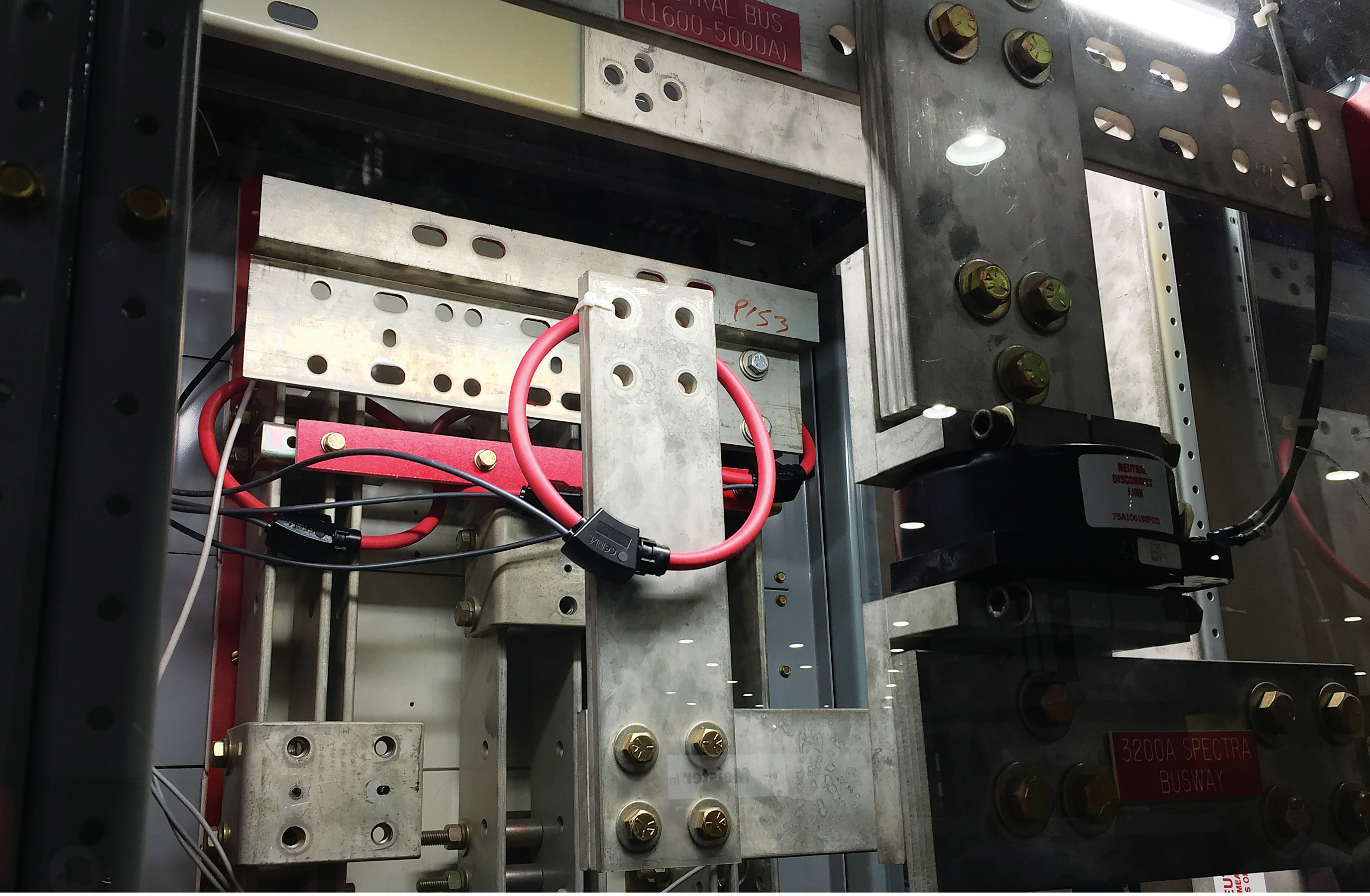

"Elimination is the first priority! Ensure a risk assessment is completed before energized work tasks are completed."

IEEE 1584 2018 Edition: Interpretation & Application Guidance

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

The long-anticipated update to the IEEE 1584 Guide for Performing Arc-Flash Hazard Calculations finally published November 30, 2018. The First Edition was published in 2002 and established formulas for the basis of calculating a predicted incident energy and an arc flash boundary distance related to an abnormal condition occurring on energized electrical equipment creating an arcing fault and arc flash incident. The formulas apply to electrical equipment from 208VAC to 15kV three phase, 50 or 60 HZ. The new 2018 formulas apply to similar base parameters with a slight change in the fault current levels considered depending on the voltage level. The formulas provided do not apply to single phase systems or DC.

It is critical that company's follow a strict Management of Change (MOC) process when reviewing the potential changes to existing arc flash hazard incident energy analysis studies. Some of the information presented below needs careful consideration, if conservative assessments are made incident energy levels could go up by 200%. You are cautioned to ensure that realistic interpretations and good engineering judgement are utilized when reviewing the application of the updated IEEE 1584 2018 Edition. Information provided below is the authors interpretation based on specific review and interaction and discussion with colleagues and those involved in the IEEE 1584 Technical Committee.

My history with arc flash started in 2004 at an IEEE PCIC Conference where I attended a presentation on the 2004 Edition of NFPA 70E Standard for Electrical Safety in the Workplace. Following attending that presentation and with additional research at the time I discovered that there were formulas for calculating “arc flash.” This led me to the IEEE 1584 2002 Edition while working for EnCana Corporation as a Staff Electrical Engineer. At the time (2005) none of the engineering consulting firms (over 20 that I contacted) that EnCana was using even knew what an arc flash was and had not completed IEEE 1584 based arc flash hazard incident energy analysis studies.

Things have changed and as of 2018 I would estimate that all engineering consulting firms across Canada have completed arc flash incident energy analysis studies across all industry sectors.

The challenge now is the new IEEE 1584 2018 Edition utilizes new updated formulas and specific parameters have changed that require realistic and reasonable oversight by a P.Eng. Electrical Engineer with suitable experience or the resulting calculations may be incorrect or too conservative.

Some of the key details and parameters from the 2002 to 2018 Edition are shown in the tables. Some comments are also provided related to the updated electrode and box configurations used and what electrical equipment and work tasks they may apply to.

With respect to low voltage less than 240V three-phase electrical equipment. The 2002, 125 kVA transformer guideline related to not having to complete calculations has been removed and replaced with following quote:

“Sustainable arcs are possible but less likely in three-phase systems operating at 240V nominal or less with an available short-circuit current less than 2000A.” This results in a very conservative requirement for identifying the potential exposure of a Qualified Electrical Worker to an arc flash hazard when working on 208VAC three phase

Table 1 – IEEE 1584 2018 Range of Application 50/60HZ

Voltage Range (3-P kV LL)	I_{bf}	Gap (mm)	Working Distance (inch)	Arc Duration (cycles)
0.208 to 0.600	0.5 to 106	6.35 to 76.2 (0.25 to 3 inches)	Greater than or equal to 12	No Limit
0.601 to 15kV	0.2 to 65	19.05 to 254 (0.75 to 10 inches)	Greater than or equal to 12	No Limit

Table 2 – Enclosure Dimensions

Enclosure Dimensions	(inches or inch
Height	14 to 49
Width	(4 X Gap) to 49
Opening Area	2401

1 A “Correction Factor” is required to be used for enclosure dimensions greater than 49 inches in width and height.

Table 3 Electrode Configurations & Orientation

Electrode Configuration	IEEE 1584 2002 vs 2018	Electrode Orientation	Configuration	Termination
VOA	2002 / 2018	Vertical	Open Air	In Air
VCB	2002 / 2018	Vertical	In a Box	In Air
VCBB	2018	Vertical	In a Box	Terminated into or above an Insulated Barrier
HOA	2018	Horizontal	Open Air	In Air
HCB	2018	Horizontal	In a Box	In Air

Table 4 Guidance on Box & Electrode Configuration

Electrode & Box	Explanation	Electrical Equipment & Work Task Application Guidance
VOA	Vertical Conductors / Electrodes In Open Air.	Outdoor HV transformer open bushings, overhead distribution in outdoor substations up to 15kV.
VCB	Vertical Conductors / Electrodes Inside A Metal Box / Enclosure. Electrodes are Open Tipped and End in the Middle of the Box.	There may be limited applications in electrical equipment and related to specific work tasks.
VCBB	Vertical Conductors / Electrodes Terminated in an Insulated Barrier Inside a Metal Box / Enclosure. Electrodes are Terminated into or above an Insulating Barrier.	Most likely most common configuration that will be used. Low and high voltage electrical equipment and related work tasks. Inside MCC buckets and breaker/disconnect enclosures. Most common for Panelboards.
HOA	Horizontal Conductors / Electrodes In Open Air. New in 2018. Expected to Provide Higher Incident Energy Levels than VCB. Ejected Arcing Fault.	May be pad mounted transformer terminations if the terminations are not enclosed inside the “box.” The doors open and terminations are exposed.
HCB	Horizontal Conductors / Electrodes Inside a Metal Box / Enclosure. New in 2018. This Configuration Would Result in the Highest Incident Energy Levels due to Enclosure and Ejected Arcing Fault. LEAST Common Configuration.	This configuration results in highest calculated incident energy. Not recommended to be used for power circuit breaker racking in or out. Breaker is a barrier. Use this configuration if testing for absence of voltage or phasing on stabs with shutter defeated. Use VCBB for power circuit breaker racking.

systems. Caution and a practical interpretation is recommended. It is noted that the CSA Z462 Clause 4.3.7.3.15 Arc flash PPE category method can be used for 208VAC three phase electrical equipment to determine "Additional Protective Measures" instead of incident energy analysis for an available maximum fault current of up to 25kA.

It is also noted that the "2 Second Guideline" for maximum arcing duration should still be used when completing incident energy analysis. Yes, consideration must be given to the Qualified Electrical Worker been able to egress the area where the work task is been completed.

It is noted that the information provided above is brief and only a summary. Not all details are provided or reviewed in this article. Every P.Eng. Electrical Engineer completing incident energy analysis studies should purchase a copy of the IEEE 1584 2018 Edition from the IEEE as well as the IEEE 1584.1 Guide for the Specification of Scope and Deliverable Requirements for an Arc-Flash Hazard Calculation Study in Accordance with IEEE Std. 1584. Do not rely on the software vendors manual for specific interpretation, ensure you have the source documents.

Some final comments related to arc flash incident energy analysis and the studies completed to date and moving forward. The report issued is not an "Arc Flash Risk Assessment" and is not an "Arc Flash Program." The report issued only identifies predicted incident energy and an arc flash boundary if an arcing fault occurs that results in an arc flash. The report issued should not provide specific recommendations for arc flash PPE based on an HRC#, Arc Flash PPE Category or Level. The Arc Flash & Shock Equipment Labels provided in the report may not be compliant to CSA Z462 requirements and the Equipment Labels need to be specific on where the identified incident energy applies (e.g. load or line side of the listed protective device, or the bus). It is critical that the Equipment Label in the footer list the protective device that the arcing fault duration was based on and the Qualified Electrical Worker ensures they are working downstream of that specific protective device and that they are working on the location listed, line or load side or the bus. The P.Eng. Electrical Engineer completing the arc flash incident energy analysis is most likely NOT a Subject Matter Expert on the CSA Z462 Workplace electrical safety Standard and on arc flash PPE. You are advised to consult a specific Subject Matter Expert on the CSA Z462 Standard and arc flash PPE related to having a Qualified Electrical Worker using the incident energy data related to a specific work task's Arc Flash Risk Assessment as identified in CSA Z462 Clause 4.3.5. Ensure that any arc flash & shock training you provide to workers is provided by a CSA Z462 Subject Matter Expert.

It is also noted to consult CSA Z462 Clause 4.3.5.6 Arc flash PPE; incident energy analysis is only one method to use to determine arc flash PPE for a specific energized electrical work task. Please also consult CSA Z462 Clause 4.3.7.3.15 Arc flash PPE category method for the second method that can be used to determine "Additional Protective Measures" (e.g. arc flash PPE) for a specific work task based on electrical equipment description and voltage. It is recommended that that arc flash PPE category method may be preferred for low voltage 208VAC three phase systems up to a 300kVA transformer size (depending on impedance in %Z).

In closing the new IEEE 1584 2018 Edition provides updated formulas for predicting incident energy and the arc flash boundary distance. The physics of arcing faults and our understanding of them are evolving. Good engineering judgement and a reasonable, practical approach needs to be applied to: retrieving system data and equipment installation data, determining the system modes of operation, determining bolted fault currents, determining typical gap and enclosure sizes (and correction factors), electrical equipment electrode configuration, the working distances based on classes of electrical equipment, calculating arcing current, determining arc duration and then calculating the resulting incident energy and arc flash boundary.

Please ensure your company follows a strict MOC process before you expend any additional funds on updating any existing arc flash hazard incident energy analysis studies. Issuing a formal Technical Specification to the P.Eng. Electrical Engineer completing the analysis ensures that you control the decisions made. Please ensure you are reasonable, and practical and in any interpretation and application of the new IEEE 1584 2018 Edition.

Please submit any questions or comments you may have to Kevin Buhr and Terry Becker at kevinb@electricalline.com and terry.becker@twbesc.ca.

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