IEEE Standards Interpretation for IEEE Std 1584™-2002 IEEE Guide for Performing Arc-Flash Hazard Calculations

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This is an interpretation of IEEE Std 1584-2002.

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Interpretation Request #1
Is there an accepted practice or method in which incident energies can be lowered, therefore lowering the PPE category?

Interpretation Response #1
The answer is IEEE Std 1584-2002 does not address practices or methods of lowering the incident energy because it would be outside the scope of this edition. However, the question is of great interest to users of the Guide and it will be addressed in the next edition. In the meantime, information on the subject is available from IEEE papers presented at the 2002 and 2003 PCIC Conferences. The papers are available in the PCIC record. The next opportunities to learn how people are solving this problem will be at the 2004 IAS Electrical Safety Workshop and at the 2004 IAS PCIC Conference. There are, in fact, many ways to reduce incident energy.

Interpretation Request #2
An interpretation of IEEE Std 1584-2002 – "Guide for Performing Arc-Flash Hazard Calculations" is requested. In 5.1, 7.5, and 9.1 the criteria for the model for incident energy calculations includes "Bolted fault current in the range of 700A-106,000A." What is the significance of "700A," the lower limit of the range. Is there a particular reason why it is 700A, and not 600A, 500A, 400A, etc.?
Several arc flash studies are currently being conducted in which the bolted fault current for a few busses is lower than 700A. The software tools used to conduct the studies make it clear that this fault level is outside of the range of IEEE 1584 and leave it at that. How to treat these situations is uncertain. Can it be concluded, for example, that

incident energy is low and would be always be classed as NFPA 70E – 2004, Category 0 (i.e. less than 2.00 cal/cm2)?

Interpretation Response #2

The model in the Guide was empirically derived, i.e., it was developed through statistical analysis of test data. This type of model has no defined accuracy outside the range of the test data and, in fact, it can give obviously incorrect calculation results outside the stated range of the model the lower limit of 700A is based.

In answer to your question on applications where the bolted fault current is below 700A, note that the Guide offers two models. The Lee Model can be applied outside the range of the empirically derived model. Note also that Annex B suggests a limit to arc duration may be applied, depending on the application.

Recognize that the Guide is just a guide and engineering judgment must be applied when performing an arc flash hazard calculations study.

Interpretation Request #3

Topic: Accuracy of material in IEEE 1584-2002 and amendment IEEE 1584a-2004 **Relevant Clauses:** Section 9.5 and Equation 5.3(4) Section 9.5 states: "Two grounding classes are applied in the equations considered, as follows: a) Ungrounded, which included ungrounded, high-resistance grounding and low-resistance grounding. b) Solidly grounded." We have a system with a resistance grounded secondary on a 750kVA transformer. In line with the statements above, the incident energy level determined by our software tools for the secondary side is significantly higher (about 30%) for resistance grounding than the scenario where the transformer is modeled as having solid grounding. This seems to be contrary to statements in other standards concerning resistance grounding as referenced below. Perhaps the key consideration is phase-to-ground fault versus three-phase fault. Clarification would be appreciated, since it would seem that solidly grounding the secondary would improve arc flash hazards as per above, while resistance grounding is recommended below. IEEE Std 141™-1993 (Red Book™) section 7.2.4 states "A safety hazard exists for solidly grounded systems from the severe flash, arc burning, and blast hazard from any phase-to-ground fault." For this reason, IEEE recommends resistance grounding. IEEE Std 142™-1991 (Green Book™) section 1.4.3 states "The reasons for limiting the current by resistance grounding may be one or more of the following:

1) To reduce burning and melting effects in faulted electric equipment, such as switchgear, transformers, cables, and rotating machines.
2) To reduce mechanical stresses in circuits and apparatus carrying fault currents.
3) To reduce electric-shock hazards to personnel caused by stray ground-fault currents in the ground return path.
4) To reduce the arc blast or flash hazard to personnel who may have accidentally caused or who happen to be in close proximity to the ground fault.
5) To reduce the momentary line-voltage dip occasioned by the clearing of a ground fault.

6) To secure control of transient over-voltages while at the same time avoiding the shutdown of a faulty circuit on the occurrence of the first ground fault (high resistance grounding).

IEEE Std 141-1993 (Red Book) section 7.2.2 states "There is no arc flash hazard, as there is with solidly grounded systems, since the fault current is limited to approximately 5A."

Interpretation Response #3
I agree with your assessment that IEEE std 1584 seems to be contrary to statements in the other standards you cited, but appearances sometimes deceive. Each statement you quote from a standard is correct and your two calculations show the difference in results that I would expect.

The IEEE 1584 statement is based on three-phase testing with ungrounded and grounded systems and analysis of the results. This is because it is recognized that arc power is higher in three phase faults than in line-to-line or ground faults and single phase faults often escalate to become three-phase faults. IEEE 1584 considers only that worst case.

The other two standards you quote are discussing only ground faults, based on the fact that most faults begin as ground faults. If fault current can be limited, the fault is not likely to escalate to become a three phase fault. Arc fault energy will be quite small by comparison to the three phase fault case.

However, even with resistance grounding, a three phase fault is still possible and so it must be considered when calculating incident energy.