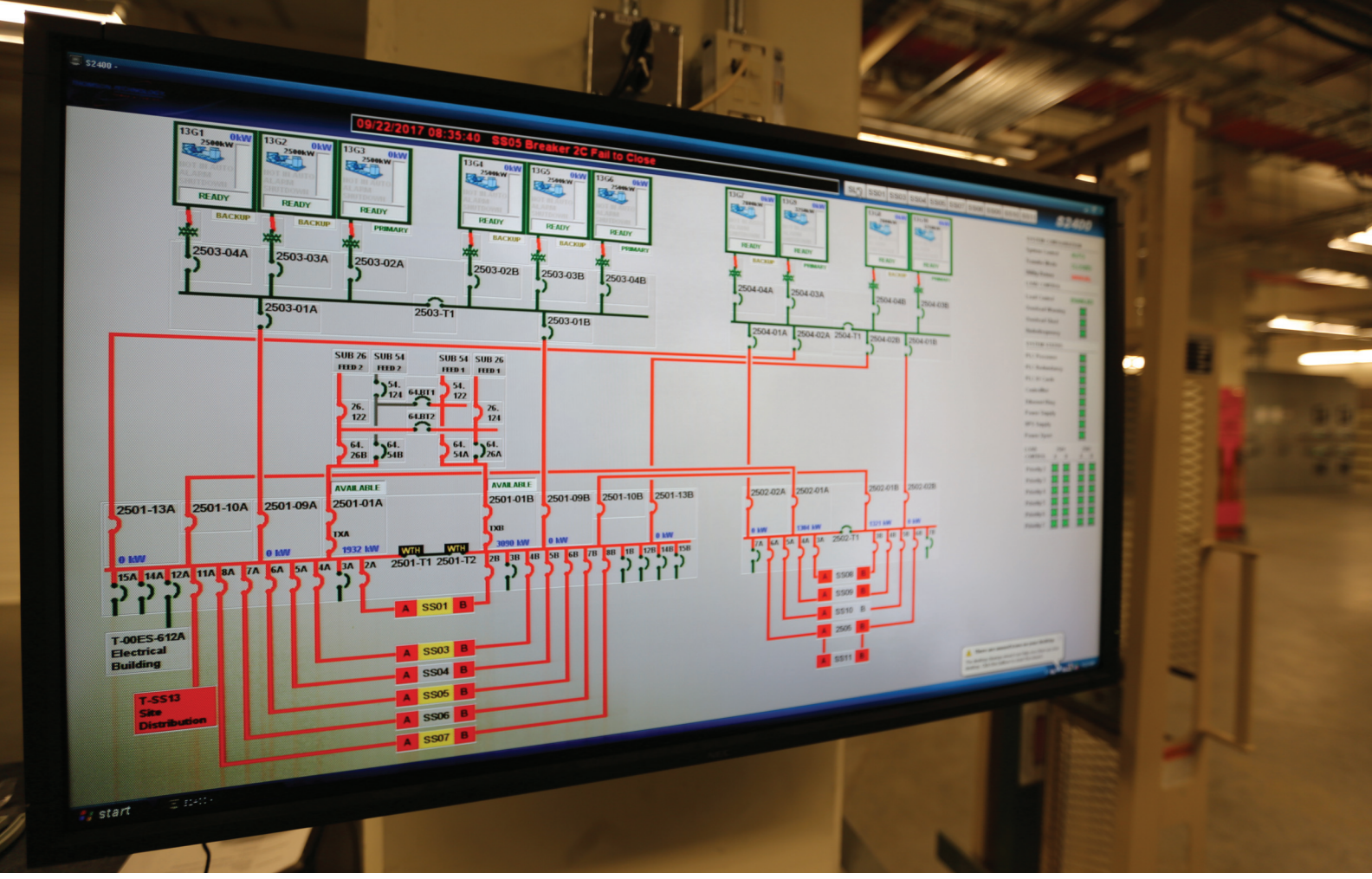

Safety Measures ELECTRICAL

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

IEEE 1584.1– IEEE Guide For The Specification Of Scope And Deliverable Requirements For An Arc-Flash Hazard Calculation Study In Accordance With IEEE Std 1584

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

It has been my experience in my work as an independent electrical safety consultant working in industry across Canada that not many P.Eng. Electrical Engineers are aware that the *IEEE 1584.1 Guide for Specification of Scope and Deliverable Requirements for an Arc-Flash Hazard Calculation Study in Accordance with IEEE Std 1584* exists.

This is unfortunate as IEEE 1584.1 is a complimentary document to the core IEEE 1584 Standard and provides additional explanatory information and specific guidance on what content should be included in the report generated. IEEE 1584.1 was published in 2013 to attempt to ensure that arc flash hazard incident energy analysis studies were completed correctly and with a report issued that was detailed and aligned with good engineering practice.

The IEEE 1584.1 Standard is a companion Standard to *IEEE 1584 IEEE Guide for Performing Arc-Flash Hazard Calculations*. You should ensure that you have a copy of both IEEE 1584 and IEEE 1584.1 if you are performing arc flash hazard incident energy calculations and submitting reports to a client. This will also allow you to substantiate

any assumptions or disclaimers you may include in your report.

Currently the IEEE 1584.1 Standard is been updated from its 2013 Edition to a new Edition that will reference applicable content from the recently updated and published IEEE 1584-2018 Standard. As is the IEEE 1584.1-2013 Standard content that is generic in nature is applicable. Where the updated IEEE 1584-2018 includes additional new content please ensure you reference it as a priority. Please review the Electrical Line Magazine, March/April 2019 edition for the previous article that summarizes some of the key changes included in the IEEE 1584-2018 Edition.

With respect to completing arc flash hazard incident energy calculations the following steps are required to be completed in order as summarized in the IEEE 1584-2018 Edition:

Step 1: Collect the system and installation data. Start with an available Single Line Diagram. Use specific electrical equipment data sheets. Request Electrical Utility Fault Data for each service.

Step 2: Determine the system modes of operation. This is a different requirement from strictly completing a short circuit analysis. You need to consider single mode or multiple modes when determining bolted fault currents. Determine both maximum and minimum short circuit currents.

Step 3: Determine the bolted fault currents.

Step 4: Determine the typical gap for the electrical equipment and enclosure sizes based upon system voltages and classes of equipment. Reference IEEE 1584-2018 Table 8. If you increase the gap from the default values incident energy calculated will go up. Smaller box size increases incident energy.

Step 5: Determine the electrical equipment electrode configuration. IEEE 1584-2018 Table 9 provides guidance of VCB, VCBB, HCB, VOA and HOA. HCB will yield the highest calculated incident energy. Also review Annex C and G.

Step 6: Determine the working distances. This is the anticipated distance from the arcing fault location to the Qualified Electrical Worker's face and torso. Reference IEEE 1584-2018 Table 10.

Step 7: Calculate arcing current.

Step 8: Determine the arc duration.

Step 9: Calculate the incident energy for each specific location on the electrical equipment where an energized work task may be completed.

Step 10: Determine the Arc Flash Boundary distance for the electrical equipment where energized work tasks will be completed.

As identified in IEEE 1584.1 the recommended content of the P.Eng. Stamped Report would include:

1. **P.Eng. Stamped Cover Page**.
2. **Executive Summary**.
3. **Scope of Study & Results Summary**.
4. **Background Information**. Requirement for completing the incident energy analysis as a method to determine "Additional Protective Measures" specifically arc flash PPE and the Arc Flash Boundary distance as outlined in CSA Z462 Clause 4.3.5.6 and CSA Z462 Clause 4.3.5.5. Additional information can be summarized here with explanation such as modes of operation (e.g. single or multiple) that were short listed and utilized in completing the short circuit and arcing fault current calculations. Analysis software used and configuration settings.
5. **Review of System Data**. Identify basis of electrical equipment data used to create the power system model, utility available fault currents, cable sizes, motor data and the motor hp cut off for using the lumped load feature in the power system analysis software (e.g. <200hp). Any data assumptions made shall be listed. Include AutoCAD single line diagrams and data sheets in Appendix of report.
6. **Short Circuit Analysis Results**. Summarize the basis for the calculations and findings. Identify if any electrical equipment was found to be outside of its current withstand ratings.
7. **Protective Device Coordination Study**. Review the findings and discuss results and reference applicable Time-Current-Curves. Discuss basis for any potential changes to protective device settings to lower incident energy and ensure any implications are documented.
8. **Arc Flash Hazard Incident Energy Analysis**. List the results of the base incident energy calculations with existing power system configuration in a summary table in the body of the report. Make recommendations for incident energy reduction. There is no 40 cal/cm^2 "Dangerous" incident energy level, where "No PPE Exists." This information was included in the power system software you have used in error. Incident energy doesn't correlate directly to arc blast pressure. You can have higher incident energy levels at lower available fault currents and on low voltage equipment over high voltage electrical equipment. Technically incident energy over 140 cal/cm^2 is high risk energized electrical work as there is no available arc-rated clothing greater than 140 cal/cm^2 ATPV. The results table should not include any reference to HRC #, Cat #, Level # or "letter" for arc flash PPE related to the incident energy results.
   With respect to any recommendations made and documented in the report related to Arc Flash & Shock Equipment Labels the content on the label needs to meet the minimum requirements identified in CSA Z462 Clause 4.3.5.7 and the presentation of the information and use of signal pane wording should comply with ANSI Z535. The Equipment Label should not include any reference to HRC#, Cat #, Level # or "letter" for arc flash PPE, the employer will define the arc flash PPE they provide to their workers.
9. **Recommendations for Incident Energy Reduction**. Advise client for Management of Change purposes recommended protective device setting changes. Client will decide based on cost benefit and technically feasible any other incident energy reduction methods that are recommended.
10. **Conclusion**
11. **Appendices** include AutoCAD single line diagram, analysis software single line diagram, field data sheets, provided utility short circuit data, short circuit analysis report, TCCs, arc flash incident energy analysis results table(s), example Arc Flash & Shock Equipment Labels. Anything else?

Based on my experience in reviewing Arc Flash Hazard Incident Energy Analysis Reports for clients across Canada many of the reports I have reviewed were deficient in content and included errors & omissions based on the detailed requirements and basis of the incident energy calculations as documented in IEEE 1584. With the new updated 2018 Edition of the IEEE 1584 Standard it will be even more important that the responsible P.Eng. Electrical Engineer documents in detail the assumptions made, any disclaimers, field data validation, etc.

As noted in my previous Article it is also extremely important that any Arc Flash & Shock Equipment Label recommendations provided to a client in a report meet the minimum requirements of Equipment Labeling as identified in CSA Z462 Workplace electrical safety Standard, Clause 4.3.5.7 and also reference CSA Z462 Annex Q Arc flash and shock warning and information labels. It is important to note that the "Danger" signal pane should only be used if the calculated incident energy is greater than 140 cal/cm^2 NOT 40 cal/cm^2. Make sure the footer of the label indicates the protective device ID and location of the incident energy (e.g. load side, line side or bus).

This article is a simplified summary of the *IEEE 1584.1 Guide for Specification of Scope and Deliverable Requirements for an Arc-Flash Hazard Calculation Study in Accordance with IEEE Std 1584*. You are advised to purchase a copy of IEEE 1584.1 and review its content in detail when completing your incident energy analysis study and drafting the report that is issued to clients.

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

***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 Guideline for 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 BC, AB, SK, MN and ON. Terry is an Electrical Safety Specialist, Management Consultant, and can be reached at 587.433.3777 or by email **terry.becker@twbesc.ca**.*