



ELECTRICAL HAZARD CLASSIFICATION

RELEASE DATE: February 2, 2024



TW BECKER
ELECTRICAL SAFETY CONSULTING

ELECTRICAL SAFETY BULLETIN

Electrical hazard classification is an important requirement of an employer's Electrical Safety Program. The employer defines worker roles that are authorized to complete energized electrical work tasks and shall complete electric shock and arc flash hazard identification. Ensuring the employer has a clear understanding of the latest electrical hazard classification information is extremely important.

The USA DOE has developed and implemented an Electrical Safety Program. In reviewing the electrical hazards related to their business/projects and work tasks performed they created a comprehensive electrical hazard classification system and then applied this against work tasks and developed and implemented a comprehensive qualitative risk assessment process that included a related risk matrix.

In Table 1 below TW Becker Electrical Safety Consulting Inc. has provided a simple summary of the electrical hazard classifications the USA DOE initially created and evolved over the years. Some of the information is also extracted/validated from other information sources as noted in the references below the table.

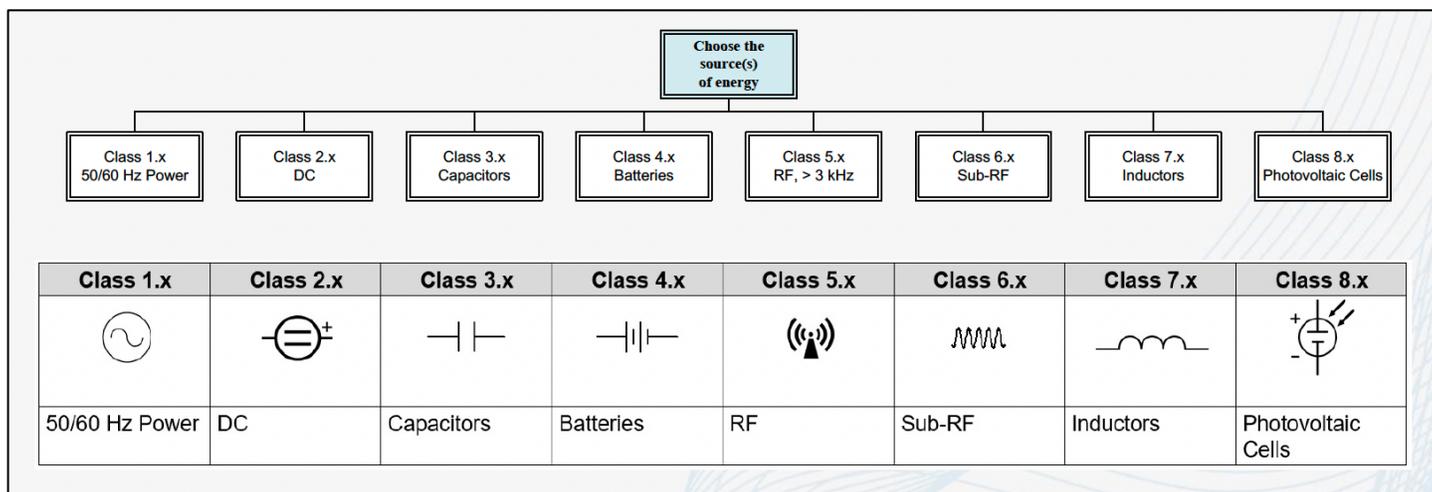


Table 1 – Electrical Hazard Classification Summary Table

Electrical Hazard Classification Voltage or Electrical Equipment	Potential Severity of Injury or Damage to Health
<p><u>50/60hz AC Electrical Equipment, Single Phase.</u> Abnormal arcing fault, no arc flash. Electric shock hazard.</p> <ul style="list-style-type: none"> • ≤30VAC, CSA Z462. No shock. • <50VAC, NFPA 70E. No shock. • 120VAC single phase. • 240VAC single phase. • 277VAC single phase. • 347VAC single phase. 	<p><u>Abnormal Arcing Fault:</u> Resulting in potential thermal exposure burn injury to the Qualified Person’s hands, noise, ejected molten metal, and bright light.</p> <p><u>Electric Shock Effects:</u></p> <ul style="list-style-type: none"> • ≥30VAC, CSA Z462. • ≥50VAC, NFPA 70E. • Current flow into body, survivable injury. • Electrocutation. • Electric shock sequela (long term effects of injuries from electrical current).
<p><u>50/60hz AC Electrical Equipment, Three Phase.</u> Abnormal arcing fault resulting in an arc flash. Electric shock hazard.</p> <ul style="list-style-type: none"> • ≥208VAC three phase, 2000A available fault current. • 480VAC/600VAC three phase. • >1000VAC. 	<p><u>Abnormal Arcing Fault and Arc Flash Multiple Potential Effects:</u></p> <ul style="list-style-type: none"> • Thermal burn injury. • Expansion of air resulting in arc blast pressure. • Molten metal/shrapnel. • UV/IR light. • Toxic smoke/vapour. • Noise

	<p>Electric Shock Effects:</p> <ul style="list-style-type: none"> • Current flow into body, survivable injury. • Electrocutation. • Electric Shock Sequela.
<p>Batteries</p> <ul style="list-style-type: none"> • ≤60VDC, CSA Z462. No electric shock. • <50VDC, NFPA 70E. No electric shock. • ≥125VDC power (e.g. UPS battery rack or other DC power source). NFPA 70E Table 130.7(C)(15)(b) and CSA Z462 Table V.3 updated 100VDC to 150VDC (based on industry research, not IEEE 1584). For 125VDC, unlikely probability of sustaining if <17kA available fault current. 	<p>Abnormal arcing fault and arc flash multiple potential effects:</p> <ul style="list-style-type: none"> • Thermal burn injury. • Expansion of air resulting in arc blast pressure. • Molten metal/shrapnel. • UV/IR light. • Toxic smoke/vapour. • Noise. <p>Electric Shock Effects:</p> <ul style="list-style-type: none"> • Current flow into body, survivable injury. • Electrocutation. • Electric shock sequela.
<p>Capacitors</p> <p>Stored Energy Hazard Thresholds (NFPA 70E, Article 360.3 and Annex R or CSA Z462 Clause 6.7 and Annex W):</p> <ul style="list-style-type: none"> • <100V and >100J stored energy. • ≥100V and >1.0 J of stored energy. • ≥400V and >0.25 J of stored energy. 	<p>Abnormal Arcing Fault:</p> <ul style="list-style-type: none"> • >120kJ, >1.2 cal/cm². • Thermal hazard if >100J of stored energy. • Acoustical shock wave, hearing protection >100J of stored energy. • Hearing protection boundary. <p>Electric Shock Effects:</p> <ul style="list-style-type: none"> • Function of energy, risetime, pulse length and body impedance. • Impulse electric shock. • ≥100V threshold. • <u>Energy delivered, 1 to 10ms:</u> • Slight sensation, 0.05 to 1mJ. • Disagreeable, 5 to 100mJ. • Painful, 0.1 to 0.5J. • Injury likely, 1 to 50J. • Fibrillation likely, 50 to 1000J. <p>Other:</p> <ul style="list-style-type: none"> • Lung protection boundary, >122kJ. • Fire hazard, dielectric fluids. Toxic vapours.
<p>RF (Radiofrequency)</p> <ul style="list-style-type: none"> • >3kHz to 100MHz. 	<p>Electric Shock/Burn Threshold:</p> <ul style="list-style-type: none"> • 0.003 to 0.1 MHz: • ≤1000f mA. No injury, no controls • >1000f mA. Injury or fatality. • 0.1 to 100 MHz:

	<ul style="list-style-type: none"> • $\leq 100\text{mA}$. No injury, no controls. • $> 100\text{mA}$. Injury or fatality.
<p>Sub-RF (Sub-Radiofrequency)</p> <ul style="list-style-type: none"> • 1Hz to 3kHz. 	<p>Thermal Threshold:</p> <ul style="list-style-type: none"> • <u>$\leq 50\text{V}$:</u> • $\leq 1000\text{ W}$. No injury, no controls. • $\geq 1000\text{ W}$. Injury or fatality. • <u>50-250V:</u> • $\leq 5\text{ mA}$. No injury, no controls. • $> 5\text{ mA}$. Injury or fatality. • <u>$> 250\text{V}$:</u> • <u>Electric Shock threshold:</u> • $\leq 5\text{ mA}$. No injury, no controls. • 5-75 mA. Injury or fatality. • <u>Arc Flash Threshold:</u> • 75 mA to 500A. Injury or fatality. • $> 500\text{A}$. Very serious, avoid work.

Note: This is a summary table only and may not be a complete reference. See references below.

References:

1. CSA Z462 Workplace electrical safety Standard, 2024 Edition. CSA Group, Mississauga, ON.
2. NFPA 70E Standard for Electrical Safety in the Workplace, 2024 Edition. NFPA, Quincy, MA.
3. IEEE 1584 Guide for Performing Arc-Flash Hazard Calculations, 2018 Edition. IEEE, New York, NY.
4. IEEE 3007 Series: Operation and Management, Maintenance, and Safety of Industrial and Commercial Power Systems (IEEE Yellow Book).
5. L. B. Gordon, L. Cartelli, "A Complete Electrical Hazard Classification System and Its Application", IEEE Electrical Safety Workshop, 2009.
6. A.M. Smoak, A.J. Keeth, "An Investigation of Low Voltage Arc Flash Exposure," IEEE Electrical Safety Workshop, 2013, ESW2013-30.
7. L. B. Gordon, N. Graham, "A Complete Electrical Arc Hazard Classification System and Its Application," IEEE Electrical Safety Workshop, 2015, ESW2015-21.
8. L. B. Gordon, K. Carr, N. Graham, "A Complete Electrical Arc Hazard Classification System and Its Application," IEEE Transactions on Industry Applications", Vol. 53, pp. 5078-5087, Sept./Oct. 2017.
9. L.B. Gordon, T. Martinez, "Complete Electrical Risk Assessment Method," IEEE Electrical Safety Workshop, 2018, ESW2018-09.
10. L. B. Gordon, L. Cartelli, N. Graham, "A Complete Electrical Shock Hazard Classification System and Its Application," IEEE Transactions on Industry Applications, Vol. 54, pp 6554-6565, Nov/December 2018.
11. J. Martin, A. Machado, G. Christiansen, J. Whipple, L.B. Gordon, "Low Voltage 208Y/120V && 240VAC Arc Sustainability," USA DOE EFCOG Best Practice - #232-2019.
12. L.B. Gordon, J. Liechty, T. Martinez, E. Stromberg, J. Williams, "Electrical Injuries and Fatalities: Facts, Myths and Unknowns," IEEE Electrical Safety Workshop, 2019, ESW2019-32.
13. J.F. Wade, "Arc Flash in Single-Phase Electrical Systems," University of Tennessee, TN, PhD. Doctoral Dissertations, 12-2020.
14. J.F. Wade, "Investigation of Arc Flash in Single-Phase Vertical Conductors in a Box," IEEE Industry Applications, Volume 2, 2021, April 15, 2021.
15. L.B. Gordon, T. Martinex, K. Carr, "Risk Assessment for Electrical Work for All Electrical Hazards," IEEE Electrical Safety Workshop, 2022. March 11, 2022, Tutorial 6.

RELEVANT RESOURCES

FREE DOWNLOADS

<https://twbesc.ca/esp-free-tools>

CONTACT



**Terry W. Becker, P.Eng.,
CESCP, IEEE Senior Member**

terry.becker@twbesc.ca

1-587-433-3777

CONNECT ON LINKEDIN

linkedin.com/in/twbecker

www.twbesc.ca