2021 Update of the Canadian CSA Z462 Electrical Safety Standard

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Webinar Plan

- 1. Webinar Objectives
- 2. Electrical Safety Standards in Canada
- 3. IEEE 1584-2018 Update
- 4. CSA Z462-2021 Update
- 5. Questions?

01

Webinar Objectives

Webinar Objectives

Past webinars:

- Understanding Canadian Electrical Workplace Safety Standards - CSA Z462 and CAN/ULC-S801: https://www.easypower.com/resources/article/understanding-canadian-electrical-workplace-safety-standards-csa-z462
- The Impact of the New IEEE 1584-2018 Standard on Arc Flash Studies: https://www.easypower.com/resources/article/impact-of-ieee-1584-2018-standard-on-arc-flash-studies

By the end of this webinar, participants will be able to:

- Know how and when to use the CSA Z462 standard
- Understand the changes in the 2021 version of the CSA Z462 standard

02

Electrical Safety Standards in Canada

Electrical Safety Standard in Canada

Applicable standards:

- OHSA
- CEC Rule 2-306 and Appendix B
- Canadian Bill C-45
- CSA Z462-21 (NFPA 70E)
- IEEE 1584-2018
- CAN/ULC-S801

Arc flash history:

- 1979 (First version of NFPA 70E)
- 1980 (Lee)
- 1995 (Arcs and limits of approach)
- 2008 (First version of CSA Z462)
- 2012, 2015, 2018 (Revisions of CSA Z462)
- 2021 (Latest version of CSA Z462)

Electrical Safety Standard in Canada

Example case

- An arc flash study is not mandatory but Bill C-45 strongly encourages business owners or employers to complete an arc flash study and implement live work safety procedures
- Reference: https://news.ontario.ca/archive/en/2009/04/20/Court-Bulletin-Domtar-Inc-fined-87000-after-worker-injured.html

Court Bulletin - Domtar Inc. fined $87,000 after worker injured

WAWA, ON, April 20 /CNW/ - Domtar Inc., a Montreal, Quebec company that makes pulp, paper, and wood products at facilities across Canada and the United States, was fined $87,000 on April 16, 2009, for a violation under the Occupational Health and Safety Act, after a worker was injured.

On March 20, 2007, at the company's facility in White River, an electrician was doing maintenance work on a machine in the plant. While the worker was testing the voltage inside an electrical panel on the machine, an arc flash, or electrical blast, burned the worker's hand and face.

A Ministry of Labour investigation found that the worker was not wearing rubber gloves or wearing a shield.

Domtar Inc. pleaded guilty to failing, as an employer, to ensure the worker used protective equipment and procedures adequate for protection against electrical shock and burns.

The fine was imposed by Justice of the Peace Pierre Leclerc. In addition to the fine, the court also imposed a 25-per-cent victim fine surcharge on the total, as required by the Provincial Offences Act. The surcharge is credited to a special provincial government fund to assist victims of crime.

Electrical Safety Standard in Canada

Applicable standard – OHSA

- Every employer ensures, as far as it is reasonably practicable for the employer to do so, to:
  - Take every reasonable precaution to ensure the workplace is safe
  - Train employees about any potential hazards
  - Supply personal protective equipment (PPE) and ensure workers know how to use the equipment safely and properly
- Every worker shall, while engaged in an occupation:
  - Work in compliance with OH&S acts and regulations
  - Use personal protective equipment (PPE) and clothing as directed by the employer
  - Take reasonable care to protect the health and safety of the worker and of other workers present while the worker is working

Electrical Safety Standard in Canada

Applicable Codes

- CEC Rule 2-306

2-306 Shock and arc flash protection (see Appendix B)

(1) Electrical equipment such as switchboards, panelboards, industrial control panels, meter socket enclosures, and motor control centres that are installed in other than dwelling units and are likely to require examination, adjustment, servicing, or maintenance while energized shall be field marked to warn persons of potential electric shock and arc flash hazards.

(2) The marking referred to in Subrule (1) shall be located so that it is clearly visible to persons before examination, adjustment, servicing, or maintenance of the equipment.

- Appendix B

Rule 2-306

CSA Z462 provides assistance in determining the severity of potential exposure, planning safe work practices, and selecting personal protective equipment to protect against shock and arc flash hazards.

ANSI/NEMA Z535.4 provides guidelines for the design of safety signs and labels for application to products.

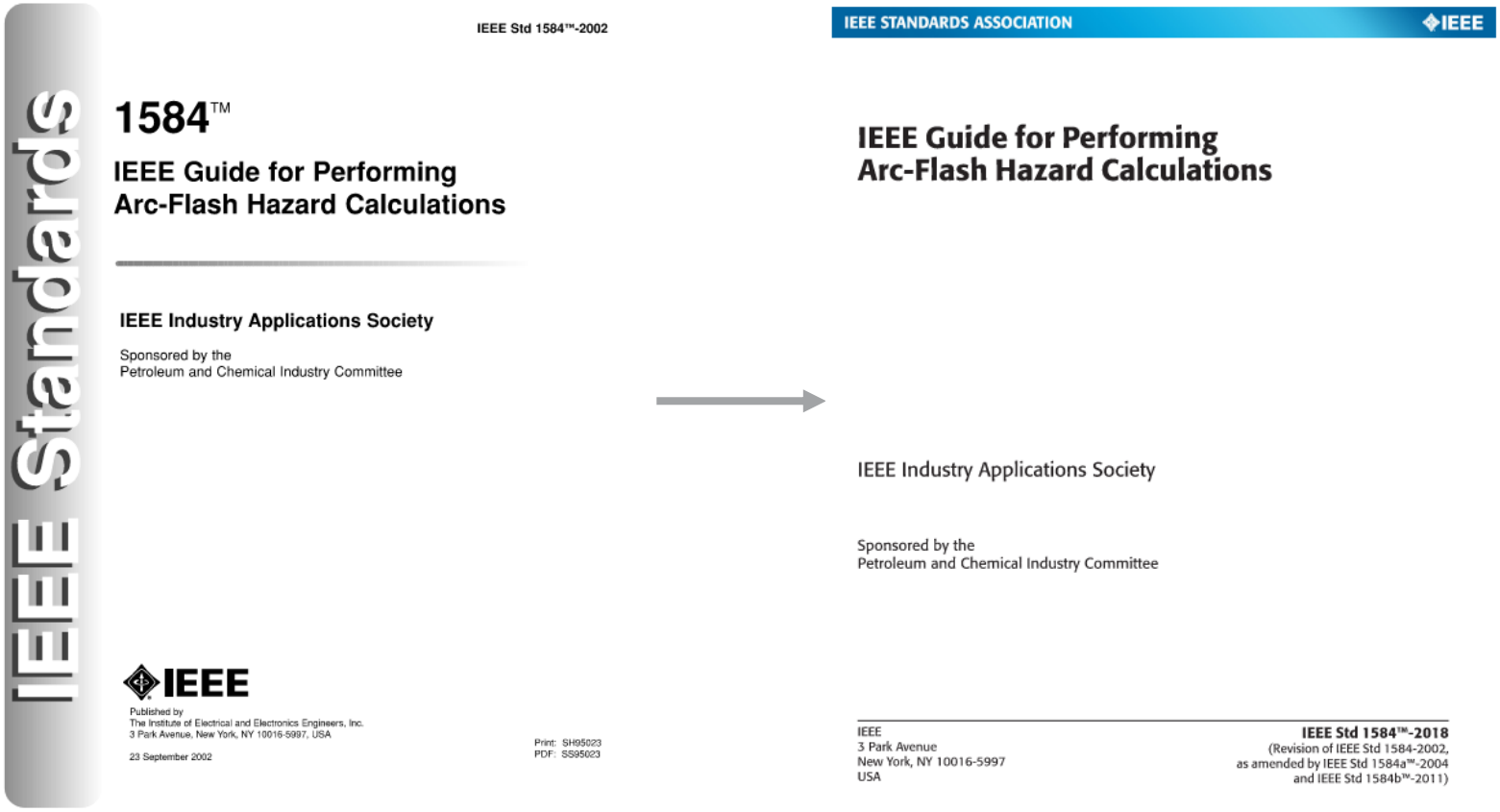
IEEE 1584 provides assistance in determining the arc flash hazard distance and incident energy that workers may be exposed to from electrical equipment.

03

IEEE 1584-2018 Update

IEEE 1584-2018 Update

- Previous CSA Z462-2018 version only referred to IEEE 1584-2002, adoption of IEEE 1584-2018 was a “grey zone“ (Annex D)
- CSA Z462-2021 now officially adopts the IEEE 1584-2018 standard



IEEE 1584-2018 Update

- Update of the arc flash calculation algorithm on which the CSA Z462 is based (Annex D)

- First update since 2002, except for amendments in 2004 and 2011

- The incident energy calculation formulas were revised and replaced by models based on statistical analyses based on more than 1860 tests, while the 2002 version was based on about 300 tests

- The electrode (busbar) configuration is now used as a parameter in the equations : VCB, VCBB, HCB, VOA, HOA

- The enclosure size of the equipment is now used in the calculations : height, width, depth

IEEE 1584-2018 Update

- IEEE 1584 model application limits were extended
  - **2002 Version:**
    - Voltage: 208 V to 15 kV, three-phase
    - Short-circuit current: 700 A to 106 kA
    - Distance between phases: 13 mm to 152 mm
  - **2018 Version:**
    - Voltage: 208 V to 15 kV, three-phase
    - Short-circuit current:
      - 208 V to 600 V: 500 A to 106 kA
      - 601 V to 15 kV: 200 A to 65 kA
    - Distance between phases:
      - 208 V to 600 V: 6.35 mm to 76.2 mm
      - 601 V to 15 kV: 19.05 mm to 254 mm
- The system grounding (delta, floating wye, wye grounded with impedance, wye solidly grounded) is no longer considered in arc flash calculations

IEEE 1584-2018 Update

- 2 seconds limit for the duration of the arc fault still applies
  - **2002 Version** : "*It is likely that a person exposed to an arc flash will move away quickly if it is physically possible and two seconds is a reasonable maximum time for calculations.*"
  - **2018 Version** : "*It is likely that a person exposed to an arc flash will move away quickly if it is physically possible, and 2 s usually is a reasonable assumption for the arc duration to determine the incident energy.*"

- Exception for small distributions is modified, the power limit of 125 kVA is replaced by a fault current of 2 kA
  - **2002 Version** : "*Equipment below 240 V need not be considered unless it involves at least one 125 kVA or larger transformer in its immediate power supply.*"
  - **2018 Version** : "*Sustainable arcs are possible but less likely in three-phase systems operating at 240 V nominal or less with an available short-circuit current less than 2000 A.*"

2 kA equivalent in transformer power rating

208 V Secondary : $S = \sqrt{3} * V * I_{cc} * \%Z = \sqrt{3} * 208\ V * 2\ kA * 0.04 = \mathbf{29\ kVA}$

IEEE 1584-2018 Update

- Motor rated power limit of ≥ 50 hp is modified and now only refers to "large motors", but other standards in reference still refer to the ≥ 50 hp limit
  - **2002 Version** : "*The study must take into account all sources, including utilities, standby and power generators, and **large motors** – those 37 kW (**50 hp**) and larger that contribute energy to short circuits.*"
  - **2018 Version** *: "Systems containing multiple sources of short-circuit current, such as generators, **large motors**, or more than one utility supply, can be more accurately modeled with a dynamic simulation method. Methods may include multiple calculations to account for decaying short-circuit current contributions from rotating equipment, and the effect on protective device opening times and resulting incident energy."*
  - **References** :
    - **IEEE 1584.1-2013 :** *"The higher available fault current calculations should be based on all simultaneously operating **large motors (greater than or equal to 50 hp)** turned on, and the lower calculations should be based on no large motors running."*
    - **IEEE 551-2006 (Violet Book)** *: "For application of ac medium-voltage circuit breakers, symmetrical (ac component) short-circuit current duties are calculated according to IEEE Std C37.010-1999 […]. The calculations omit all motors of less than **50 hp** each."*
    - **IEEE C37.010-2016** *: "Neglect all three-phase induction motors below 37.5kW (**50 hp**) and all single-phase motors*."

IEEE 1584-2018 Update

- Recommended method for > 15 kV is no longer specifically the Lee method, therefore other methods or software now are more relevant
  - **2002 Version** : "*For cases where voltage is over 15 kV, or gap is outside the range of the model, the theoretically derived Lee method can be applied and it is included in the IEEE Std 1584-2002 Incident Energy Calculators.*"
  - **2018 Version** : "*There are alternative calculation methods for system parameters that fall outside of the range of the model. However, no particular recommendation can be made because there are other application details such as bolted fault current levels, voltage, gap length, operating frequency, number of phases, types of faults, etc. The user is advised to properly research alternative calculation methods and their application viabilities.*"

- The Lee method was far too conservative compared to other software for voltages >> 15 kV

$$E = 5.12 \times 10^5 V I_{bf} \left(\frac{t}{D^2} \right)$$

where

E	is incident energy (cal/cm^2)
V	is system voltage (kV)
t	is arcing time (seconds)
D	is distance from possible arc point to person (mm)
I_{bf}	is bolted fault current

IEEE 1584-2018 Update

- Single-phase systems: still not explicitly covered by IEEE 1584, but a conservative method is given
  - **2002 Version** : *"Single-phase ac systems [...] are not included in this guide."*
  - **2018 Version** : *"This model does not cover single-phase systems. Arc-flash incident energy testing for single-phase systems has not been searched with enough detail to determine a method for estimating the incident energy. Single-phase systems can be analyzed by using the single-phase bolted fault current to determine the single-phase arcing current (using the equations provided in 4.4 and 4.10). The voltage of the single-phase system (line-to-line, line-to-ground, center tap voltage, etc.) can be used to determine the arcing current. The arcing current can then be used to fnd the protective device opening time and incident energy by using the three-phase equations provided in this guide. The incident Energy result is expected to be conservative."*
- DC networks: still not explicitly covered by IEEE 1584, publications (i.e. Doan) are now added as references
  - **2002 Version** : "*There is ongoing testing at dc, but it was not used in this analysis. Therefore dc and other frequencies of operation such as 400 Hz are not included in the IEEE Std 1584-2002 empirically derived model.", " [...] DC systems are not included in this guide.*"
  - **2018 Version** : "*Arc-flash incident energy calculation for DC systems is not part of this model. However, publication references (Ammerman et al. [B1], Das [B16], [B17], Doan [B25], Klement [B62]) provide some guidance for incident energy calculation.*"

04

CSA Z462-2021 Update

CSA Z462-2021 Update

- Addition of new PPE category 5 (40 to 75 cal/cm^2) + high-visibility apparel + hand protection (Table 6C):

Table 6C
Personal protective equipment (PPE)
(See Clauses 4.3.5.6.1, 4.3.7.3.15.4, D.5.3, H.1, H.2, and Q.4 and Tables 6A, 6B, H.1, and V.1.)

Arc flash PPE category	PPE
1	Arc-rated clothing, minimum arc rating of 4 cal/cm^2 (16.75 J/cm^2) (Note 1): • Arc-rated long-sleeve shirt and pants or arc-rated coverall • Arc-rated faceshield or arc flash suit hood (Note 2) • Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN) (Note 3) Protective equipment: • Hard hat • Safety glasses or safety goggles (SR) • Hearing protection (ear canal inserts) (Note 4) • Heavy duty leather gloves, arc-rated gloves, or rubber insulating gloves with leather protectors (SR) (Note 5) • Leather footwear (AN) (Note 6)
2	Arc-rated clothing, minimum arc rating of 8 cal/cm^2 (33.5 J/cm^2) (Note 1): • Arc-rated long-sleeve shirt and pants or arc-rated coverall • Arc-rated arc flash suit hood; or arc-rated faceshield (Note 2) and arc-rated balaclava • Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN) (Note 3) Protective equipment: • Hard hat • Safety glasses or safety goggles (SR) • Hearing protection (ear canal inserts) (Note 4) • Heavy duty leather gloves, arc-rated gloves, or rubber insulating gloves with leather protectors (SR) (Note 5) • Leather footwear (Note 6)
3	Arc-rated clothing, selected so that the system arc rating meets the required minimum arc rating of 25 cal/cm^2 (104.7 J/cm^2) (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, or rubber insulating gloves with leather protectors (SR) (Note 5) • Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN) (Note 3) Protective equipment: • Hard hat • Safety glasses or safety goggles (SR) • Hearing protection (ear canal inserts) (Note 4) • Leather footwear (Note 6)
4	Arc-rated clothing, selected so that the system arc rating meets the required minimum arc rating of 40 cal/cm^2 (167.5 J/cm^2) (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, or rubber insulating gloves with leather protectors (SR) (Note 5) • Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN) (Note 3) Protective equipment: • Hard hat • Safety glasses or safety goggles (SR) • Hearing protection (ear canal inserts) (Note 4) • Leather footwear (Note 6)
5	Arc-rated clothing, selected so that the system arc rating meets the required minimum arc rating of 75 cal/cm^2 (314 J/cm^2) (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, or rubber insulating gloves with leather protectors (SR) (Note 5) • Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN) (Note 3) • Protective equipment: • Hard hat • Safety glasses or safety goggles (SR) • Hearing protection (ear canal inserts) (Note 4) • Leather footwear (Note 6)

CSA Z462-2021 Update

- New definitions (Clause 3):

Normal operation — to cause electrical equipment to function within the manufacturer's and engineered system's specified design and operational parameters.

Procedure — specified way to carry out an activity or a process.
Note: *A procedure may be documented or not.*

Process — set of interrelated or interacting activities which transforms inputs into outputs.

Program — a documented set of interrelated requirements that direct activity toward a goal.

CSA Z462-2021 Update

- “Normal operating condition” now becomes “normal equipment condition” (Clause 4.1.7.8.4):

> **Normal operation** — to cause electrical equipment to function within the manufacturer’s and engineered system’s specified design and operational parameters.

4.1.7.8.4 Normal equipment condition

The risk assessment procedure shall include determining whether a normal equipment condition exists. A normal equipment 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.

Notes:

1) *Identifying whether electrical equipment is in a normal equipment condition is necessary to estimate likelihood of occurrence and severity of injury or damage to health when performing a shock risk assessment and an arc flash risk assessment. See Clauses 4.3.4 and 4.3.5 and Table 2.*
2) *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.*

CSA Z462-2021 Update

- New requirement for employers to create and document an electrical safety policy (Clause 4.1.5):

4.1.5 Electrical safety policy

Employers shall create and document an electrical safety policy that affirms the organization's commitment to

a) proactively identify and eliminate electrical hazards and assess and control the associated risks; and

b) create an electrically safe work condition in accordance with the requirements of this Standard.

The policy may be documented in the employer's occupational health and safety management system (OHSMS), where one exists, or in the employer's electrical safety program.

CSA Z462-2021 Update

- Recognized methods of electrical training have been updated (Clause 4.1.8.1.5):
- 2021 (new version):

4.1.8.1.5 Type of training

The training required by Clause 4.1.8.1.1 shall be designed to achieve specific measurable learning objectives and outcomes for the intended audience. The type and extent of the training provided shall be determined in accordance with the risk to the worker.

Notes:

1) *Classroom training may include interactive electronic or interactive web-based training components.*
2) *Training may include, but is not limited to, classroom, on-the-job, electronic, or web-based training methodologies with interactive components.*

- 2018 (old version):

4.1.7.1.5 Type of training

The training required by Clause 4.1.7.1.1 shall be classroom or on-the-job training, or both. The type and extent of the training provided shall be determined in accordance with the risk to the worker.

CSA Z462-2021 Update

- Minimum voltage threshold for hazard has been changed from 30 V to 30 V AC or 60 V DC (now excludes 48 V DC telecom networks) (Clauses 4.1.6, 4.1.11 & 4.3.7):

4.1.6.1 General

Energized electrical conductors and circuit parts operating at voltages greater than 30 V ac or 60 V dc shall be put into an electrically safe work condition before a worker works within the limited approach boundary of those conductors or parts.

Electrical conductors and circuit parts shall not be considered to be in an electrically safe work condition until all of the requirements of Clause 4.2 have been met.

Safe work practices applicable to the circuit voltage and energy level shall be used in accordance with Clause 4.1 and Clause 4.3 until such time that electrical conductors and circuit parts are in an electrically safe work condition.

Note: *See Clause 4.2.5 for the steps to establish and verify an electrically safe work condition.*

CSA Z462-2021 Update

- Minimum voltage threshold for hazard has been changed from 30 V to 30 V AC or 60 V DC (now excludes 48 V DC telecom networks) (Clauses 4.1.6, 4.1.11 & 4.3.7):

4.1.6.2.3 Equipment operating at less than or equal to 30 V ac or 60 V dc

Energized electrical conductors and circuit parts that operate at less than or equal to 30 V ac or 60 V dc shall not be required to be de-energized when the capacity of the source and any overcurrent protection between the energy source and the worker are considered and it is determined that there will be no increased exposure to electrical burns or to explosion due to electric arcs.

4.1.11.5 Operation verification

When test instruments are used to test for the absence of voltage on conductors or circuit parts operating at voltages greater than 30 V ac or 60 V dc, the operation of the test instrument shall be verified on any known voltage source before and after an absence of voltage test is performed.

4.3.7.4.8 Barriers

Barriers used to insulate or guard exposed energized electrical conductors or circuit parts operating at greater than 30 V ac or 60 V dc shall

a) be in accordance with Clauses 4.3.7.4.9 to 4.3.7.4.11;
b) prevent unintentional contact by a person, tool, or equipment; and
c) be supported to remain in place.

CSA Z462-2021 Update

- New method to select PPE levels for AC (Clauses 4.3.5, 4.3.7, B.2, H.1, H.2, Annex V, Table 6C and Table H.1):

4.3.5.5 Arc flash boundary

The arc flash boundary shall be the distance at which the incident energy equals 1.2 cal/cm^2 (5 J/cm^2).

Note: *For information on estimating the arc flash boundary, see Annex D.*

The arc flash boundary may be determined by Table 6A or V.1 for ac, or Table 6B for dc when the requirements of these Tables apply.

4.3.5.7 Equipment labelling

Electrical equipment such as switchboards, panelboards, industrial control panels, meter socket enclosures, and motor control centres (MCCs) that are in other than dwelling units and that are likely to require examination, adjustment, servicing or maintenance while energized shall be marked with a label containing all the following information:

a) nominal system voltage;
b) arc flash boundary;
c) at least one of the following:
   i) available incident energy and the corresponding working distance or the arc flash PPE category in Table 6A or V.1 for ac or Table 6B for dc for the equipment, but not both;
   ii) minimum arc-rating of PPE; or
   iii) site specific level of PPE; and
d) date the information required by this Clause was determined.

CSA Z462-2021 Update

- New method to select PPE levels for AC (Clauses 4.3.5, 4.3.7, B.2, H.1, H.2, Annex V, Table 6C and Table H.1):

4.3.7.3.15.2 Alternating current (ac) equipment

When the arc flash risk assessment performed in accordance with Clause 4.3.5 indicates that arc flash PPE is required and the arc flash PPE category method is used for the selection of PPE for ac systems in lieu of the incident energy analysis method specified in Clause 4.3.5.6.2, Table 6A, or Table V.1 shall be used to determine the arc flash PPE category.

Note: *The purpose of Table V.1 is to simplify the information gathering required to use the Table.*

The parameters of estimated maximum available short-circuit current, maximum fault clearing times and minimum working distances for various ac equipment types or classifications are listed in Table 6A. Table 6A shall not be used where the listed parameters are exceeded or for equipment types and classifications that are not listed.

Table V.1 parameters and instructions for use for various ac equipment types or classifications are listed in Table V.1 and the associated notes. Table V.1 shall not be used where the listed parameters are exceeded or for equipment types and classifications that are not listed.

Where neither Table 6A nor V.1 can be used, an incident energy analysis shall be required in accordance with Clause 4.3.5.6.2.

4.3.7.3.15.4 Protective clothing and personal protective equipment (PPE)

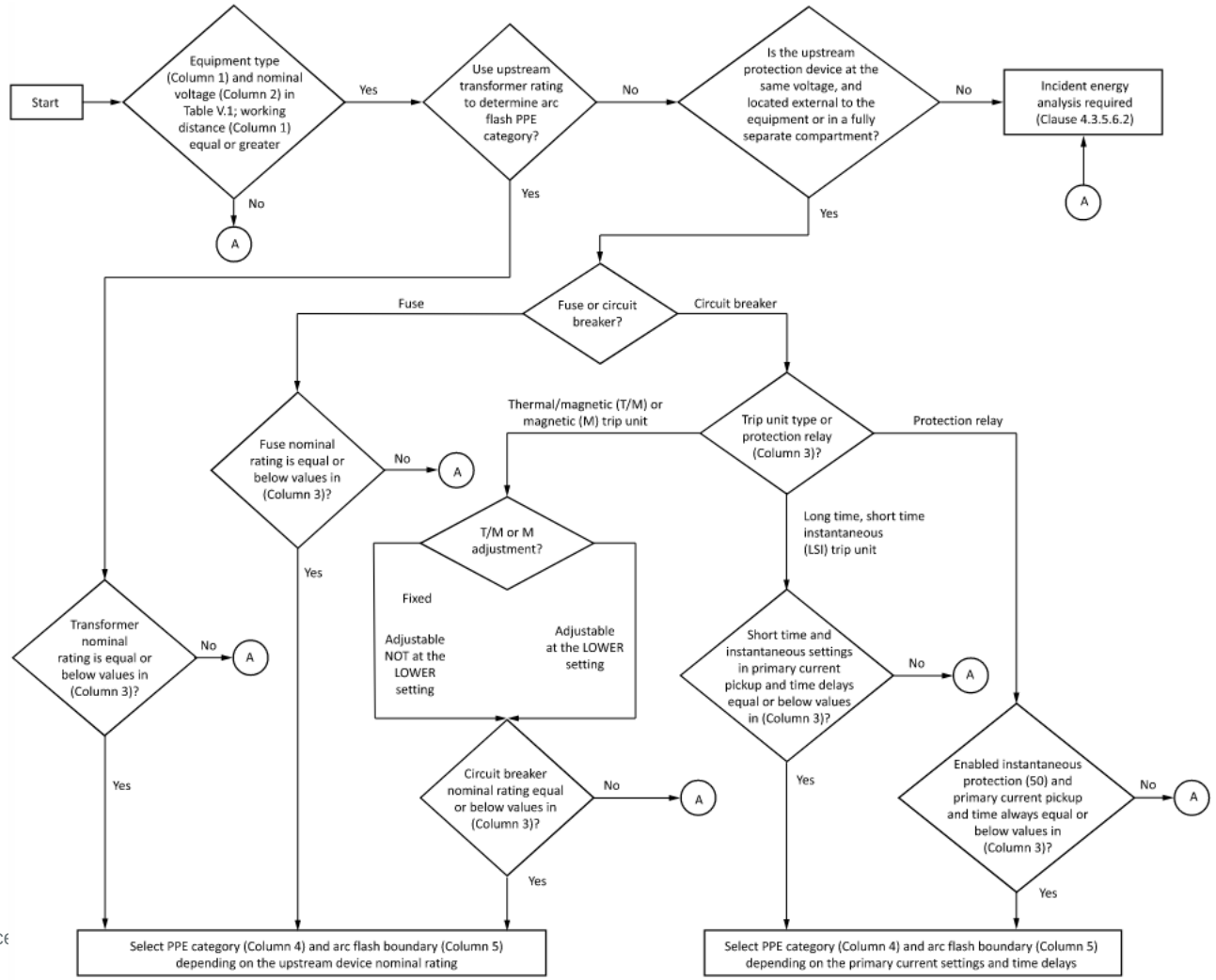
Once the arc flash PPE category has been identified from Table 6A or V.1 for ac or Table 6B for dc (including associated notes), Table 6C shall be used to determine the required PPE. Table 6C specifies requirements for PPE based on arc flash PPE category numbers 1 to 5. This clothing and equipment shall be used when working within the arc flash boundary. PPE other than or in addition to that listed in Table 6C may be used, provided it meets the requirements of Clause 4.3.7.3.7.

Notes:

1) *See Annex H for a suggested simplified approach to ensure adequate PPE for electrical workers in facilities with large and diverse electrical systems.*

CSA Z462-2021 Update

- New method to select PPE levels for AC (Clauses 4.3.5, 4.3.7, B.2, H.1, H.2, Annex V, Table 6C and Table H.1): Figure V.1:



CSA Z462-2021 Update

- New method to select PPE levels for AC (Clauses 4.3.5, 4.3.7, B.2, H.1, H.2, Annex V, Table 6C and Table H.1): Table V.1:

Table V.1
Arc-flash PPE categories for alternating current (ac) systems
(See Clauses 4.3.5.5, 4.3.5.7, 4.3.7.3.15.2, 4.3.7.3.15.4, B.2, H.1, H.2, and V.1, Table H.1, and Figure V.1.)

(1) Equipment	(2) Nominal voltage	(3) Upstream device at same voltage in separate compartment *	(4) Arc flash PPE category	(5) Arc-flash boundary
Panelboard, Motor control centre (MCC), Disconnect switch, or Other equipment (rated ≤ 800 A) Minimum working distance: 46 cm	240 V (1ϕ)	Transformer:		
		≤ 15 kVA	N/A	< 0.46 m
		≤ 50 kVA (Z ≥ 1.8%), or ≤ 75 kVA (Z ≥ 3%)	2	1.5 m
		≤ 250 kVA	4	3.0 m
		Fuses:		
		≤ 150 A	N/A	< 0.46 m
		≤ 600 A	2	1.5 m
		≤ 800 A	4	3.0 m
		Circuit breaker with fixed or adjustable T/M or M trip unit:		
		≤ 80 A	N/A	< 0.46 m
		≤ 300 A	2	1.5 m
		≤ 800 A	4	3.0 m
Panelboard, Motor control centre (MCC), Disconnect switch, or Other equipment (rated ≤ 800 A) Minimum working distance: 46 cm	208 V (3ϕ)	Transformer:		
		≤ 10 kVA	N/A	< 0.46 m
		≤ 45 kVA (3ϕ), or 3 x 10 kVA (1ϕ)	2	2.0 m
		≤ 150 kVA (3ϕ), or 3 x 25 kVA (1ϕ)	4	4.5 m
		Fuses:		
		≤ 60 A	N/A	< 0.46 m
		≤ 200 A	2	2.0 m
		≤ 800 A	4	4.5 m
		Circuit breaker with T/M or M trip unit:		
		Fixed or adjustable magnetic not set at lowest setting:		
		≤ 30 A	N/A	< 0.46 m
		≤ 90 A	2	2.0 m
		≤ 400 A	4	4.5 m
		Adjustable magnetic set at lowest setting:		
		≤ 225 A	2	2.0 m
		≤ 600 A	4	4.5 m

CSA Z462-2021 Update

- New method to select PPE levels for AC (Clauses 4.3.5, 4.3.7, B.2, H.1, H.2, Annex V, Table 6C and Table H.1):

B.2 Maintenance, protective device operating times, and incident energy

Incident energy and the arc flash boundary are a function of the operating times of protective devices such as fuses, relays, and circuit breakers. The arc flash PPE category method requires careful attention to the clearance times specified in Tables 6A and V.1 for ac and Table 6B for dc.

H.1 Arc-rated clothing and other personal protective equipment (PPE) for use with the arc flash PPE category method

Tables 6A and V.1 for ac, Table 6B for dc, and Table 6C provide guidance for the selection and use of personal protective equipment when using the arc flash PPE category method.

H.2 Simplified two-category clothing approach for use with Tables 6A, V.1, 6B, and 6C

The use of Table H.1 is a simplified approach to provide minimum PPE for electrical workers within facilities with large and diverse electrical systems. The clothing specified in Table H.1 fulfills the minimum arc-rated clothing requirements of Tables 6A, V.1, 6B, and 6C. The clothing systems specified in Table H.1 should be used with the other PPE appropriate for the arc flash PPE category (see Table 6C). The assumed short-circuit current capacities and fault-clearing times specified in Tables 6A, V.1, and 6B also apply to Table H.1.

CSA Z462-2021 Update

- New method to select PPE levels for AC (Clauses 4.3.5, 4.3.7, B.2, H.1, H.2, Annex V, Table 6C and Table H.1):

Table H.1
Simplified two-category arc-rated clothing system
(See Clause H.2.)

Clothing*	Applicable situations †
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)	Situations when a risk assessment indicates PPE is required and when Tables 6A, V.1, or 6B specify arc flash PPE category 1 or 2
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)	Situations when a risk assessment indicates PPE is required and when Tables 6A, V.1, or 6B specify arc flash PPE category 3 or 4

** See Table 6C for other PPE required for each arc flash PPE category, which includes arc-rated faceshields or arc flash suit hoods, arc-rated hard hat liners, safety glasses or safety goggles, hard hats, hearing protection, heavy duty leather gloves, and rubber insulating gloves with leather protectors. Arc rating for a garment is expressed in cal/cm².*

† The estimated available fault current capacities and fault-clearing times are specified in Tables 6A, V.1, and 6B. For power systems with greater than the estimated available fault current capacity or with longer than the assumed fault-clearing times, this Table cannot be used and arc flash PPE must be determined and selected by means of an incident energy analysis in accordance with Clause 4.3.5.6.2.

CSA Z462-2021 Update

- Added guidance on practices when incident energy exceeds available PPE limits (Clause 4.3.7.3.1):

4.3.7.3.1 General

When a worker is within the restricted approach boundary, the worker shall wear PPE in accordance with Clause 4.3.4. When a worker is within the arc flash boundary, the worker shall wear protective clothing and other PPE in accordance with Clause 4.3.5. All parts of the body inside the arc flash boundary shall be protected.

Note: *Where the estimated incident energy exposure is greater than the arc rating of commercially available arc-rated PPE, for the purpose of testing for the absence of voltage, the following examples of risk reduction methods may be used to reduce the likelihood of occurrence of an arcing event or the severity of exposure:*

a) *Use non-contact proximity test instrument(s) or measure voltage on the secondary side of a low voltage transformer (VT) mounted in the equipment before use of a contact test instrument to test for the absence of voltage below 1000 V.*

b) *If equipment design allows, observe visible gaps between the equipment conductors and circuit parts and the electrical source(s) of supply.*

c) *Increase the working distance.*

d) *Consider system design options to reduce the incident energy level.*

CSA Z462-2021 Update

- New Table 4A includes rubber insulating gloves classes voltage levels:

Table 4A
Maximum use voltage for rubber insulating gloves
(See Clause 4.3.7.3.7.)

Class designation of glove or sleeve	Maximum AC use Voltage rms, V	Maximum DC use Voltage avg, V	Distances between gauntlet and cuff, min
00	500	750	13 mm (0.5 in)
0	1000	1500	13 mm (0.5 in)
1	7500	11 250	25 mm (1 in)
2	17 000	25 500	51 mm (2 in)
3	26 500	39 750	76 mm (3 in)
4	36 000	54 000	102 mm (4 in)

CSA Z462-2021 Update

- Table 6A has been changed (new equipment categories and PPE categories):

Table 6A
Arc-flash PPE categories for alternating current (ac) systems
(See Clauses 4.3.5.5, 4.3.5.7, 4.3.7.3.15.2, 4.3.7.3.15.4, B.2, H.1, and H.2 and Table H.1.)

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)
600-V class motor control centers (MCCs) Parameters: Maximum of 65 kA available fault current; maximum of 0.03 s (2 cycles) fault clearing time; minimum working distance 18 in	2	1.5 m (5 ft)
600-V class motor control centers (MCCs) Parameters: Maximum of 42 kA available fault current; maximum of 0.33 s (20 cycles) fault clearing time; minimum working distance 18 in	4	4.3 m (14 ft)

CSA Z462-2021 Update

- Clause 5 on maintenance requirements has been completely overhauled:

New table of contents (2021)

- 5 Safety-related maintenance requirements
  - 5.1 General
  - 5.2 Maintenance program
  - 5.3 General maintenance requirements
    - 5.3.1 Equipment maintenance
    - 5.3.2 Qualified persons
    - 5.3.3 Single-line diagram
    - 5.3.4 Identification of components
    - 5.3.5 Identification of circuits
    - 5.3.6 Warning signs
    - 5.3.7 Spaces about electrical equipment
    - 5.3.8 Grounding and bonding
    - 5.3.9 Safety equipment
    - 5.3.10 Life safety systems
    - 5.3.11 Electrical cables and single and multiple conductors
    - 5.3.12 Overhead line clearances
  - 5.4 Specific maintenance requirements
    - 5.4.1 Protective devices
    - 5.4.2 Overcurrent relays
    - 5.4.3 Fuses
    - 5.4.4 Arc flash relays
    - 5.4.5 Ground fault devices and systems
    - 5.4.6 Disconnecting means
    - 5.4.7 Capacitors
    - 5.4.8 Control equipment
    - 5.4.9 Equipment in hazardous locations
    - 5.4.10 Batteries and battery rooms

Old table of contents (2018)

- 5 Safety-related maintenance requirements
  - 5.1 General
  - 5.2 General maintenance requirements
  - 5.3 Substations, switchgear assemblies, switchboards, panelboards, motor control centres, and disconnect switches
  - 5.4 Premises wiring
  - 5.5 Control equipment
  - 5.6 Fuses and circuit breakers
  - 5.7 Rotating equipment
  - 5.8 Hazardous locations
  - 5.9 Batteries and battery rooms
  - 5.10 Portable electric tools and equipment
  - 5.11 Personal safety and protective equipment

CSA Z462-2021 Update

- Clause 5 on maintenance requirements has been completely overhauled:

5.3.2 Qualified persons

Workers who perform maintenance on electrical equipment and installations shall be qualified persons as specified in Clause 4.1.8.1.2 and trained in and familiar with the specific maintenance procedures and tests.

5.3.3 Single-line diagram

A single-line diagram for the electrical system, where provided, shall be maintained in a legible condition and shall be kept current (see Clause E.3).

5.3.4 Identification of components

Required signs, etc., that identify components, and safety-related instructions (operating or maintenance), if posted, shall be visible, securely attached, and maintained in legible condition.

5.3.5 Identification of circuits

Circuit or voltage identification signs, etc., shall be securely affixed, kept up-to-date, and maintained in legible condition.

5.3.6 Warning signs

Warning signs, where required, shall be visible, securely attached, and maintained in legible condition.

CSA Z462-2021 Update

- Clause 5 on maintenance requirements has been completely overhauled:

5.3.7 Spaces about electrical equipment

The following requirements apply to spaces about electrical equipment:

a) All working space and clearances shall be maintained in such a way that they continue to meet the requirements of Parts I and III of the *Canadian Electrical Code*.
b) Access to working space and escape passages shall be kept clear and unobstructed.
c) Enclosures shall be kept free of material that could expose workers to an electrical hazard.
d) Fences, physical barriers, enclosures, or other protective means, where required to guard against unauthorized access or unintentional contact with exposed energized electrical conductors and circuit parts, shall be maintained to meet its intended purpose.

5.3.8 Grounding and bonding

Equipment and enclosure bonding and grounding shall be maintained in a way that ensures electrical continuity.

Grounding conductors, grounding rods, and ground grids shall be

a) electrically tested for continuity, and when applicable, conductivity; and
b) inspected for degradation or missing parts.

5.3.9 Safety equipment

Locks, interlocks, and other safety equipment shall be maintained in proper working condition.

Note: *See also CSA Z432.*

CSA Z462-2021 Update

- Clause 5 on maintenance requirements has been completely overhauled:

5.3.10 Life safety systems

Life safety systems and hazard detection systems that provide notification of hazardous events and situations shall be monitored and maintained to ensure their reliable operation. This maintenance shall include a functional test of any associated detection and alarm systems that shall be verified and documented.

Note: *Life safety systems and hazard detection systems Include fire alarm systems, gas detection systems, emergency lighting systems, and smoke and fume exhaust systems.*

5.3.11 Electrical cables and single and multiple conductors

Electrical cables and single and multiple conductors shall be maintained free of damage, shorts, and ground that could expose workers to an electrical hazard.

5.3.12 Overhead line clearances

For overhead electric lines under the employer's control, grade elevation shall be maintained to preserve no less than the minimum designed vertical and horizontal clearances.

CSA Z462-2021 Update

- Clause 5 on maintenance requirements has been completely overhauled:

5.4.4 Arc flash relays

Arc flash relays shall be tested in accordance with the manufacturer's instructions. Light sensors shall be maintained clean and free from obstructing debris. Testing shall include light sensing and controls as well as current sensing and controls if implemented. Setting of current threshold, if implemented, shall be reviewed against the incident energy analysis.

5.4.5 Ground fault devices and systems

Ground fault devices and systems shall be inspected and tested to ensure they are functioning correctly and within the trip or alarm time specified.

5.4.6 Disconnecting means

5.4.6.1 General

Disconnecting means used in establishing an electrically safe working condition shall be maintained and tested in accordance with the manufacturer's instructions or industry consensus standards.

Note: *For guidance on switching and isolation to establish an electrically safe work condition, see Annex P.*

5.4.6.2 Switches

Switches shall be inspected, exercised, tested, and maintained to ensure proper mechanical operation and circuit isolation.

5.4.6.3 Key interlocks

Key interlocks between the switch and the fuse compartment and between disconnecting means shall be tested for proper operation.

CSA Z462-2021 Update

- Clause 5 on maintenance requirements has been completely overhauled:

5.4.7 Capacitors

Before performing maintenance on capacitors, they shall be isolated, discharged, and then grounded in accordance with industry consensus standards or manufacturer's requirements.

Capacitor discharge resistors shall be tested in accordance with manufacturer's instructions.

Note: *See Scott (2019) for information regarding discharging and grounding capacitors.*

CSA Z462-2021 Update

- Clause 5 on maintenance requirements has been completely overhauled:

5.4.9 Equipment in hazardous locations

Equipment and installations in areas identified as hazardous locations in accordance with the *Canadian Electrical Code, Part I* shall be maintained in such a way that

a) no energized parts are exposed (intrinsically safe and non-incendive circuits excepted);
b) there are no breaks in conduit systems, fittings, or enclosures resulting from corrosion or other damage, or from other causes;
c) all bonding conductors are securely fastened and intact;
d) the bolts for all fittings, boxes, and enclosures with bolted covers are installed and bolted tight;
e) all threaded conduit is wrench-tight and enclosure covers are tightened in accordance with the manufacturer's instructions;
f) there are no open entries into fittings, boxes, or enclosures that could compromise their protection characteristics;
g) all close-up plugs, breathers, seals, and drains are securely in place;
h) marking of luminaires (lighting fixtures) for maximum lamp wattage and temperature rating is legible and the maximums are not exceeded; and
i) required markings are secure and legible.

CSA Z462-2021 Update

- Table A1 on correspondance between CSA Z462 and CSA Z45001 has been rewritten:
- CSA Z462: Electrical Workplace Safety
- CSA Z45001: Occupational Health and Safety Management Systems (OHSMS)

Table A.1
Correspondences between this Standard and CSA Z45001
(See Clause A.1.)

CSA Z45001 Table of contents	OHSMS intent or objective*	CSA Z462 correspondence
1 Scope		1 Scope
2 Normative references		2 Reference publications
3 Terms and definitions		3 Definitions
4 Context of the organization 4.1 Understanding the organization and its context 4.2 Understanding the needs and expectations of workers and other interested parties 4.3 Determining the scope of the OH&S management system 4.4 OH&S management system	The organization (employer) is required to establish, implement, maintain and continually improve an OHSMS. The OHSMS must have a defined and documented scope that is applicable to the internal and external context in which the organization operates. Scope and context will be used to guide planning (Clause 6).	4.1.7.1 General The employer's electrical safety program must be implemented as part of the employer's OHSMS, when one exists.
5 Leadership and worker participation 5.1 Leadership and commitment 5.3 Organizational roles, responsibilities and authorities 5.4 Consultation and participation of workers	To be effective, the OHSMS must have active leadership from top management that includes • defining roles and responsibilities for the implementation of the OHSMS; and • establishing a process for worker consultation and participation.	4.1.3.1 Employer responsibility The employer has the responsibility to • establish, document, and implement the safety-related work practices and procedures required by CSA Z462; and • provide workers with training in those work practices and procedures.

CSA Z462-2021 Update

- New job planning checklist example added (Figure I.2):

Figure I.2
Sample job planning checklist
(See Clause 4.1.7.9.4.)

Job safety planning checklist	
Job number:	Date:
Client:	Location:
Supervisor(s):	
Emergency response planning	
Contacts and phone numbers:	
Special procedures	
Describe the scope of work and list the individual tasks (use a separate sheet if necessary)	

CSA Z462-2021 Update

- New job planning checklist example added (Figure I.2):

Identify and list hazards associated with each task Select risk control method(s) from the hierarchy of risk control methods)	
Hazard	Risk control method(s)

Additional shock risk assessment information				
Tasks with a shock hazard	Nominal voltage	Class of gloves	Approach boundaries	
			Limited	Restricted

Additional arc flash risk assessment information PPE selection method used: ☐ Incident energy: ☐ Arc flash PPE category or other method		
Tasks with an arc flash hazard	Incident energy or PPE category #	Arc flash boundary

CSA Z462-2021 Update

- New job planning checklist example added (Figure I.2):

Final review before starting work — (√) or N/A with explanation			
Emergency response plan discussed		Required PPE available	
First aid kit(s) readily accessible		Required tools and equipment available	
Fire extinguisher(s) readily accessible		Lockout procedure(s) discussed	
Single-line diagram consulted		Switching sequence prepared	
All hazards identified and risk control(s) selected		Temporary protective grounding discussed	
Notes:			

Job safety briefing attendance (use a separate sheet if necessary)	
Name and contact # (print)	Date and time

Pre-energization check list — (√) or N/A	
Jumpers and test leads removed	
Tools and equipment accounted for	
Electrical equipment inspected and ready to energize	
All personnel accounted for and clear	
All temporary protective grounds removed and accounted for	
Locks removed	
Other:	

CSA Z462-2021 Update

- Annex O rewritten to provide more and clearer ways to reduce arc flash or shock hazard (not a mandatory part of this standard):
  - Incident energy reduction methods : ZSI, differential relays, maintenance switches, arc flash relays, line-side isolation, arc quenching devices, high resistance grounding, current-limiting devices, shunt-tripping for blown fuses
  - Safety by design methods : finger-safe components, insulating barriers, disconnects clost to motors or branches, current-limiting cable limiters, inspection windows, windows for IR scanning of joints, ultra-sonic ports for non-contact diagnostics, multiple disconnects instead of one, instantaneous overcurrent protection and reducing protection adjustments, arc-resistant equipment, remote device racking and deracking, remote device operating, GFCI, permanent voltage measurement, detection or absence of voltage detection, remote electrical equipment communication, GIS to reduce maintenance requirements on switchgears

CSA Z462-2021 Update

- New Annex P: Electrical switching and isolation (not a mandatory part of this standard):

P.2 Planning and elements of switching

A documented switching and isolation plan ("plan") should be completed whenever three or more disconnecting means are operated to establish an electrically safe work condition, or whenever temporary protective grounding equipment is applied.

The plan is a sequential listing of communication and actions taken to isolate and de-energize electrical equipment and to re-energize and return the equipment to normal operation. Preparation of the plan is done as part of job safety planning and should be completed by a qualified person.

Figure P.2
Example switching order
(See Clause P.4.)

Step	Work task description	Completed by	Verified by
1.0	**Setup**		
	Ensure authorization to start switching and that all required personnel are aware switching will begin		
	Secure work area, only switching team allowed in area while completing Step 2		
	Complete risk assessment and review that procedure is adequate		
	Ensure there are no system alarms or active trouble flags on equipment.		
2.0	**Isolation**		
	Close circuit breaker 52 -TIE		
	Open circuit breaker 52-T2, remove K3		
	Verify voltage remains present on bus "B"		

CSA Z462-2021 Update

- New Annex T: Temporary protective grounding (not a mandatory part of this standard):

T.1 General

Temporary protective grounds are used when required in accordance with Clause 4.2.5 as part of the procedure to place electrical conductors or circuit parts in an electrically safe work condition. Situations in which temporary protective grounds might be required include, but are not limited to,

- stored electrical charge in insulated conductors or in capacitors connected to the power distribution system;
- capacitively and inductively coupled energy from adjacent or parallel energized conductors;
- static electricity produced by wind on overhead transmission and distribution lines;
- inadvertent energization of electrical equipment from human error or electrical equipment malfunction; and
- back feed through a transformer such as an instrument, metering, or protection voltage transformer (VT) or potential transformer (PT).

Table T.1
Examples of ultimate ratings of temporary protective grounding cables
(See Clause T.3.5.)

	Fault current rating (kA)	
Conductor size	**15 cycle fault duration**	**30 cycle fault duration**
#2 AWG	16	12
#1 AWG	21	16
#1/0 AWG	26	20
#2/0 AWG	33	25
#3/0 AWG	42	32
#4/0 AWG	53	40
250 kcmil	62	47
2 x 2/0 AWG (Note 4)	62	47
350 kcmil	87	67
2 x 4/0 AWG (Note 4)	87	67

Questions?
(submit them through the question box)

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