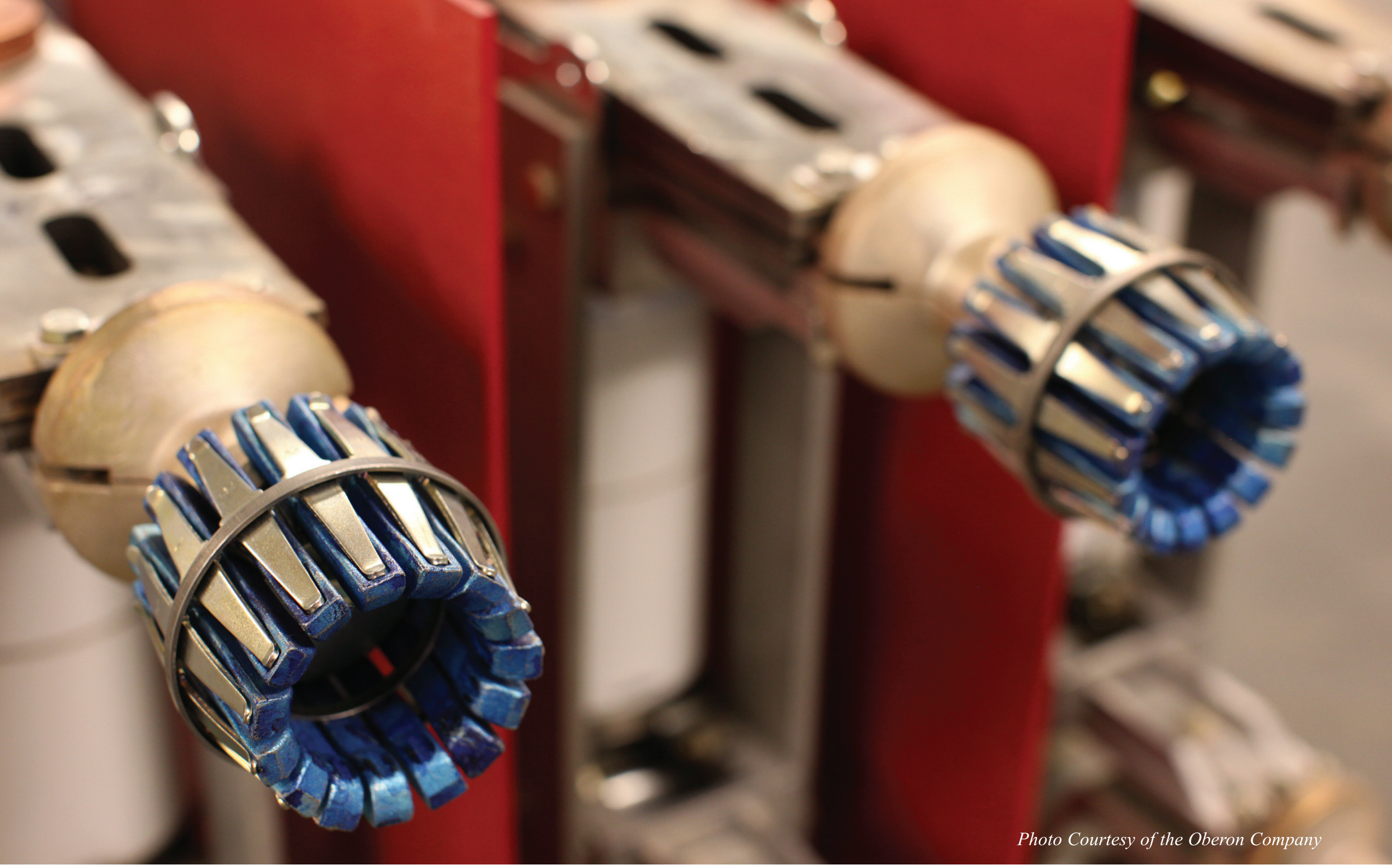

Safety Measures ELECTRICAL

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

IEEE 1584 2018 Edition – Part 2

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

This is Part 2 of the first article on IEEE 1584 2018 Edition that was published in the March/April 2019 Edition and I wanted to place additional focus on this topic and provide an update. Some of the information is the same as was published in the previous article.

Since publishing the first article I attended the IEEE PCIC Conference and the IEEE 1584 Technical Committee meeting in Vancouver, B.C. Not much was discussed about any concerns or issues of interpretation to date, most of the meeting was spent reviewing the status of the work in progress to update 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 from the published 2013 Edition to include necessary content to align with the 2018 Edition of IEEE 1584.

If you were not aware that 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 is available, it can and should be used when you are completing arc flash hazard incident energy analysis studies. It is highly recommended that you purchase a copy from the IEEE and use it to audit the study process you have used and the content of the report you generate and issue.

I also attended a Tutorial at the IEEE PCIC Conference on IEEE 1584 and a separate 2 Day IEEE 1584 2018 Edition Incident Energy Analysis training course. Much of what I believe and have communicated was validated, but there were also other opinions with respect to some of the parameters that have to be established.

Additionally since the first article published a Practice Advisory was issued by Engineers, Geoscientists of British Columbia (EGBC), it can be reviewed on the EGBC website, www.egbc.ca, under Practice Resources, Professional Practice Guides, "Updated Standard – IEEE 1584 Guide for Performing Arc-Flash Hazard Calculations," Version 1.0, November 4, 2019.

It is critical that companies 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.

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 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.

Revisiting The 40 cal/cm^2 Myth

I have been communicating to clients and in delivery of arc flash & shock training for over 10 years that 40 cal/cm^2 of incident is not a "dangerous" incident energy, and not a stop point for energized

Table 1 – IEEE 1584 2018 Edition Parameters

Item	Comments	Impact on Incident Energy
System Modes of Operation	Select reasonable modes to evaluate, but do not be overly conservative.	Ensure lower available fault current mode(s) are evaluated as yields higher incident energy.
2 Second Guideline	If analysis results in maximum fault clearing time exceeding 2 seconds. Fix at 2 seconds and calculate incident energy.	Consideration must be given to the Qualified Electrical Worker been able to egress the area where the work task is been completed.
Conductor Gap	Use Typical data.	Do not over analyze and actual measurements are not practical. Higher incident energy for wider gap as arcing fault goes down.
Box Correction Factor	Opening area impacts incident energy. Shallow vs typical.	For shallow incident energy increases as the size of the enclosure increases. For typical increased incident energy for smaller enclosure.
VCB, VCBB and HCB	Conservative selection will inflate incident energy calculated. VCB yields lowest incident energy.	VCBB higher incident energy than VCB. HCB higher incident energy than VCBB. In some limited cases VCB may yield higher incident energy than VCBB.

Table 2 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 3 Guidance on Box & Electrode Configuration Selection

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.	MCCs, panelboards and switchboards. Yields lowest incident energy.
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 circuit breaker/ disconnect switch enclosures. Most common for panelboards and switchboards.
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. Client to ultimately decide.

electrical work tasks. It was also reported that “No PPE Exists” for above 40 cal/cm^2 which was also not true. There is an available arc flash suit with an ATPV of 140 cal/cm^2 that performs the same with respect to burn injury protection as a 12.4 cal/cm^2 pair of arc-rated coveralls.

Arc blast pressure correlates to arcing fault current NOT incident energy. New information available from informal research also validates that vaporization of copper or other metals by the arc fault doesn’t produce a life threatening arc blast pressure. The informal research also confirmed that arc flash pressure is negligible when an electrical equipment door is open or cover removed and an arcing fault and arc flash occurs.

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.

In closing the new IEEE 1584 2018 Edition provides updated formulas for predicting incident energy at an assumed working distance 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.

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