DOCUMENT REVISION

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Summary Statement:

With respect to an abnormal arcing fault and arc flash there are risk control methods that proactively reduce incident energy. Technical feasibility and costs need to be considered.

Arc Flash Incident Energy Reduction

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

Over the last 17 years that I have focussed my career on electrical safety, industry in Canada has become aware of and has been incented to hire electrical engineering consultants to complete arc flash hazard incident energy analysis studies for low and high voltage electrical equipment. I have identified and written many articles on the need for a defined scope of work and technical specification to be used and have provided a FREE very detailed and comprehensive document that can be adopted and used by industry. Within this scope of work it defines a target incident energy level of 75.0 cal/cm^2 to be considered and would require that the P.Eng. Electrical Engineer provides proposals to achieve this outcome with incident energy reduction methods where the initial calculations result in an incident energy level higher than this value. This is Part 1 or a two-part article.

CSA Z462, Clause 4.1.5 Electrical safety policy advises that eliminating exposure to electric shock and arc flash is required by policy and that if an electrically safe work condition cannot be achieved appropriate risk control methods shall be implemented. CSA Z462, Clause 4.1.7.8 Risk assessment procedure identifies six hierarchy of risk control methods the employer can implement and in the order indicated.

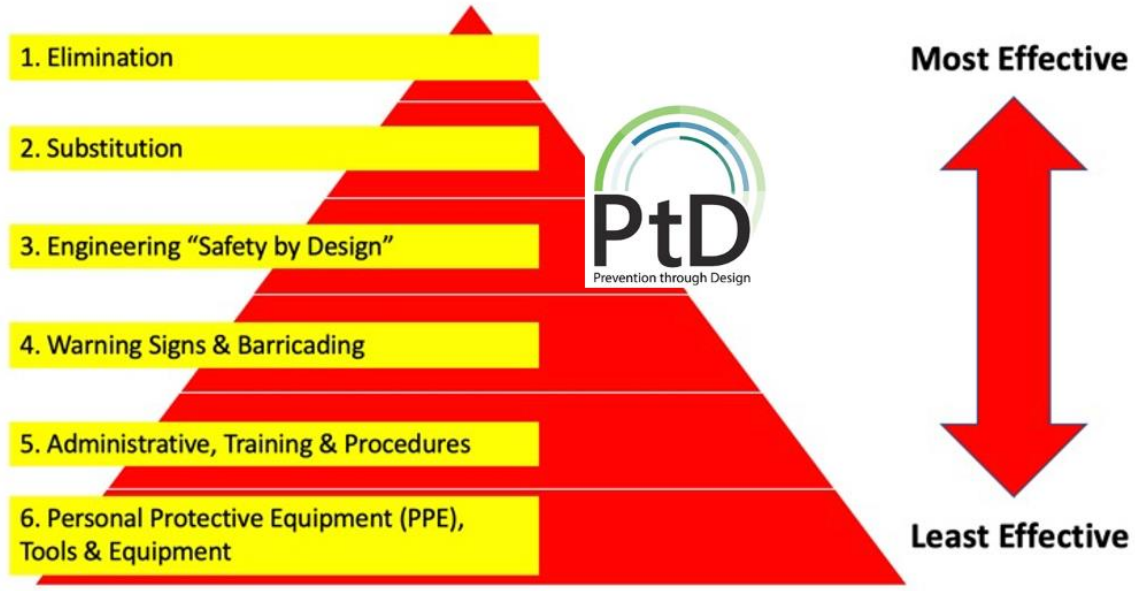

Figure 1 – Hierarchy of Risk Control Methods

As illustrated substitution and "engineering safety by design," "Prevention by Design (PtD)" are a higher priority than arc flash and electric shock personal protective equipment, tools and equipment. There are multiple options for reducing incident energy that can be considered. A reasonable and practical approach, technical feasibility and costs need to be considered. There needs to be a balance between potential options for incident energy reduction and arc flash PPE. Some electric shock PPE can actually increase the arc flash related working distance and reduce incident energy by 50% or more for under $100.

The following are a generic list of options for reducing incident energy (reference Part 2 of this article for additional methids).

Method 1 Increasing the Working Distance With Fluke Probe Extenders for Low Voltage Work Tasks

Electric shock PPE can actually reduce the potential severity of injury or damage to health from arc flash. For less than $100 Fluke Probe Extenders increase the working distance related to arc flash from 18" to 30" and can reduce the calculated incident by over 50%. The Qualified Person's hands do not go into the electrical equipment and they can see the electrical equipment more clearly that they are working on, reducing likelihood of occurrence. See the picture and table below.

Bus	Nominal kV	Scenario	Electrode Configuration	Box Height (in)	Box Width (in)	Box Depth (in)	Working Distance (in)	Final FCT (s)	Ia at FCT (kA)	Total Ibf at FCT (kA)	AFB (ft-in)	Total Energy (cal/cm2)
MCC-A (18in WD)	0.48	UTIL_MTRS_ON	VCBB	14	12	8	18	0.5	18.5	22.2	8'2"	25.8
MCC A MAIN BRKR LINE (18in WD)	0.48	UTIL_MTRS_ON	VCBB	14	12	8	18	2	18.5	22.2	18'5"	112.2
MCC-A (30in WD)	0.48	UTIL_MTRS_ON	VCBB	14	12	8	30	0.5	18.5	22.2	8'2"	10.2
MCC A MAIN BRKR LINE (30in WD)	0.48	UTIL_MTRS_ON	VCBB	14	12	8	30	2	18.5	22.2	18'5"	44.5
MCC-A (32in WD)	0.48	UTIL_MTRS_ON	VCBB	14	12	8	32	0.5	18.5	22.2	8'2"	9.1
MCC A MAIN BRKR LINE (32in WD)	0.48	UTIL_MTRS_ON	VCBB	14	12	8	32	2	18.5	22.2	18'5"	39.6
MCC-A (40in WD)	0.48	UTIL_MTRS_ON	VCBB	14	12	8	40	0.5	18.5	22.2	8'2"	6.1
MCC A MAIN BRKR LINE (40in WD)	0.48	UTIL_MTRS_ON	VCBB	14	12	8	40	2	18.5	22.2	18'5"	26.4

Method 2 Increasing the Working Distance With Cementex Insulated Hand Tool Probe for Low Voltage Electrical Equipment Resets

If Qualified Persons have to hit “reset” push buttons inside low voltage electrical equipment an insulated hand tool probe not only reduces exposure to electric shock but also increases the working distance from 18” to 32” and can reduce the calculated incident energy by over 50%. See the picture and table below.

Bus	Nominal kV	Scenario	Electrode Configuration	Box Height (in)	Box Width (in)	Box Depth (in)	Working Distance (in)	Final FCT (s)	Ia at FCT (kA)	Total Ibf at FCT (kA)	AFB (ft-in)	Total Energy (cal/cm2)
MCC-A (18in WD)	0.48	UTIL_MTRS_ON	VCBB	14	12	8	18	0.5	18.5	22.2	8'2"	25.8
MCC A MAIN BRKR LINE (18in WD)	0.48	UTIL_MTRS_ON	VCBB	14	12	8	18	2	18.5	22.2	18'5"	112.2
MCC-A (30in WD)	0.48	UTIL_MTRS_ON	VCBB	14	12	8	30	0.5	18.5	22.2	8'2"	10.2
MCC A MAIN BRKR LINE (30in WD)	0.48	UTIL_MTRS_ON	VCBB	14	12	8	30	2	18.5	22.2	18'5"	44.5
MCC-A (32in WD)	0.48	UTIL_MTRS_ON	VCBB	14	12	8	32	0.5	18.5	22.2	8'2"	9.1
MCC A MAIN BRKR LINE (32in WD)	0.48	UTIL_MTRS_ON	VCBB	14	12	8	32	2	18.5	22.2	18'5"	39.6
MCC-A (40in WD)	0.48	UTIL_MTRS_ON	VCBB	14	12	8	40	0.5	18.5	22.2	8'2"	6.1
MCC A MAIN BRKR LINE (40in WD)	0.48	UTIL_MTRS_ON	VCBB	14	12	8	40	2	18.5	22.2	18'5"	26.4

Method 3 Increasing the Working Distance for High Voltage Electrical Equipment

Similar to Method 1 and 2 if the Qualified Person can complete high voltage work tasks by increasing their working distance with hot sticks or power circuit breaker racking tools that are extended in length the incident energy will be reduced. There is a telescopic hot stick “Extend-a-Rack” https://www.amidyne.com/xtend-a-rack product available that could move the Qualified Electrical Worker outside of the arc flash boundary.

Bus Name	Protective Device Name	Bus kV	Bus Bolted Fault (kA)	Bus Arcing Fault (kA)	Prot Dev Bolted Fault (kA)	Prot Dev Arcing Fault (kA)	Trip/ Delay Time (sec.)	Breaker Opening Time/Tol (sec.)	Equip Type	Electrode Config	Box Width (in)	Box Height (in)	Box Depth (in)	Gap (mm)	Arc Flash Boundary	Working Distance	Incident Energy (cal/cm2)
SWGR-8000	FPR-8000 (Phase)	15.00	15.64	14.74	15.39	14.50	0.2071	0.0833	SWG	VCBB	30	45	30	152	9' 11"	18"	28.1
	FPR-8000 (Phase)	15.00	15.64	14.74	15.39	14.50	0.2071	0.0833	SWG	VCBB	30	45	30	152	9' 10"	30"	12.0
	FPR-8000 (Phase)	15.00	15.64	14.74	15.39	14.50	0.2071	0.0833	SWG	VCBB	30	45	30	152	9' 10"	32"	10.7
	FPR-8000 (Phase)	15.00	15.64	14.74	15.39	14.50	0.2071	0.0833	SWG	VCBB	30	45	30	152	9' 10"	36"	8.8
	FPR-8000 (Phase)	15.00	15.64	14.74	15.39	14.50	0.2071	0.0833	SWG	VCBB	30	45	30	152	9' 10"	40"	7.4

Method 4 Increasing the Working Distance for Low Volage Electrical Equipment

As illustrated above if any other method can be deployed to increase working distance for low voltage electrical equipment the table below illustrates the potential reductions in incident energy as the working distance increases

Bus Name	Protective Device Name	Bus kV	Bus Bolted Fault (kA)	Bus Arcing Fault (kA)	Prot Dev Bolted Fault (kA)	Prot Dev Arcing Fault (kA)	Trip/ Delay Time (sec.)	Breaker Opening Time/Tol (sec.)	Equip Type	Electrode Config	Box Width (in)	Box Height (in)	Box Depth (in)	Gap (mm)	Arc Flash Boundary	Working Distance	Incident Energy (cal/cm2)
MB-8100	FPR-TX1 (Phase)	0.48	49.32	35.21	44.50	31.77	0.2000	0.0833	MCC	VCBB	12	14	10	25	9' 0"	18"	31.1
	FPR-TX1 (Phase)	0.48	49.32	35.21	44.50	31.77	0.2000	0.0833	MCC	VCBB	12	14	10	25	9' 0"	30"	12.3
	FPR-TX1 (Phase)	0.48	49.32	35.21	44.50	31.77	0.2000	0.0833	MCC	VCBB	12	14	10	25	9' 0"	32"	11.0
	FPR-TX1 (Phase)	0.48	49.32	35.21	44.50	31.77	0.2000	0.0833	MCC	VCBB	12	14	10	25	9' 0"	36"	8.9
	FPR-TX1 (Phase)	0.48	49.32	35.21	44.50	31.77	0.2000	0.0833	MCC	VCBB	12	14	10	25	9' 0"	40"	7.3

The Benefit of Incident Energy Reduction

The incident energy reduction techniques highlighted in this article do not eliminate the potential severity of injury or damage to health for a Qualified Person from been exposed to an abnormal arcing fault. The primary benefit would be to reduce the arc-rating of arc flash PPE required from an arc-rated Level 2 arc flash suit to an arc-rated Level 1 everyday task wear arc flash PPE as illustrated below.

Arc-Rating Level #	Arc Flash PPE Minimum Requirements
Level 1 **8.0-12.0 cal/cm²** **ATPV or E_{BT}** 	**Body:** Everyday/task wear long sleeved shirt/pant or coverall (with storage bag). 100% natural fibre clothing to be worn underneath. **Emergency Rescue:** "Escape Strap" vest available for use. **Head & Face:** CSA approved eyewear, clear lens. Arc-rated balaclava and arc-rated face shield (with storage bag) with true colour grey lens, CSA approved Class E hard hat and LED lamp. **Hearing:** CSA approved minimum ear canal insert ear plugs. **Hands:** Appropriate Class # of rubber insulating gloves with protectors (with storage bag sized to the Class #). **Footwear:** CSA approved Ohm rated leather/rubber footwear. Note: Rubber insulating gloves with protectors provide arc flash protection for the hands. Where there is no electric shock hazard exposure heavy duty leather work gloves or specifically tested arc-rated gloves provide arc flash protection for the hands.
Level 2 **Minimum 75, 100 or 140 cal/cm²** **ATPV** 	**Body:** Arc flash suit: bib overalls, and jacket with "Escape Strap." 100% natural fibre clothing to be worn underneath. Manufacturer's storage bag. **Emergency Rescue:** "Escape strap" can be used. **Head & Face:** CSA approved eyewear, clear lens. Arc flash suit hood with true colour grey lens, CSA approved Class E hard hat, arc flash suit hood ventilation system and LED lamp. **Hearing:** CSA approved minimum ear canal insert ear plugs. **Hands:** Appropriate Class # of rubber insulating gloves with protectors (with storage bag sized to Class #). **Footwear:** CSA approved Ohm rated leather/rubber footwear. Note: Rubber insulating gloves with protectors provide arc flash protection for the hands. Where there is no electric shock hazard exposure heavy duty leather work gloves or specifically tested arc-rated gloves provide arc flash protection for the hands. Arc flash suits are available with an ATPV of up to 140.0 cal/cm² and can be procured for use.

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 (when applied and applied correctly)! TAKE CONTROL of ARC FLASH (with a compliant Electrical Safety Program)!!!!!

If you are interested in discussing the information presented in this article or would like a specific topic presented do not hesitate to contact me at terry.becker@twbesc.ca or 587-433-3777.

Terry Becker, P.Eng., CESCP, IEEE Senior Member is 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 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, the USA, Italy, India and Australia. Terry is a Professional Engineer in the Provinces of BC, AB, ON and PEI. Terry is an Electrical Safety Specialist, Management Consultant, and can be reached at 1-587-433-3777 or by email

terry.becker@twbesc.ca.