ELECTRICAL Safety Measures

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

Refresher: Abnormal Arcing Fault & Arc Flash – **ASK WHY!**

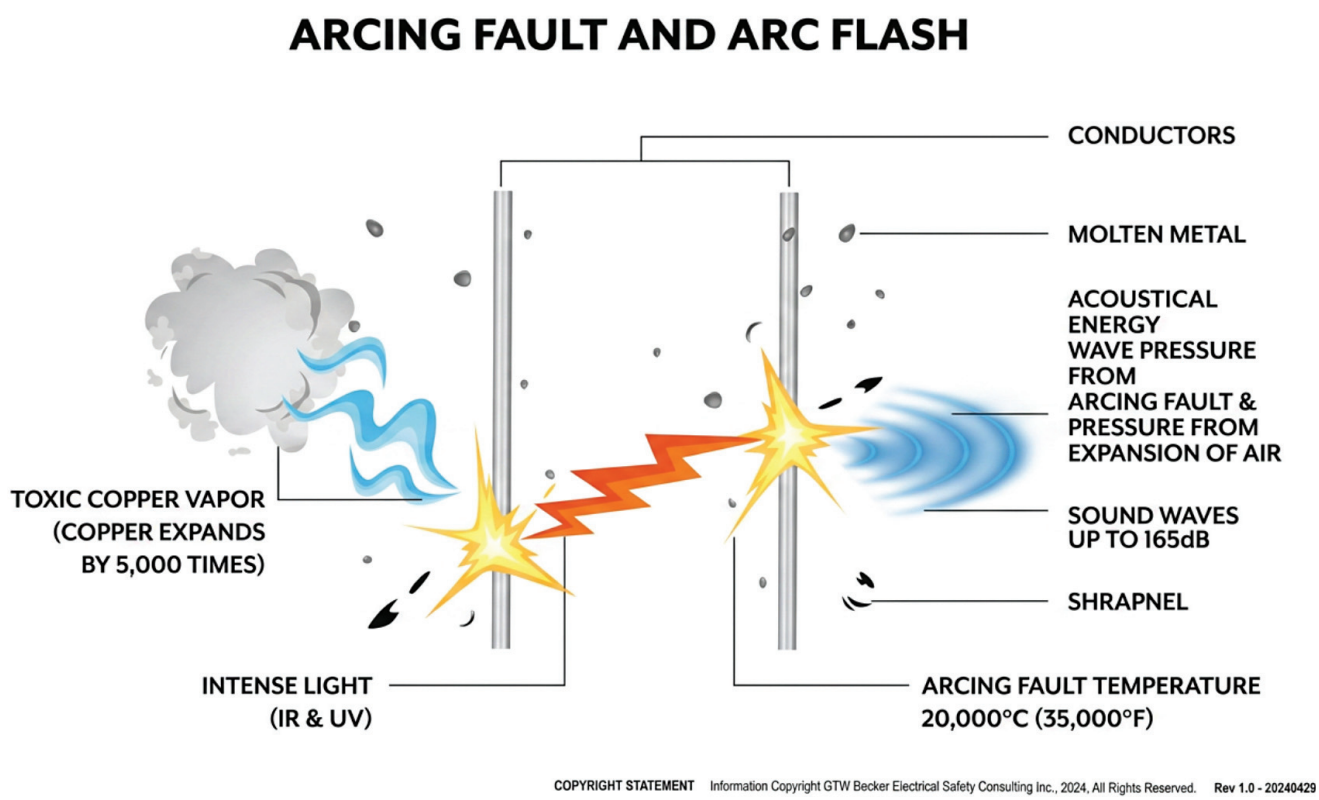
By Terry Becker, P.Eng., CESCP, IEEE Senior Member

I thought a refresher article on the status of electrical hazard classification and specifically abnormal arcing fault/arc flash was required. Recently on social media, there are posts that have been generated on arc flash by AI: text content for posts and infographics. Unfortunately, they only focus on "arc flash" and the information in the cloud is flawed, inaccurate, disinformation, misinformation, assumptions or completely wrong so the posts and infographics are wrong.

It is important that anyone responsible for electrical safety within your company obtains substantiation for information provided regarding abnormal arcing faults/arc flash. If you have been presented with information about abnormal arcing faults/arc flash during training or in an engineer's report related to an arc flash hazard incident energy analysis, **ASK WHY?**

Do not accept the statement that if the incident energy is greater than 40.0 cal/cm^2 that it is "Dangerous" and "No PPE Exists!" Both statements are FALSE! **ASK WHY?** Unfortunately, globally this specific topic is out of control and formal risk assessments, if completed, have been ultra conservative and biased by misinformation with no substantiation.

Other myths and misinformation have also continued to propagate, such as implying that opening and closing a circuit



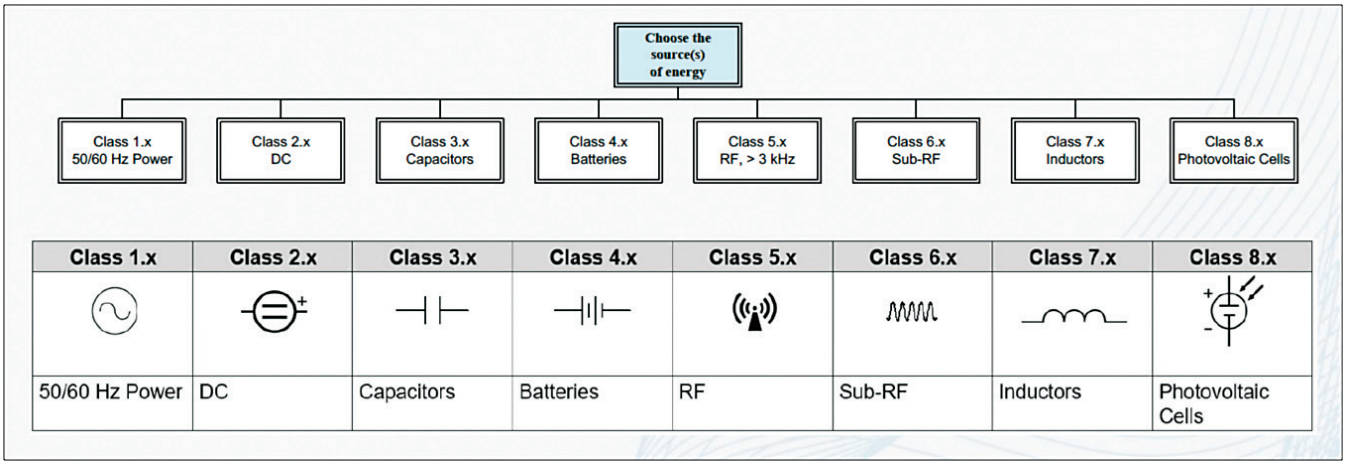
breaker or disconnect switch is 100% likely, or has a very high likelihood, to fail catastrophically in a manner that could create an abnormal arcing fault/arc flash when opened or closed energized. But no substantiation is provided, no explanation is given, and no comments are provided by electrical equipment manufacturers. **ASK WHY?** Use the qualitative risk assessment procedure in a robust and compliant Electrical Safety Program to determine the likelihood of any electrical equipment asset failing, with formal analysis and review.

The next edition of the CSA Z462 Workplace electrical safety Standard will most likely be published in March 2027 and, in this 7th Edition, Clause 6 will be restructured and will finally include some good, updated content, as well as some new content related to electrical hazard classification (see Figure 1 below and previous ESM articles). In turn, that information can be used for improved work-task-based electrical hazard identification of ac, dc and capacitor-related electrical equipment that energized electrical work tasks will be performed on. Remember, testing for absence of voltage is energized electrical work.

CSA Z462 Annex K, *General Categories of Electrical Hazards*, will also be updated in the 2027 Edition to further clarify what electrical hazards are and will include new content specifically addressing electrical incident statistics in Canada.

The NFPA 70E 2027 Edition (14th Edition) always publishes early in the year before the published year on the cover, and for this cycle published really early, May 6, 2026. Chapter 3 Safety Requirements for Special Equipment has been updated with new content and reorganized. This content will be adopted into the

Figure 1 – Electrical Hazard Classification



2027 Edition of CSA Z462 in Clause 6.

NFPA 70E, 2027 Edition, Chapter 3 Articles:

- Article 300 Introduction
- Article 310 Direct Current (dc) Electrical Hazards **[UPDATED]**
- Article 320 Capacitor Electrical Hazards **[UPDATED]**
- Article 330 Electrical Hazards 1 Hz to 110MHz Excluding dc and 50/60Hz
- Article 340 Electrical Hazard for Mixed Frequencies (Reserved)
- Article 350 Safety-Related Work Practices for Electrolytic Cells
- Article 360 Safety-Related Requirements for Batteries **[UPDATED]**
- Article 370 Safety-Related Work Practices for Electrical Double Layer Capacitors (EDLCs) **[NEW]**
- Article 380 Safety-Related Work Practices for Photovoltaic Systems **[NEW]**
- Article 390 Safety-Related Work Requirements for Research and Development (R&D) Laboratories

There has been new or updated formulas created for calculating incident energy and the arc flash boundary for direct current, alternating current and capacitors in the last three years. Reference Table 1, Table 2 and Table 3. Additional research has been completed related to 120VAC and 240VAC single phase power to determine if the voltages can sustain an abnormal arcing fault and create an arc flash hazard. The employer needs to manage what formulas are used and the hired electrical engineering consultant should be **ASKED WHY** specific formulas are being used and why specific parameters have been selected.

Table 1 – Alternating Current Incident Energy & Arc Flash Boundary

Item	Description	Comments
1	Lee Method, Ralph Lee, (1982)	Calculates the arc flash boundary for arc in open air. Conservative over 600V ac and becomes more conservative as voltage increases.
2	Doughty et al. (1998)	Calculates the incident energy for a three-phase arc on systems rated 600 V ac and below. Applies to short-circuit currents between 16 and 50 kA.
3	IEEE 1584 (2018) IEEE 1584.1 (2022) IEEE 1584.2 (Pending)	Calculates the incident energy and arc flash boundary for power distribution systems with the following parameters: a) 208VAC to 15 kV ac; b) Three phase; c) 50 or 60 Hz; d) Available fault current (rms symmetrical): i) 500 A to 106 kA (208V ac to 600V ac) and ii) 200A to 65kA (601VAC to 15 kV ac); and e) Conductor gaps: i) 6.35 mm to 76.2 mm (208V ac to 600 V ac); and ii) 19.05 mm to 254 mm (601VAC to 15 kV ac). **Doesn't apply to single phase 240VAC.**
4	Kinectrics Kinectrics is independent research lab. Canada. Kinectrics has commercially available software model that's backbone is based on arc physics modeling and thermal dynamic equations.	AC: High voltage >10kV ac, single phase and three phase. DC: DC in-box arc flash calculations. IEEE 1584-2018 formulas available.
5	EPRI Report 1022632 (2011) Arc Flash Issues in Transmission and Substation Environments Results from Tests with Long Arcs https://www.epri.com/research/products/1022632 Electric Power Research Institute, USA.	Applies to electric transmission and distribution facilities ≥1000V ac with large gap of at least 1ft. Open air, line to ground. Can be expanded to analyze enclosed configurations along with 3 phase and line to line faults.
6	Doughty/Neal Based on NFPA 70E 2024 Annex D.3.	Reference NFPA 70E, Annex D.3.

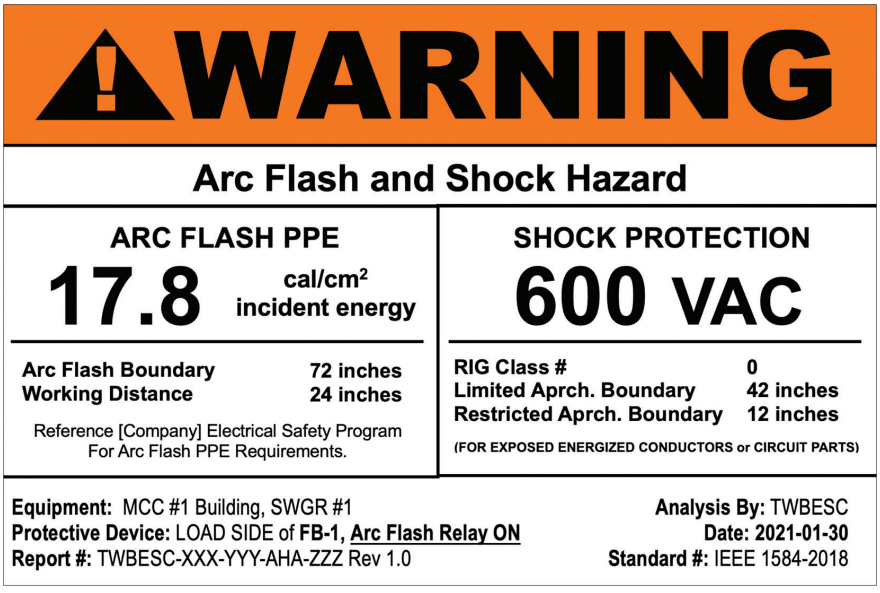
Table 2 – Direct Current Incident Energy & Arc Flash Boundary

Item	Description	Comments
1	Max. Power Method, D. Doan (2010)	Calculates incident energy for dc systems rated up to 1000 V dc. Do not use for >1000V dc. For arc in a box or enclosure use a 3X multiplier to calculate resulting incident energy value.
2	A.D. Stokes and W.T. Oppenlander	Can be used for ≤1000V dc and >1000V dc.
3	J. Paukert Method	Can be used for >1000V dc. ≤200mm electrodes gap. 100A to 100KA.
4	D. Rosewater, L. Gordon and B. Cantor (2025) IEEE Electrical Safety Workshop, 2025, Paper ESW2025-18.	Self-Extinguishing Method Model. Open-source MS Excel download: https://github.com/DavidRosewater/battery_arc_flash

Table 3 – Capacitors Incident Energy & Arc Flash Boundary

Item	Description	Comments
1	CSA Z462, Clause 6.7 CSA Z462, Annex W	Incident energy and arc flash boundary formulas, unique to capacitors. Calculate distances for two unique boundaries: Lung Protection Boundary. Hearing Protection Boundary.

Figure 2 – Compliant Arc Flash & Shock Equipment Label Example



An additional and ongoing challenge continues related to the arc flash and shock equipment labels provided by an electrical engineering consultant. I continue to find equipment labels that are not compliant to ANSI Z535 and as provided in CSA Z462 Annex Q, Figure Q.3. See Figure 2 for an example of a compliant arc flash and shock equipment label. In many cases the footer of the equipment doesn't include the electrical protective device ID and indication of load side, line side, bus, maintenance mode ON or arc flash relay ON. It is important that the Qualified Person reviewing and applying the information from the equipment label understands where on the electrical equipment the incident energy has been calculated.

One last item that was deleted from the CSA Z462, 2024 Edition is the term "arc flash PPE category." This was done in order to eliminate the confusion that arc-rated arc flash PPE is rated with a "category" when this is incorrect. Arc-rated arc flash PPE is rated with an Arc Thermal Performance Value (ATPV) based on flame resistant (FR) fabric been tested to the ASTM F1959 to provide the FR fabric with an arc-rating with an ATPV or Ebt. The CSA Z462 Workplace electrical safety Standard, 2024 Edition also further clarified and recommended an employer specify and provide only two arc-rated arc flash PPE levels as identified in Table 2 Selection of arc-rated clothing and other PPE when the incident energy analysis method or an arc flash PPE selection table method is used.

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!

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**.