The Best is Yet To Come! IEEE 1584 Update

Work Continues on the next edition of IEEE 1584

By Jim Phillips ▪ Brainfiller, Inc. / ArcFlashForum.com
Published: May 2013 ▪ Electrical Contractor Magazine

A lot has happened since 2002 when IEEE 1584–IEEE Guide for Arc-Flash Hazard Calculations was first published by the Institute of Electrical and Electronics Engineers. The development of this landmark document included conducting more than 300 arc flash tests, which were used to create the empirically derived equations. Applicable for three-phase calculations and voltages ranging from 208 volts (V) to 15,000V, four main calculation methods are the backbone of this standard. They include the following:

- Arcing short-circuit current—systems less than 1,000V
- Arcing short-circuit current—systems from 1,000 to 15,000V
- Incident energy
- Flash hazard boundary (known today as the arc flash boundary)

Let's collaborate

When IEEE 1584 was first introduced, it not only became the primary standard for arc flash studies in the United States and North America, but it also quickly gained widespread global acceptance. (See Arc Flash Safety on page 54 of the May 2013 issue of Electrical Contractor Magazine for information about IEEE 1584's global use.) Not wanting to rest on the accomplishment of producing the 2002 edition, the focus began to shift toward improving what we have while exploring other areas. Everyone began to ask the same question: How do we take this standard to the next level?

The arc flash tests used for the 2002 edition were based on the electrodes placed in a vertical configuration similar to the photo above. Thoughts began to turn toward answering new questions. What if the electrodes were horizontal instead of vertical? What if the enclosure was a different size? What if it was a DC arc flash? The "what if" list quickly began to grow, which helped define what the next edition of IEEE 1584 might include.

Questions were not just coming from people within the IEEE community. They were also coming from the National Fire Protection Association, which publishes NFPA 70E, Standard for Electrical Safety in the Workplace. Since research and testing requires significant financial resources, a collaborative effort was developed where both IEEE and NFPA would participate. This new collaboration combined with the financial support from many companies and individuals in the industry would result in a multiyear project that would include conducting more than 1,000 new tests as well as new research and analysis to take what we know about arc flash to the next level.

Caution! Science in progress

Although the testing and research has been ongoing for several years, the work is incomplete and continues today. In addition, much of it is still in the proprietary review stage (sorry, no peeking). Data analysis, additional testing, and fine-tuning of the models are just a few of the many tasks that remain; it is still a work in progress. This means that information in this article must be considered preliminary and is subject to change.

The IEEE 1584 committee will continue evaluating new information such as test data and equations as it becomes available from the project team. Ultimately, the IEEE 1584 committee will consider all the new information for possible use in the next edition of the standard.

Electrode/bus orientation

The 2002 edition of IEEE 1584 was based on three electrodes placed in a vertical orientation as shown in the photo above. When an arc flash occurs with this orientation, the arc plasma is driven toward the bottom of the box and often spills out of the front.

Subsequent research has shown that electrode orientation can also influence incident energy. As a result, the project team has conducted tests using additional electrode orientations including both horizontal electrodes and vertical electrodes that terminate into an insulating barrier similar to the photo below.

When the electrodes are placed horizontally, the arc plasma is directed from the ends of the electrodes outward. Research has also indicated that if vertical electrodes are terminated into an insulating barrier, the arc hits the barrier and the plasma cloud is directed more toward the enclosure opening. The barrier configuration is relatively common and represents conditions such as when conductors terminate into a terminal block or other device.

Five different bus configurations have been included in the testing program:

- Vertical electrodes in a cubic metal box
- Vertical electrodes terminated in a “barrier”–cubic metal box
- Horizontal electrodes in a cubic metal box
- Vertical electrodes in open air
- Horizontal electrodes in open air

The new test results have been used to develop preliminary equations for further committee review and possible inclusion in the new standard. Currently, the new equations have not been made public since they continue to be refined as the research continues.

With all of the different electrode orientations combined with many variables such as gap distance, voltage, enclosure size and others, the new standard has the potential to make modeling more complex. Fortunately, I have the privilege of leading a task group, which is exploring the use of the new equations for equipment modeling.

More than just incident energy

In the past, an arc flash study focused on predicting the prospective incident energy, but other areas are being investigated.

Blast Pressure: Some testing has been conducted to evaluate blast pressure from an arc flash. One such test was conducted using a short-circuit current of 20,000 amperes (A) with a 25-milimeter (mm) arc gap and 12-cycle duration. It resulted in pressures between 110 to 200 pounds of force that a worker could experience over a 1-by-1.5-foot area. Although this specific test at the lower level of fault current may not necessarily result in a crushing blow, it could knock a worker over, possibly contributing to other injuries.

Sound Pressure: Sound pressure from arc flash can result in severe hearing damage. Some testing at 4,160V has produced average sound levels upwards of 155 to 160 decibels at distances of 3 meters or more. The sound levels are affected by the short-circuit current and the size and shape of the testing lab.

Light: When an arc flash occurs, there can be a bright flash of light that can cause eye injury and blindness. As part of the testing program, some light (luminance) measurements have been performed. As a frame of reference, it has been stated that the luminance level on a bright summer day will have a midday ground level illumination on the order of 100,000 lux, where lux is a measure of light intensity. Luminance measurements for several different short-circuit current levels have resulted in recordings of tens of millions of lux during the arc flash.

Enclosure Size: It is widely accepted that the enclosure size can influence arc flash incident energy. The project team has been evaluating the effect of enclosure size, and consideration is being given to the use of adjustment factors for different dimensions as part of the calculation process.

DC arc flash

Large rectifiers, direct current (DC) traction power systems and large battery systems are just a few of the possible sources of a DC arc flash. Although the 2002 Edition of IEEE 1584 did not consider calculation methods for DC arc flash, there has been some private testing and technical papers developed on the subject. The hope is that DC arc flash testing will be conducted in the final phases of this project.

The 125 kVA transformer exception

Often referred to as the “125 kVA Exception,” the 2002 edition of IEEE 1584 contains language that permits a study to exclude calculations on circuits with voltages less than 240V and fed by transformers 125 kilovolt-amperes (kVA) and smaller. This exception was based on a few tests that indicated, that if an arc flash occurs at lower voltages and also with a lower magnitude of short-circuit current, it would be difficult to sustain the arc. Therefore, it would result in a lower level of incident energy.

Since 2002, significant testing has indicated, under certain conditions, it is possible to sustain an arc flash at much lower levels of short-circuit current. Although this exception is still under evaluation and review, it is likely that the cutoff will be greatly reduced from the existing 125 kVA transformer size.

What is an arc flash study? IEEE 1584.1

If you ask 10 people what an arc flash hazard calculation study is, you likely will receive 10 different answers. Some might say, “Don’t you just take some data, dump it into a program, and out pops some labels?” Others might say, “It requires very complex system modeling, analysis and data gathering and is quite a massive undertaking.”

Also, many arc flash studies were being commissioned by safety managers that had limited knowledge of what is involved in an arc flash study. This made it difficult to compare proposals from various consultants.

Since there are so many widely varying opinions about what an arc flash study is and what should be included, the IEEE 1584 committee formed a separate task group to address this problem. I had the privilege of being one of the two people to lead this group, which developed what would become known as “IEEE Guide for the Specification of Scope and Deliverables Requirements for an Arc-Flash Hazard Calculations Study in Accordance with IEEE Std. 1584.” This new document would receive the designation IEEE 1584.1, or “dot one” as we all began to call it.

The objective of this soon-to-be-released guide is to provide direction for the information and suggested deliverables of an arc flash hazard calculation study. It also outlines the minimum recommended requirements of the study.

Now in the home stretch of the standards-making process, “dot one” should be available later this year from IEEE.

Fast forward to what’s next

More than a thousand new arc flash tests have been performed so far with many more to be conducted. The additional testing combined with a detailed review and analysis of results—validating the models and developing new text for the next edition—will take some time. Once a complete draft of the standard is ready to go, the balloting process begins. Comments are addressed, and additional changes may occur. Yes, it will take some time to complete, but the effort will be worth the wait. The best is yet to come!

JIM PHILLIPS, P.E., founder of www.brainfiller.com and www.ArcFlashForum.com is Secretary of the IEEE 1584 Arc Flash Working Group, Liaison Officer for IEEE 1584 and IEC WG13. He is an internationally known educator on electrical power systems with experience that includes industrial, commercial and utility systems. You may reach him at jphillips@brainfiller.com

ELECTRICAL CONTRACTOR magazine serves the field of electrical construction, including inside, line work, lighting, maintenance, control, electrical work, voice/data systems, security, fire and life safety, fiber optics, home and building automation systems, integrated building systems applications and others applicable to the field. ELECTRICAL CONTRACTOR Magazine is the Official Publication of the National Electrical Contractors Association. (NECA).