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Safety Measures ELECTRICAL

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

A Guide To Updating An Existing Arc Flash Hazard Incident Energy Analysis Study

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

Over the past 10 years, industry across Canada has procured an arc flash hazard incident energy analysis study for their commercial, industrial or institutional facility(ies) – typically through a competitive procurement process. In many cases a detailed scope or work and technical specification was not developed and utilized.

Following the completion of the study there may have been facility power distribution system changes that would require it to be updated (e.g. Utility fault data changes, increase in Utility transformer size due to load additions, additional capital projects involving load changes resulting in electrical protective device changes and electrical equipment identified that was not included in original study). Additionally if the study was completed prior to 2018, the second edition of the IEEE 1584 Guide for Performing Arc-Flash Hazard Calculations was published with new updated formulas and new/updated parameter selections, this would also prompt an employer to review and update an existing study considering

the changes that occurred to IEEE 1584.

In my electrical safety consulting work across Canada and the United States, I complete a QA/QC review of existing arc flash hazard incident energy analysis studies and identify potential errors, omissions or misinformation, level of detailed provided and interpretation of IEEE 1584 etc. that the issued report may contain and if the arc flash & shock equipment label installed is compliant to CSA Z462, Clause 4.3.5.7, Annex Q and ANSI Z535.

If a detailed scope of work and technical specification was not used in the original procurement process, it is recommended that your company develop one and ensure it is used to improve the outcome of the updated study (e.g. report quality, project schedule, project cost, IEEE 1584 parameter selections, ensuring compliant arc flash & shock equipment label is provided, etc.).

Based on my experience, some of the electrical equipment assets that may not have been considered during an initial arc flash hazard incident energy analysis study are:

1. Automatic Transfer Switch (ATS) panels.
2. Stand-alone Automatic Power Factor Correction panels.
3. Splitters, 480VAC or 600VAC.
4. 120/208VAC panelboards sourced by a transformer <112.5kVA. IEEE 1584, 2018 Edition now requires 208VAC electrical equipment with maximum available fault current of >2000A to be included.
5. UPS DC power distribution panel, ≥125VDC.
6. Cathodic protection local disconnects, 208VAC, 480VAC or 600VAC.
7. HVAC local disconnects, 208VAC, 480VAC or 600VAC.
8. UPS Chargers, 208VAC, 480VAC or 600VAC input and ≥125VDC output.
9. OH Door or Crane local disconnects, 208VAC, 480VAC or 600VAC.
10. Elevator or moving sidewalks local disconnects, 208VAC, 480VAC or 600VAC.
11. Process packaged equipment combined 480V/600VAC power and control power panel.

With respect to the scope of work and technical specification and as identified in 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, the following steps are recommended in completing the updated study.

Step 1 – If you have not retrieved the digital back-up file(s) and any custom library files from the previous consultant, contact them and get the files. Ensure you have the latest as-built single line diagrams. Create an Electrical Equipment Asset Classification list to be used for defining digital bus count for incident energy calculations, this will assist in ensuring an accurate man-hour estimate is generated and limit extras after project award. Confirm electrical equipment not originally included in the existing study, reference list above and use a separate formal Electrical Equipment Asset Classification and Equipment Label Installation Instructions document. Review the hierarchy or risk control methods, Substitution and Engineering "Safety by Design/Prevention Through Design (PtD)" that you want considered by the consultant.

Step 2 – Finalize scope of work & technical specification. Issue request for bids. Ensure detailed pre-qualification of the consultants that will provide bids, use a checklist included with bid package. Ensure scoring for bids places more weight on the technical proposal than cost. Clarify bids. The lowest bid is not necessarily the best bid. Award contract.

Step 3 – Assign Project Manager and work with consultant's Project Manager to establish project schedule, milestones and minimum bi-weekly status meetings. Ensure all electrical engineering is performed in Canada. Confirm electrical equipment data validation and collection requirements. Consultant receives/collects/validates data. Control any extras using scope or work and technical Specification.

Step 4 – Revalidate "System Modes of Operation." Confirm most realistic mode is utilized.

Step 5 – Validate 208VAC electrical equipment, 2000A maximum available fault current (e.g. typically 45kVA rating depending on %Z), new parameter in IEEE 1584, 2018 Edition.

Step 6 – Confirm IEEE 1584 2018 parameter selections (see Table 1 on following page).

Step 7 – For DC incident energy calculations confirm use of Stokes-Oppenlander formulas, they will provide most reasonable incident energy calculation results based on testing completed by industry. For greater than 15kV electrical equipment review and validate formulas to be used.

Step 8 – Consultant validates existing digital single line diagram and update as required.

Step 9 – Consultant reviews, updates and validates Short Circuit Analysis. Confirm electrical equipment is not over dutied.

Step 10 – Consultant review, update and validate Protective Device Selection & Coordination. Validate electrical protective device settings.

Step 11 – Consultant reviews, updates and validates Arc Flash Hazard Incident Energy Analysis. Determine if incident energy reduction opportunities exist, target min. 75.0 cal/cm^2 incident energy.

Step 12 – Consultant generates engineering draft report. Follow report table of contents requirements outlined in Technical Specification. Review draft report and follow up on any questions. Final report issued.

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 these may yield 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. Ensure you have reviewed why the protective device setting causes over a 2 second fault clearing time, is it correct?
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 (until height or width reaches 508mm at which point the enclosure becomes "Typical"). 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.

Step 13 – Issue formal Management of Change for updated arc flash & shock equipment label installation and to the specification for the equipment label included in technical specification (refer to Figures). Provide detailed installation instructions for electrical contractor to use when installing the equipment labels. For a large facility install equipment labels on electrical equipment in a single electrical room and use it to validate, then have electrical contractor replicate installation for consistency in other electrical rooms and other electrical equipment. In this case new equipment labels will be installed over existing equipment labels, or the location of an existing equipment label will have to be abandoned. If an equipment label is abandoned a generic equipment label as below can be used or a complete white or grey blank put over top of it. Alternately a generic arc flash & shock equipment label can be installed, and "Arc Flash Incident Energy Results Table" created and issued to Qualified Persons for reference and/or posted in defined electrical rooms (Figure 6).

The following compliant arc flash & shock equipment labels format is recommended (see below):

Figure 1. Arc Flash & Shock Equipment Label Over Existing Label

Figure 2. Warning Signal Pane Arc Flash & Shock Equipment Label

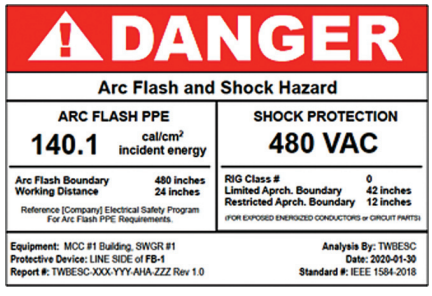

Figure 3. Danger Signal Pane Arc Flash & Shock Equipment Label (incident energy ≥140 cal/cm^2

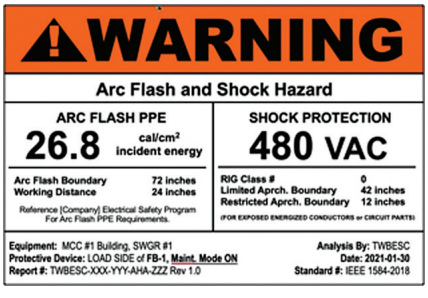

Figure 4. Warning Arc Flash & Shock Equipment Label Maintenance Mode ON

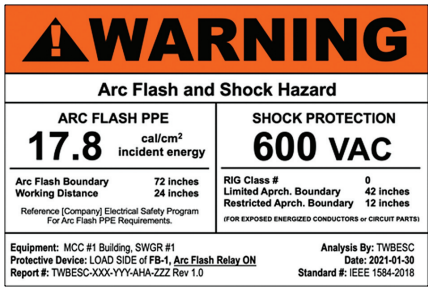

Figure 5. Warning Arc Flash & Shock Equipment Label Arc Flash Relay ON

Figure 6. Warning Arc Flash & Shock Equipment Label Results Table

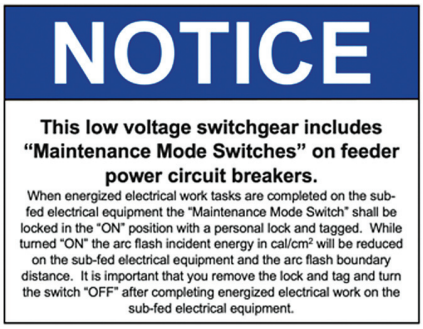

Figure 7. Notice Signage "Maintenance Mode Switches"

Figure 8. Notice Signage Arc Resistant Electrical Equipment

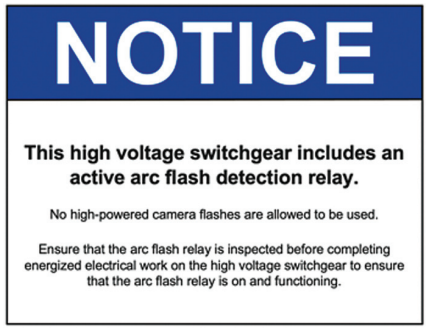

Figure 9. Notice Signage Arc Flash Relay Installed

Additional electrical equipment Notice signage for general awareness and notification is recommended (see Figures 7 through 9).

Step 14 – Issue formal Management of Change for any electrical equipment changes or electrical protective device changes.

Step 15 – Close out project, retrieve all raw electrical equipment data, digital pictures files, electrical equipment asset classification list, digital back-up files, custom library files, PDF of P.Eng. authenticated report, issued hardcopies of final report, etc.

When updating an existing arc flash hazard incident energy analysis study from a continuous improvement perspective ensuring you use a detailed scope of work and technical specification and following a procedural process as outlined above will allow your company to "take control of arc flash" and ensure you can validate the incident energy analysis information, formally manage change, control costs and quality of engineering work completed for your company.

References:

1. CSA Z462, Clauses 4.3.5.6.2, Clause 4.3.5.7 and Annex Q.
2. IEEE 1584 Guide For Performing Arc-Flash Hazard Calculations.
3. 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.
4. Engineers, Geologists of British Columbia (EGBC), Updated Standard – IEEE 1584 – Guide for Performing Arc-Flash Hazard Calculations
5. TWBESC Scope or Work & Technical Specification.
6. TWBESC Electrical Equipment Asset Classification & Equipment Installation Instructions.
7. TWBESC Electrical Safety Design Basis Memorandum.

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!!

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 Working Group Leader for Clause 4.1 and the Annexes. 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 Arc-Flash Hazard Calculations. Terry has presented at Conferences and Workshops on electrical safety in Canada, the USA, India and Australia. Terry is a Professional Engineer in the Provinces of B.C., Alberta and Ontario. Terry is an Electrical Safety Specialist, Management Consultant, and can be reached at 587.433.3777 or by email **terry.becker@twbesc.ca**.