City of New Westminster ELECTRICAL OPERATIONS – R3
Shock and Arc Flash Protection Safe Work Procedures

The following procedures will apply to prevent injury due to shock hazard or arc flash.

1. All electrical work shall to be done by qualified/certified personnel only, as per the Canadian Electrical Code (CEC), WorkSafe BC (WSBC) and Canadian Standards Association (CSA) Standard Z462-15 Workplace Electrical Safety.

2. Equipment must be de-energized and locked out in accordance with WSBC OHSR Part 10, and 19, using **Electricians Individual Lock-Out Procedures** to reduce the risk of shock or arc flash hazards before work proceeds.

3. The following general procedures will apply:

    a) Electrical Services staff shall use as a minimum standard, the **Simplified Two-Category Clothing Approach for use with Tables 4A, 4B, 4C and 5, as** outlined in Annex H of CSA Z462-15.

    b) Electrical Services staff shall use CSA Z462-15 - Table 4A for **Arc flash Hazard Identification of Alternating Current (AC) and Direct Current (DC) Systems** as the minimum requirement for their work tasks.

    c) Electrical Services staff shall use CSA Z462-15 - Table 4B **for Identification of Arc flash PPE Categories for Alternating Current (AC)** as the minimum requirement for their work.

    d) Electrical Services staff shall use CSA Z462-15 - Table 4C **for Identification of Arc flash PPE Categories for Direct Current (DC) Systems** as the minimum requirement for their work.

    e) Electrical Services staff shall use CSA Z462 -Table 5, **Personal Protective Equipment (PPE)** as a minimum requirement for PPE in accordance with Table 4A, B and C.

    f) For any work on energized equipment above 120v, **two** qualified personnel shall be present. Work methods and procedures, hazard classification and PPE will be discussed and documented as part of the pre-job safety meeting.

4. If special circumstances arise where **live electrical work** is required, a specific safe work procedure shall be developed and approved by the Person in Charge (PIC), in accordance with WSBC OHSR Part 10 and 19, before starting that work AND the Electrical Services Energized Electrical Work Permit shall be completed. **Q. What activity would be an example of this requirement?**

Annex H (informative)

Guidance on selection of protective clothing and other personal protective equipment

Note: *This Annex is not a mandatory part of this Standard.*

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

Tables 4A, 4B, 4C, and 5 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 4A, 4B, 4C, and 5.

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 4A, 4B, 4C, and 5. The clothing systems specified in Table H.1 should be used with the other PPE appropriate for the arc flash PPE category (see Table 5). The assumed short-circuit current capacities and fault-clearing times specified in Tables 4B and 4C also apply to 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)	Tasks when PPE is required by Table 4A and when Tables 4B or 4C 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)	Tasks when PPE is required by Table 4A and when Tables 4B or 4C specify arc flash PPE category 3 or 4

**See Table 5 for other PPE required for each arc flash PPE category which includes arc-rated face shields or arc flash suit hoods, arc-rated hard hat liners, safety glasses or safety goggles, hard hats, hearing protection, leather gloves, rubber insulating gloves, and insulated or insulating hand. Arc rating for a garment is expressed in cal/cm^2.*
†The assumed short-circuit current capacities and fault-clearing times are specified in Tables 4B and 4C. Various tasks are listed in Table 4A. For tasks not listed, or for power systems with greater than the assumed short-circuit current capacity or with longer than the assumed fault-clearing times, an arc flash risk assessment is required in accordance with Clause 4.3.5.

Table 4A
Arc flash Hazard Identification for Alternating Current (AC) and Direct Current (DC) Systems

(See Clauses 3, 4.3.1, 4.3.7.3.15, and 4.3.7.4.2, Table 5, and Annex H)

Task	Equipment condition (2)	Arc flash PPE required (1)
Reading a panel meter while operating a meter switch	Any	No
Normal operation of a circuit breaker (CB), switch, contactor or starter	All of the following: • the equipment is properly installed; • the equipment is properly maintained; • all equipment doors are closed and secured; • all equipment covers are in place and secured; and • there is no evidence of impending failure.	No
	One or more of the following: • the equipment is not properly installed; • the equipment is not properly maintained; • equipment doors are open or not secured; • equipment covers are off or not secured; or • there is evidence of impending failure.	Yes
For ac systems: Work on energized electrical conductors and circuit parts, including voltage testing	Any	Yes
For dc systems: Work on energized electrical conductors and circuit parts of series-connected cells, including voltage testing	Any	Yes
Voltage testing on individual battery cells or individual multi-cell units	All of the following: • the equipment is properly installed; • the equipment is properly maintained; • covers for all other equipment are in place and secured; and • there is no evidence of impending failure.	No
	One or more of the following: • the equipment is not properly installed; • the equipment is not properly maintained; • equipment doors are open or not secured; • equipment covers are off or not secured; or • there is evidence of impending failure.	Yes
Removal or installation of CBs or switches	Any	Yes

(Continued)

Table 4A (Continued)

Task	Equipment condition (2)	Arc flash PPE required (1)
Removal or installation of covers for equipment such as wireways, junction boxes, and cable trays that does not expose bare, energized electrical conductors, and circuit parts	All of the following: • the equipment is properly installed; • the equipment is properly maintained; and • there is no evidence of impending failure.	No
	One or more of the following: • the equipment is not properly installed; • the equipment is not properly maintained; or • there is evidence of impending failure.	Yes
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	Any	Yes
Removal of battery intercell connector covers	All of the following: • the equipment is properly installed; • the equipment is properly maintained; • covers for all other equipment are in place and secured; and • there is no evidence of impending failure.	No
	One or more of the following: • the equipment is not properly installed; • the equipment is not properly maintained; • covers for any other equipment are off or not secured; or • there is evidence of impending failure.	Yes
Opening hinged door(s) or cover(s) (to expose bare energized electrical conductors and circuit parts)	Any	Yes
Perform infrared thermography and other non-contact inspections outside the restricted approach boundary. This activity does not include opening of doors or covers	Any	No
Application of temporary protective grounding equipment, after voltage test	Any	Yes
Work on control circuits with exposed energized electrical conductors and circuit parts, 120 V or below without any other exposed energized equipment over 120 V including opening of hinged covers to gain access	Any	No

(Continued)

Table 4A (Continued)

Task	Equipment condition (2)	Arc flash PPE required (1)
Work on control circuits with exposed energized electrical conductors and circuit parts, greater than 120 V	Any	Yes
Insertion or removal of individual starter buckets from motor control centre (MCC)	Any	Yes
Insertion or removal (racking) of CBs or starters from cubicles, doors open or closed	Any	Yes
Insertion or removal of plug-in devices into or from busways	Any	Yes
Insulated cable examination with no manipulation of cable	Any	No
Insulated cable examination with manipulation of cable	Any	Yes
Work on exposed energized electrical conductors and circuit parts of equipment directly supplied by a panelboard or motor control centre	Any	Yes
Insertion or removal of revenue meters (kW-hour, at primary voltage and current)	Any	Yes
For dc systems, insertion or removal of individual cells or multi-cell units of a battery system in an enclosure	Any	Yes
For dc systems, insertion or removal of individual cells or multi-cell units of a battery system in an open rack	Any	No
For dc systems, maintenance on a single cell of a battery system or multi-cell units in an open rack	Any	No
For dc systems: Work on exposed energized electrical conductors and circuit parts of utilization equipment directly supplied by a dc source	Any	Yes

(Continued)

Table 4A (Concluded)

Task	Equipment condition (2)	Arc flash PPE required (1)
Arc-resistant switchgear Type 1 or 2 (for clearing times of < 0.5 s with a prospective fault current not to exceed the arc-resistant rating of the equipment) and metal enclosed interrupter switchgear, fused or unfused of arc resistant type construction, tested in accordance with CSA C22.2 No. 022 or IEEE C37.20.7: • Insertion or removal (racking) of CBs from cubicles; • Insertion or removal (racking) of ground and test device; or • Insertion or removal (racking) of voltage transformers on or off the bus	All of the following: • the equipment is properly installed; • the equipment is properly maintained; • all equipment doors are closed and secured; • all equipment covers are in place and secured; and • there is no evidence of impending failure.	No
	Any of the following: • the equipment is not properly installed; • the equipment is not properly maintained; • equipment doors are open or not secured; • equipment covers are off or not secured; or • there is evidence of impending failure.	Yes
Opening voltage transformer or control power transformer compartments	Any	Yes
Outdoor disconnect switch operation (hookstick operated) at 1 kV through 15 kV	Any	Yes
Outdoor disconnect switch operation (gang-operated, from grade) at 1 kV through 15 kV	Any	Yes

Notes:

(1) *Hazard identification is one component of risk assessment. Risk assessment involves a determination of the likelihood of occurrence of an incident, resulting from a hazard, which could cause injury or damage to health. The assessment of the likelihood of occurrence contained in this Table does not cover every possible condition or situation. Where this Table indicates that arc flash PPE is not required, an arc flash is not likely to occur.*

(2) *The phrase "properly installed" as used in this Table means that the equipment is installed in accordance with applicable industry codes and standards and the manufacturer's recommendations. The phrase "properly maintained" as used in this table 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" as used in this table means that there is evidence such as arcing, overheating, loose, or bound equipment parts, visible damage, or deterioration.*

Table 4B
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, 4.3.7.3.16, 4.3.7.4.2, and B.2, Table 5, 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 short-circuit current available; maximum of 0.03 s (2 cycles) fault clearing time; working distance 455 mm (18 in)	1	485 mm (19 in)
Panelboards or other equipment rated > 240 V and up to 600 V Parameters: Maximum of 25 kA short-circuit current available; maximum of 0.03 s (2 cycles) fault clearing time; working distance 455 mm (18 in)	2	900 mm (3 ft)
600 V class motor control centers (MCCs) Parameters: Maximum of 65 kA short-circuit current available; maximum of 0.03 s (2 cycles) fault clearing time; working distance 455 mm (18 in)	2	1.5 m (5 ft)
600 V class motor control centers (MCCs) Parameters: Maximum of 42 kA short-circuit current available; maximum of 0.33 s (20 cycles) fault clearing time; working distance 455 mm (18 in)	4	4.3 m (14 ft)
600 V class switchgear (with power circuit breakers or fused switches) and 600 V class switchboards Parameters: Maximum of 35 kA short-circuit current available; maximum of up to 0.5 s (30 cycles) fault clearing time; working distance 455 mm (18 in)	4	6 m (20 ft)
Other 600 V class (277 V through 600 V, nominal) equipment Parameters: Maximum of 65 kA short circuit current available; maximum of 0.03 s (2 cycles) fault clearing time; working distance 455 mm (18 in)	2	1.5 m (5 ft)
NEMA E2 (fused contactor) motor starters, 2.3 kV through 7.2 kV Parameters: Maximum of 35 kA short-circuit current available; maximum of up to 0.24 s (15 cycles) fault clearing time; working distance 910 mm (36 in)	4	12 m (40 ft)
Metal-clad switchgear, 1 kV through 15 kV Parameters: Maximum of 35 kA short-circuit current available; maximum of up to 0.24 s (15 cycles) fault clearing time; working distance 910 mm (36 in)	4	12 m (40 ft)

(Continued)

Table 4B (Continued)

Equipment	Arc flash PPE category	Arc flash boundary
Arc-resistant switchgear Type 1 or 2 (for clearing times of < 0.5 s (30 cycles) with a prospective fault current not to exceed the arc-resistant rating of the equipment), and metal-enclosed interrupter switchgear, fused or unfused of arc-resistant-type construction, tested in accordance with CSA 22.2 No. 0.22 or IEEE C37.20.7, 1 kV through 15 kV: Parameters:	N/A (doors closed)	N/A (doors closed)
Maximum of 35 kA short-circuit current available; maximum of up to 0.24 s (15 cycles) fault clearing time; working distance 910 mm (36 in)	4 (doors open)	12 m (40 ft)
Other equipment 1 kV through 15 kV Parameters: Maximum of 35 kA short-circuit current available; maximum of up to 0.24 s (15 cycles) fault clearing time; working distance 910 mm (36 in)	4	12 m (40 ft)

Notes:

(1) *See Table 5 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.*

Table 4C
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, 4.3.7.3.16, and B.2, D.5.2 Table 5, and Annex H)

Equipment	Arc flash PPE category	Arc flash boundary
Storage batteries, direct current switchboards, and other dc supply sources 100 V < Voltage < 250 V Parameters: Voltage: 250 V Maximum arc duration and working distance: 2 s at 455 mm (18 in)		
Short-circuit current < 4 kA	1	900 mm (3 ft)
4 kA □□ short-circuit current < 7 kA	2	1.2 m (4 ft)
7 kA □□ short-circuit current < 15 kA	3	1.8 m (6 ft)
Storage batteries, direct current switchboards and other dc supply sources 250 V □□ Voltage □□ 600 V Parameters: Voltage: 600 V Maximum arc duration and working distance: 2 s at 455 mm (18 in)		
Short-circuit current < 1.5 kA	1	900 mm (3 ft)
1.5 kA □□ short-circuit current < 3 kA	2	1.2 m (4 ft)
3 kA □□ short-circuit current < 7 kA	3	1.8 m (6 ft)
7 kA □□ short-circuit current < 10 kA	4	2.5 m (8 ft)

Notes:

(1) *See Table 5 for a list of protective clothing and PPE for each arc flash PPE category.*

(2) *Apparel that can be expected to be exposed to electrolyte shall meet both of the following conditions:*
(a) be evaluated for electrolyte protection in accordance with ASTM F1296; and
(b) be arc-rated in accordance with ASTM F1891, or equivalent.

(3) *"Short-circuit current," as used in this Table, is determined from the dc power system maximum available short-circuit, including the effects of cables and any other impedances in the circuit. Power system modelling is the best method to determine the available short-circuit current at the point of the arc. Battery cell short-circuit current can be obtained from the battery manufacturer. See Clause D.5 for the basis for table values and alternative methods to determine dc incident energy. Methods should be used with good engineering judgment.*

(4) *The methods for estimating the dc arc flash incident energy that were used to determine the categories for this Table are based on open-air incident energy calculations. Open-air calculations were used because many battery systems and other dc process systems are in open areas or rooms. If the specific task is within in an enclosure, it would be prudent to consider additional PPE protection beyond the value shown in this table. Research with ac arc flash has shown a multiplier of as much as 3x for arc-in-a-box (508 mm [20 in.] cube) versus open air. Engineering judgment is required when reviewing the specific conditions of the equipment and task to be performed, including the dimensions of the enclosure and the working distance involved.*

Protective Clothing and Personal Protective Equipment

Once the arc flash PPE category has been identified from Clause 4.3.7.3.15 and Tables 4B and 4C including associated notes), Table 5 shall be used to determine the required PPE for the task. Table 5 specifies requirements for PPE based on arc flash PPE category numbers 1 to 4. This clothing and equipment shall be used during work within the arc flash boundary.

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.*

(2) *The requirements of this Clause are intended to protect workers from arc flash hazards. While some situations could result in burns to the skin, even with the protection specified in Table 5, burn injury will likely be reduced and be survivable. Due to the explosive effect of some arc events, physical trauma injuries can occur. The requirements of this Clause do not provide protection against physical trauma other than exposure to the thermal effects of an arc flash.*

(3) *The arc rating for a particular clothing system can be obtained from the arc-rated clothing manufacturer.*

Table 5
Personal Protective Equipment (PPE)

(See Clauses 4.3.1, 4.3.7.3.12, and 4.3.7.3.16, Tables 4A and 4B, and Annex H.)

Arc flash PPE Category	**PPE**
1	Arc-rated clothing, minimum arc rating of 4 cal/cm^2 (Note 3): Arc-rated long-sleeve shirt and pants or arc-rated coverall Arc-rated face shield or arc flash suit hood (Note 2) Arc-rated jacket, parka, rainwear, or hard hat liner (AN) Protective Equipment: Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Heavy duty leather gloves (AN) (Note 1) Leather footwear (AN
2	Arc-rated clothing, minimum arc rating of 4 cal/cm^2 (Note 3): Arc-rated long-sleeve shirt and pants or arc-rated coverall Arc-rated face shield or arc flash suit hood (Note 2) Arc-rated jacket, parka, rainwear, or hard hat liner (AN) Protective equipment: Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Heavy duty leather gloves (AN) (Note 1) Leather footwear (AN

Table 5 (Continued)

Arc flash PPE Category	**PPE**
3	Arc-rated clothing, selected so that the system arc rating meets the required minimum arc rating of 25 cal/cm^2 (Note 3): 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 (AR) Arc-rated gloves (Note1) Arc-rated jacket, parka, rainwear, or hard hat liner (AN) Protective Equipment: Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Leather footwear
4	Arc-rated clothing, selected so that the system arc rating meets the required minimum arc rating of 40 cal/cm^2 (Note 3): 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 (AR) Arc-rated gloves (Note1) Arc-rated jacket, parka, rainwear, or hard hat liner (AN) Protective equipment: Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Leather footwear (AN

Legend: AN = as needed (optional); AR = as required; SR = selection required

Notes:

(1) *Arc rating is defined in Clause 3.*

(2) *Faceshields shall meet the requirements of Clause 4.3.7.3.10 (c). An arc flash suit hood may be worn in lieu of a face shield.*

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

4.3.7.4 Other Protective Equipment

4.3.7.4.1 General

The other protective equipment specified in Clauses 4.3.7.4.2 to 4.3.7.4.11 shall meet the requirements of the Standards specified in Table 6

4.3.7.4.2 Insulated Tools and Equipment

Workers shall use insulated tools and/or handling equipment when they are working inside the restricted approach boundary of exposed energized electrical conductors or circuit parts and tools or handling equipment might make accidental contact. Insulated tools shall be protected from damage to the insulating material.
Note: *See Clause 4.3.4.2.*

4.3.7.4.3 Insulated Tools and Equipment

The following requirements shall apply to insulated tools and equipment:
(a) Insulated tools shall be rated for the voltages on which they are used.
(b) Insulated tools shall be designed and constructed for the environment to which they are exposed and the manner in which they are used.
Insulated tools and equipment shall be inspected before each use for damage to the insulation and for damage that could limit the tool or equipment from performing its intended function or increase the potential for an incident, e.g., a damaged tip on a screwdriver.