refer to &lt;Company&gt; Electrical Safety Program for PPE Requirements.</i>			
Location: MCC #1 Building		Study provided by: Danatec	
Equipment: LOAD SIDE of <b>MCC #1 MAIN BREAKER</b>		Date: 2018-01-30	
Report #: Danatec-XXX-YYY-AHA-ZZZ Rev 1.0		Label #: 1	

 <b>DANGER</b>			
Arc Flash and Shock Hazard			
ARC FLASH PROTECTION		SHOCK PROTECTION	
Working Distance	18 inches	Shock Hazard when covers are removed	480 VAC
Incident Energy	143 cal/cm <sup>2</sup>	Limited Approach	42 inches
Arc Flash Boundary	25 feet	Restricted Approach	12 inches
<b>Refer to &lt;Company&gt; Electrical Safety Program</b>			
Location: MCC #1 Building		Study provided by: Danatec	
Equipment: LINE SIDE of <b>SWGR #1 Main BreakerK</b>		Date: 2018-01-30	
Report #: Danatec-XXX-YYY-AHA-ZZZ Rev 1.0		Label #: 3	

- Arc Flash Risk Assessment (2018):
- Method 1:

Table 6.1 – Arc-Flash Analysis Summary Table

Bus Name	Device Name	Bus kV	Bus Bolted Fault kA	Device Bolted Fault kA	Arcing Fault kA	Trip Time (s.)	Bkr. Opening (s.)	AF Boundary	Working Distance (in.)	Incident Energy (cal/cm <sup>2</sup> )
01ES-2501-A	50/51-2501-09A	25.00	6.29	1.88	1.88	1.95	0.05	28' 2"	3'	105
01ES-2501-A (Line Side)	50/51-25-26.122	25.00	6.29	4.42	4.42	1.086	0.05	27' 9"	3'	102
01ES-2501-B	50/51-2501-9B	25.00	6.29	1.88	1.88	1.95	0.05	28' 2"	3'	105
01ES-2501-B (Line Side)	50/51-25-26.122	25.00	6.29	4.42	4.42	1.086	0.05	27' 9"	3'	102
01ES-2502-A	50/51-2502-02A	25.00	5.81	1.40	1.40	1.95	0.05	23' 9"	3'	75
01ES-2502-A (LineSide)	50/51-2501-10A	25.00	5.81	4.42	4.42	0.551	0.05	20'	3'	53
01ES-2502-B	50/51-2502-02B	25.00	5.81	1.40	1.40	1.95	0.05	23' 9"	3'	75
01ES-2502-B (Line Side)	50/51-2501-10B	25.00	5.81	4.42	4.42	0.551	0.05	20'	3'	53
01ES-2503-A	50/51-2501-09A	25.00	6.29	4.42	4.42	0.231	0.05	13' 5"	3'	24
01ES-2503-A (LineSide)	50/51-01ES-2503-01A	25.00	6.29	1.88	1.88	0.77	0.05	17' 11"	3'	43
01ES-2503-B	50/51-2501-09A	25.00	6.29	4.42	4.42	0.231	0.05	13' 5"	3'	24
01ES-2503-B (LineSide)	50/51-01ES-2503-01B	25.00	6.29	1.88	1.88	0.77	0.05	17' 11"	3'	43
01ES-2504-A	50/51-2502-02A	25.00	5.81	4.41	4.41	1.086	0.05	25' 11"	3'	89
01ES-2504-A (LineSide)	50/51-2504-01A	25.00	5.81	1.41	1.41	1.95	0.05	28' 10"	3'	111
01ES-2504-B	50/51-2502-02B	25.00	5.81	4.41	4.41	1.086	0.05	25' 11"	3'	89
01ES-2504-B (LineSide)	50/51-2504-01B	25.00	5.81	1.41	1.41	1.95	0.05	28' 10"	3'	111
01ES-2505-A	50/51-2505-01A	25.00	1.40	1.40	1.40	1.95	0.05	16'	3'	34
01ES-2505-A (Line Side)	50/51-2502-06A-	25.00	1.40	1.40	1.40	1.95	0.05	16'	3'	34
01ES-2505-B	50/51-2505-01B	25.00	1.40	1.40	1.40	1.95	0.05	16'	3'	34
01ES-2505-B (Line Side)	50/51-2502-06B-	25.00	1.40	1.40	1.40	1.95	0.05	16'	3'	34

- Arc Flash Risk Assessment (2018):
- Method 2, Table 6A, Table 6B and Table 6C:

Δ

**Table 6A**  
**Arc-flash PPE categories for alternating current (ac) systems**  
(See Clauses 3, 4.3.1, 4.3.5.3, 4.3.5.5, 4.3.7.3.15, 4.3.7.4.2, and B.2, Table 6C, and Annex H)

Equipment	Arc flash PPE category	Arc-flash boundary
Panelboards or other equipment rated 240 V and below Parameters: Maximum of 25 kA available fault current; maximum of 0.03 s (2 cycles) fault clearing time; minimum working distance 18 in	1	485 mm (19 in)
Panelboards or other equipment rated greater than 240 V and up to 600 V Parameters: Maximum of 25 kA available fault current; maximum of 0.03 s (2 cycles) fault clearing time; minimum working distance 18 in	2	900 mm (3 ft)

- Arc Flash Risk Assessment (2018):
- Method 2, Table 6A [NEW list protective device opening times]:

**Notes:**

- 1) See Table 6C for a list of protective clothing and PPE for each arc flash PPE category.
- 2) For equipment rated 600 V and below and protected by upstream current limiting fuses or current limiting circuit breakers sized at 200 A or less, the arc flash PPE category may be reduced by one number, but not below arc flash PPE category 1.
- Δ 3) The following are typical fault clearing times of overcurrent protective devices:
  - a) 0.5 cycle fault clearing time is typical for current limiting fuses when the fault current is within the current limiting range;
  - b) 1.5 cycle fault clearing time is typical for molded case circuit breakers rated less than 1000 V with an instantaneous integral trip;
  - c) 3.0 cycle fault clearing time is typical for insulated case circuit breakers rated less than 1000 V with an instantaneous integral trip or relay operated trip;
  - d) 5.0 cycle fault clearing time is typical for relay operated circuit breakers rated 1 kV to 35 kV when the relay operates in the instantaneous range (i.e., “no intentional time delay”);
  - e) 20 cycle fault clearing time is typical for air frame and insulated case circuit breakers with a short time fault clearing delay for motor inrush; and
  - f) 30 cycle fault clearing time is typical for air frame and insulated case circuit breakers with a short time fault clearing delay without instantaneous trip.

See IEEE 1584 Table 1 for further information regarding Items b) to d).

- Arc Flash Risk Assessment (2018):
- Method 2, Table 6A, Table 6B and Table 6C:

Δ

**Table 6B**  
**Arc-flash PPE categories for direct current (dc) systems**  
 (See Clauses 4.3.1, 4.3.5.3, 4.3.5.5, 4.3.7.3.15.2, and B.2, Table 5, and Annex H.)

Equipment	Arc flash PPE category*	Arc flash boundary
<b>Storage batteries, direct-current switchboards, and other dc supply sources</b> Parameters: Greater than or equal to 100 V and less than or equal to 250 V Maximum arc duration and minimum working distance: 2 s at 455 mm (18 in)		
Short-circuit current less than 4 kA	2	900 mm (3 ft)
Available fault current greater than or equal to 4 kA and less than 7 kA	2	1.2 m (4 ft)
Available fault current greater than or equal to 7 kA and less than 15 kA	3	1.8 m (6 ft)
<b>Storage batteries, direct-current switchboards and other dc supply sources</b> Parameters:		

- Arc Flash Risk Assessment (2018):
- Method 2, Table 6A, Table 6B and Table 6C:

<b>Arc flash PPE category</b>	<b>PPE</b>
1	Arc rated clothing, minimum arc rating of 4 cal/cm <sup>2</sup> (16.75 J/cm <sup>2</sup> ) (Note 1): <ul style="list-style-type: none"><li>Arc rated long-sleeve shirt and pants or arc rated coverall</li><li>Arc rated faceshield or arc flash suit hood (Note 2)</li><li>Arc rated jacket, parka, rainwear, or hard hat liner (AN)</li></ul> Protective equipment: <ul style="list-style-type: none"><li>Hard hat</li><li>Safety glasses or safety goggles (SR)</li><li>Hearing protection (ear canal inserts) (Note 4)</li><li>Heavy duty leather gloves (AN) (Note 3)</li><li>Leather footwear (AN)</li></ul>
2	Arc rated clothing, minimum arc rating of 8 cal/cm <sup>2</sup> (33.5 J/cm <sup>2</sup> ) (Note 1):



- Key Changes:
- 7. Incident Energy Analysis, new CSA Z462, Table 3 (NFPA 70E, Table 130.5(G)) Personal protective equipment, moved from Annex H, Table H.2. Two ATPV values, ESP specifies two arc-rated PPE “Levels.”
  - Recommend arc flash suit specified at higher ATPV than 40. Specify and have available, 67, 106 or 140.
  - New Oberon Company True Color Grey lens for arc-rated faceshield and arc flash suit hoods. No wire color discoloration, improve human performance.

Table 3 identifies the arc-rated clothing and other PPE requirements of Clause 4.3 and may be used with the incident energy analysis method of selecting arc flash PPE.

**Notes:**

- 1) For information on estimating the incident energy, see Annex D.
- 2) For information on selection of arc-rated clothing and other PPE, see Annex H.

Δ

**Table 3**  
**Selection of arc-rated clothing and other PPE when the incident energy analysis method is used**  
(See Clause 4.3.5.6.2.)

---

**Incident energy exposures equal to 1.2 cal/cm<sup>2</sup> (5 J/cm<sup>2</sup>) up to 12 cal/cm<sup>2</sup> (50 J/cm<sup>2</sup>)**

---

Arc-rated clothing with an arc rating equal to or greater than the estimated incident energy\*

- Long-sleeve shirt and pants or coverall or arc flash suit (SR)
- Arc-rated faceshield and arc-rated balaclava or arc flash suit hood (SR)
- Arc-rated outerwear (e.g., jacket, parka, rainwear, hard hat liner) (AN)

Heavy duty leather gloves, arc-rated gloves or rubber insulating gloves with leather protectors (SR)‡

Hard hat

Safety glasses or safety goggles (SR)

Hearing protection

Leather footwear

---

*(Continued)*

**Table 3 (Concluded)**

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**Incident energy exposures greater than 12 cal/cm<sup>2</sup> (50 J/cm<sup>2</sup>)**

---

Arc-rated clothing with an arc rating equal to or greater than the estimated incident energy\*

- Long-sleeve shirt and pants or coverall or arc flash suit (SR)
- Arc-rated arc flash suit hood
- Arc-rated outerwear (e.g., jacket, parka, rainwear, hard hat liner) (AN)

Arc-rated gloves or rubber insulating gloves with leather protectors (SR)<sup>‡</sup>

Hard hat

Safety glasses or safety goggles (SR)

Hearing protection

Leather footwear

---

**Legend:**

SR = Selection of one in group is required.

AN = As needed

# CSA Z462 Changes & Updates

## True Color Grey Technology



# CSA Z462 Changes & Updates

## True Color Grey Technology



# CSA Z462 Changes & Updates

## True Color Grey Technology



# CSA Z462 Changes & Updates

## 140 ATPV Arc Flash Suit



140  
cal/cm<sup>2</sup>  
ATPV

# CSA Z462 Changes & Updates Dual Rated Chemical & AR Suit





- Key Changes:
- 8. Arc Flash PPE Category Table Method.
  - Now CSA Z462 Tables 6A, 6B and 6C (NFPA 70E, Tables 130.7(C)(15)(a), 130.7 (C)(15)(b) and 130.7(C)(15)(c)).
  - Technically no changes.
  - NEW Note content that identifies “Typical Protective Device Fault Clearing Times” when using Table 6B for AC electrical equipment.
- 9. Equipment Labelling, arc flash and shock hazard information now can be provided for supervised industrial sites with Results Tables from incident energy analysis reports, on Work Orders or on Arc Flash Single Line Diagrams.

- **CSA Z462 requires a documented Electrical Safety Program that should be a component of your overall OHSMS.**
- **Some significant changes in CSA Z462-2018.**
- **Risk Assessment Procedure now fully integrated into requirements in 2018.**
- **Arc Flash Risk Assessment major changes in CSA Z462-2018.**
- **Electrical Safety Program should be the priority.**
- **Field based documentation key to ensuring Residual Risk Level is validated by Qualified Electrical Worker.**
- **Hierarchy or Risk Control Methods applied to reduce risk.**

# THANKS!



- Thank you for listening!
- **Effective due diligence to OH&S Regulations is achieved with a developed, implemented and audited ELECTRICAL SAFETY PROGRAM!!**
- Q&As?
- Terry Becker, P.Eng., CESC, IEEE Senior Member,
  - [tbecker@danatec.com](mailto:tbecker@danatec.com), [www.danatec.com](http://www.danatec.com)
  - [www.arcflash-training.ca](http://www.arcflash-training.ca)
  - 1-403-465-3777.

