

ELECTRICAL Safety Measures

"Elimination is the first priority! Ensure a risk assessment is completed before energized work tasks are completed."

Sticker Shock: Getting Arc Flash & Shock Equipment Labels Right

By Terry Becker, P.Eng., CESCP, IEEE Senior Member

The last article I authored with respect to detailed arc flash and shock equipment labels was in the September/October 2021 Electrical Safety Measures. Long overdue that I provide an update. Let's start with what the Standards in Canada advise us is required.

Over 19 years ago my career focus changed to electrical safety and one of the Standards that influenced that change was the CE Code Part I when Rule 2-306 was added to the 2006 Edition.

Rule 2-306 Shock and Arc Flash Protection (see Appendix B)

(1) Electrical equipment such as switchboards, panbelboards, 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.



Figure 1. Rule 2-306 Warning Arc Flash and Shock Equipment Label

I also became aware that there was a different more detailed arc flash and shock equipment label required when arc flash hazard incident energy analysis was completed. The requirements for this label were identified in the CSA Z462 Workplace electrical safety Standard.

CSA Z462, Clause 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 of 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;
  (ii) The arc flash PPE minimum arc rating in Table V.1 or V.2 for ac equipment, or Table V.3 for dc equipment;
  (iii) Minimum arc-rating of PPE; or
  (iv) Site-specific level of PPE; and
(d) Date the information required by this Clause was determined.

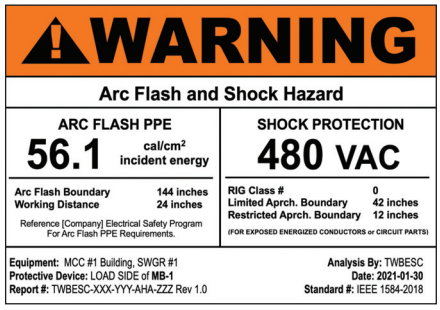


Figure 2. Compliant Arc Flash and Shock Equipment Label

The label shall be of sufficient durability to withstand the environment involved.

Additionally at supervised industrial installations where conditions of maintenance and engineering supervision ensure that only qualified persons monitor and service electrical equipment the information required in items (a) to (d) listed above can be provided in an alternate manner that is readily available to the qualified person. This could be with a provided arc flash hazard incident energy analysis results table or with a software application and with a minimum installed arc flash and shock equipment label signal pane illustrated in Figure 3.

As included in CSA Z462 Annex Q, Figure Q.3 an example of a compliant arc flash and shock equipment label was provided (Figure 4).

Unfortunately over the last fifteen years installed arc flash and electric equipment labels have deviated from the core requirements with the format of the equipment label and inclusion of

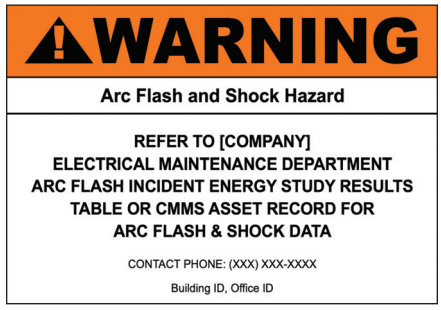


Figure 3. Arc Flash and Shock Equipment Advising To Reference Table

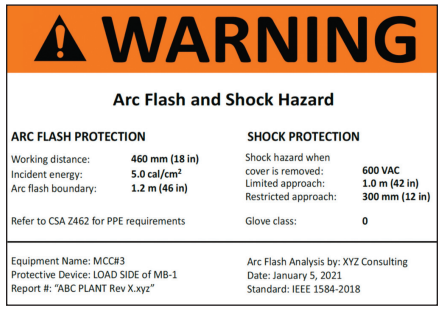


Figure 4. CSA Z462 Annex Q Figure Q.3

information that made the equipment labels non-compliant. This problem has been exasperated by the power system software vendors including non-compliant label templates in their libraries that P.Eng. Electrical Engineers select and use. This problem also led to the 40 cal/cm^2 incident energy myth related to arc blast pressure where the software generated equipment labels indicating "Dangerous" and "No PPE Exists" which were both false statements.

While in the field completing Electrical Safety Program Roll Out Orientation Training or External Electrical Safety Audits inspections of electrical equipment have resulted in identifying at least 50% of the equipment labels formatting been non-compliant. Examples of non-compliant labels are illustrated below in Figures 5 to 7.

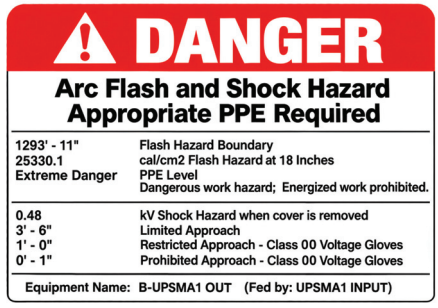


Figure 5. Non-Compliant Arc Flash and Shock Equipment Label



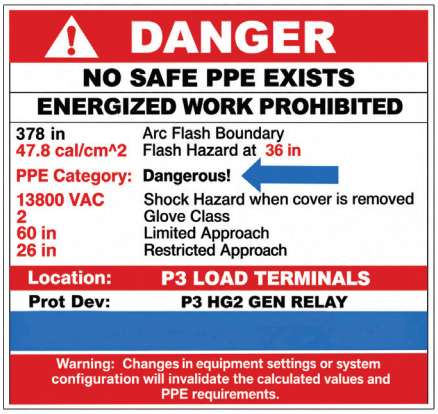


Figure 6. Non-Compliant Arc Flash and Shock Equipment Label

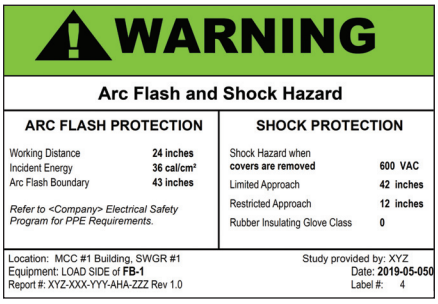


Figure 7. Non-Compliant Arc Flash and Shock Equipment Label

Additionally some companies have overreacted installing generic "Danger" equipment labels or detailed arc flash and shock equipment labels on ever door of electrical equipment such as Motor Control Centres as illustrated in Figure 8.



Figure 8. Arc Flash and Shock Equipment Label Sticker Shock

One of the most significant issues with the equipment labels installed is in the footer the electrical protective device ID and indication of where the calculated incident energy applies as "load side," "line side," or "bus" has not been included.

When the electrical protective ID is included it may not include an indication of "arc flash relay ON" or "maintenance mode switch ON" as illustrated in Figure 9 and 10 below.

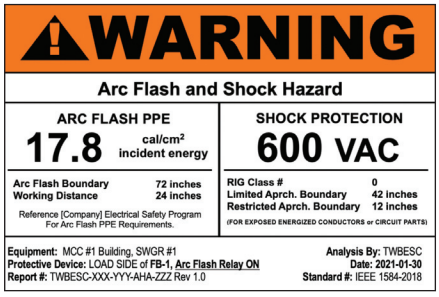


Figure 9. Detailed Arc Flash and Shock Equpment Label Arc Flash Relay ON

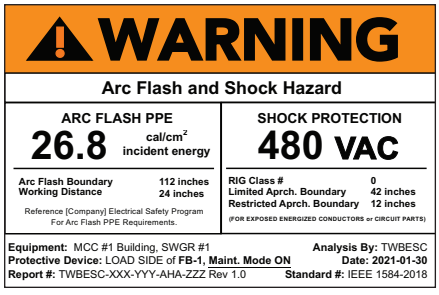


Figure 10. Detailed Arc Flash & Shock Equpment Label Maintenance Mode Switch ON

In the 2024 Edition of CSA Z462 Annex W Working with capacitors was added. This Annex included unique formulas for calculating incident energy and the arc flash boundary for capacitors when disconnected and still charged. A unique detailed arc flash and shock equipment label is required; there are two unique boundaries that only apply to capacitors. Annex W actually requires two unique equipment labels to be installed as shown in Figure 11 and 12.



Figure 11. Capacitors Arc Flash and Shock Equipment Label

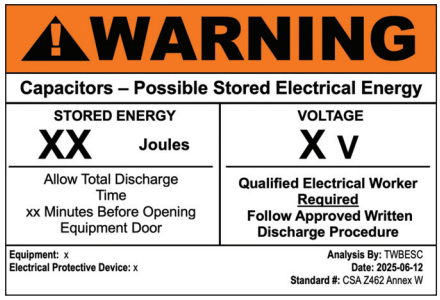


Figure 12. Generic Warning Capacitor Equipment Label Annex W, W.15

The following detailed arc flash and shock equipment label specification infographic illustrates an ANSI Z535.4 and CSA Z462 compliant arc flash and shock equipment label with detailed explanation of the signal panes.

Over the past fifteen years when arc flash hazard incident energy analysis has been completed there have unfortunately been information included in reports issued that was incorrect. Equipment labels provided to industry have not been complete to applicable Standards and have included information that was not correct or have not included important information for the Qualified Person such as the electrical protective device ID and location of the calculated incident energy.

The problems identified in this article

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DETAILED ARC FLASH & ELECTRIC SHOCK EQUIPMENT LABEL SPECIFICATION

REFERENCE CSA Z462 CLAUSE 4.3.5.7 & ANNEX Q EQUIPMENT LABELLING

SIGNAL PANE

Includes the Safety Alert Symbol: ⚠
Indicates a potential personal injury hazard.

Includes the Signal Word:
Calls attention to the safety message.
(ie. DANGER, WARNING, CAUTION, NOTICE)

INFORMATION PANE

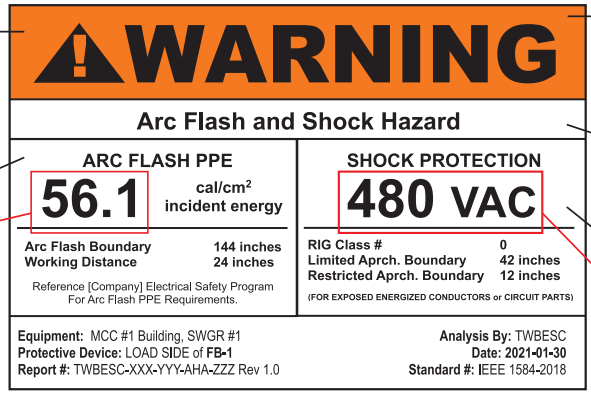
Arc-rated Arc Flash PPE Selection:
Select arc flash PPE with an Arc Thermal Performance Value (ATPV) equal to or greater than the incident energy listed.

Arc Flash Boundary:
Calculated distance where incident energy is 1.2 cal/cm².

No arc flash PPE required when standing outside the arc flash boundary.

Working Distance:
The distance to the face and torso of the Qualified Electrical Work or Task Qualified Worker who is exposed to the arc flash hazard.

Additional Note: Please reference your employer's Electrical Safety Program for specific requirements related to Arc Flash & Shock PPE.



FOOTER

Equipment: The electrical equipment that the arc flash hazard incident energy analysis has been completed for.

Protective Device: The upstream electrical protective device that the incident energy calculated is based on. Indication if any incident energy reduction method is installed and needs to be verified functional.

Report #: Consulting engineer's P.Eng authenticated report that has been issued.

Analysis By: Engineering consultant's name.

Date: Issued date of equipment labels (validate study is current every 5 years).

Standard: Applicable standard/calculation methodology.

WARNING SIGNAL - incident energy is ≤140.0 cal/cm²
DANGER SIGNAL - incident energy is ≥140.1 cal/cm²
ANSI Z535 DISTINCT COLOURS

Warning Danger

MESSAGE PANE

The equipment label applies to arc flash and electric shock hazards when a worker is exposed related to the energized electrical work task they would perform.

INFORMATION PANE

Electric Shock Protection:
Maximum nominal voltage of exposed conductors and circuit parts with inadvertent movement risk.

Rubber Insulating Glove (RIG) Class #:
See table at right for complete list of Class #s and voltage ratings.

Limited Approach Boundary:
No shock PPE tools or equipment required when inside the Limited Approach Boundary. Unqualified persons must be fully escorted.

Restricted Approach Boundary:
Qualified persons only. Qualified persons shall use rubber insulating gloves with protector gloves and other insulating tools when inside the Restricted Approach Boundary.

need to be addressed by Professional Engineers completing the studies, issuing reports and providing the equipment labels to their client.

I will continue my efforts to communicate information in Electrical Safety Measures and share the knowledge and experience I have in an effort to "Get it Right!!" My electrical safety journey and mission will continue!! Knowledge is power! TAKE CONTROL of ARC FLASH! PLACE MORE FOCUS on ELECTRIC SHOCK!

If you are interested in discussing the information presented, contact me at terry.becker@twbesc.ca or 587.433.3777.



Terry Becker, P.Eng., CESCP, IEEE Senior Member is a founding member and the First Past Vice-Chair of the CSA Z462 Workplace electrical safety Standard Technical Committee and currently a Voting Member and Clause 4.1 and Annexes Working Group Leader. Terry is also a Founding Member and a Voting Member on the CSA Z463 Maintenance of electrical systems Standard and a Voting Member of the IEEE 1584 Guide for Performing for Arc-Flash Hazard Calculations. Terry is also a voting member of the CAN/ULC S801 Workplace Electrical Safety Standard for Utility Generation, Transmission and Distribution. Terry has presented at over 95 Conferences and Workshops on electrical safety in Canada, USA, India, Australia and New Zealand. Terry is a Professional Engineer in the Provinces of BC, AB and ON. Terry is an Electrical Safety Specialist, Management Consultant, and can be reached at 587.433.3777 or by email **terry.becker@twbesc.ca**.

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