New IEEE Standards Foster Next-Generation System Compatibility

François Martzloff
f.martzloff@ieee.org

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Significance
Part 2 – Development of standards – Reality Checks
Part 6 – Tutorials and reviews

A progress report and announcement to the EPRI community of the imminent release of the IEEE Trilogy on surge environment and surge testing for low-voltage AC power circuits

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By François Martzloff

In an exclusive story, international standards expert and past *Signature* Editorial Board member, François Martzloff, presents a unique preview of three new surge-related standards that are bound to set the course for the future of system compatibility. This standards trilogy is scheduled for publication by the Institute of Electrical and Electronics Engineers early in 2003.

For electronic copies of the new standards, visit www.ieee.org. For general information about activities of the IEEE Surge Protective Devices Committee, see grouper.ieee.org/groups/spd. To access an anthology on surge protection, go to www.eeel.nist.gov/811/spd-anthology.

In November 2002, the Institute of Electrical and Electronics Engineers (IEEE) approved a set of three standards that provide critical parameters on the surge environment in low-voltage ac power circuits, and suggest improved test methods for end-use equipment connected to these circuits. When this standards trilogy is published in early 2003, manufacturers and users of surge protective devices (SPDs) will have a definitive set of documents to help them make more cost-effective and technically sound design decisions regarding the compatibility of their equipment with the surge environment.

The seminal IEEE Standard 587—*Guide on Surge Voltages in Low-Voltage AC Power Circuits*—has gone through several revisions, including a name change to C62.41, since it was first published in 1980. A companion, IEEE Standard C62.45—*Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits*—was also developed to provide guidance on test procedures.

IEEE 587/C62.41 and C62.45 served us well from 1980 to 1999. However, with the availability of new knowledge on surge protection, and after nearly 20 years of experience in applying the two standards, a major update was needed. The newly developed standards provide a more direct route to fulfilling the surge protection needs of users, and are designed to promote greater harmony with the related standards of international organizations.

The new trilogy consists of

- IEEE Standard C62.41.1™ 2002—*Guide on the Surge Environment in Low-Voltage AC Power Circuits,* which contains a comprehensive database describing the surge environment;
- IEEE Standard C62.41.2™ 2002—*Recommended Practice on Characterization of Surges in Low-Voltage AC Power Circuits,* which proposes a limited set of representative surge waveforms for test purposes; and

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New IEEE standards will help end users to evaluate the many surge protection options, and to make technically sound and cost-effective choices.

- IEEE Standard C62.45™ 2002—*Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits,* which shows how to perform reasonable, repeatable, and reliable surge testing.

New Focus

In developing the standards, IEEE focused on five key areas: transitions, temporary overvoltages, multiple-port equipment problems, scenarios, and harmonization. Because these factors can have significant impacts on hardware selection and specification, they were debated thoroughly by members of the working group and other interested parties before a consensus was reached. Fortunately, the IEEE standard format includes "normative" clauses, to emphasize important points, and "informative" annexes, to provide perspective on less definitive issues.

Transitions

Earlier versions of C62.41 offered the concept of "Location Categories" to help designers and users of equipment define surge threats by the general location of the equipment within a building. Location categories are based on the fact that the inherent inductance of the building wiring reduces *current* stress from an impinging surge as the distance from the service entrance increases, while *voltage* stress is not affected. According to this concept, SPDs can be expected to have less stress exposure as their point of use moves away from the service entrance.

While the earlier standards did not specify precise distances, they featured graphic representations with fine lines, or "boundaries," separating location categories. Because some users focused too narrowly on these boundaries, the updated guide now uses the concept of "Transitions" that connect rather than separate location categories, as the graphic shows. These transitions leave some flexibility for equipment manufacturers and users in selecting specific surge-withstand values.

Temporary Overvoltages

Although temporary overvoltages—which last seconds rather than the microseconds of surges—might be seen as outside the scope of the surge environment, their impact on SPDs can be devastating. For this reason, IEEE added a description of their occurrence and mechanism to the C62.41.1 guide.

Multiple-Port Equipment

Most of today's electronic equipment contains multiple ports, with connections to both the ac power supply and one or more additional systems that must have a ground reference, such as phone systems, television cable systems, and computer networks. Multiple-port equipment is now the most common victim of surges. A surge on any of the connected systems will cause a shift in ground reference potential to appear across the equipment ports. Guide C62.41.1 alerts the engineering community to this phenomenon—the most frequent source of insurance claims—and supports the standardization of SPDs. Furthermore, IEEE has just launched two projects for developing new standards addressing performance and test methods of multiple-port SPDs.

Scenarios

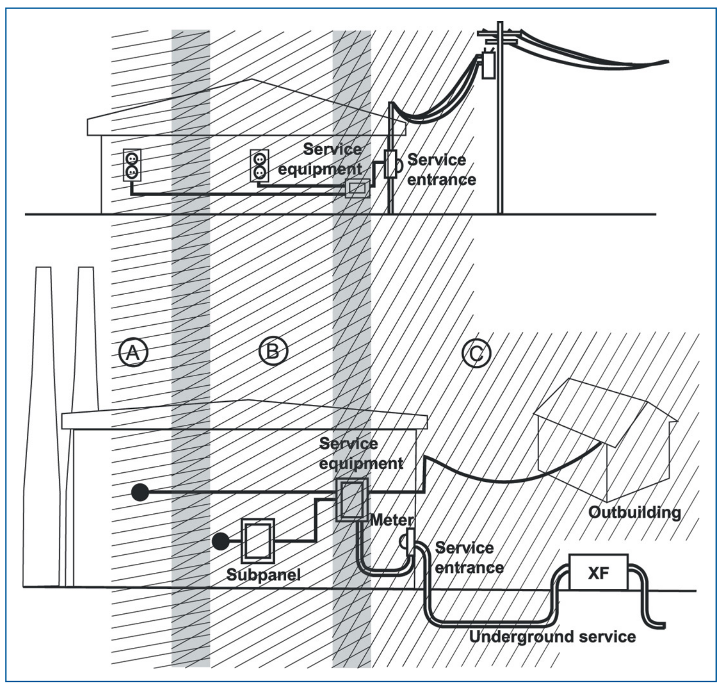
In an effort to organize and present information in a way that will be as useful and realistic as possible, the standards trilogy introduces the concept of "Scenarios," which distinguish between two types of surges. Scenario I describes surges coming from any source that *impinge* upon an installation or are generated within the installation by load switching. Scenario II covers surges that are associated with a rare but possible direct lightning flash to a building, and with surge current that *exits* the building via the service connection.

The concept of location categories applies only to surges in Scenario I—those impinging upon a building from the outside or being generated from within. These are considered to be the vast majority of surge events. Guide C62.41.1 provides a surge environment description that serves as the basis for defining the waveforms in Recommended Practice C62.41.2.

The more rare event of a direct flash to a building in Scenario II was considered to be a special case and not included in earlier documents. Given the increasing interest in the ramifications of such an event, the new standards address this situation. Definitions of appropriate parameters for this scenario did raise some discussion in gaining consensus, and therefore are proposed in an informative annex to allow case-by-case applications.

Harmonization

In keeping with the transnational aim of IEEE standards, the new standards were developed to harmonize with related documents from the International Electrotechnical Commission (IEC). The IEEE working groups established liaisons with



Overlaps between the lined areas represent "Transitions," which connect Location Categories A, B, and C. Stress levels imposed on end-use equipment, including surge protective devices, decrease from C to A for surges impinging upon the facility.

IEC Technical Committees SC37A (Low-Voltage SPDs) and TC81 (Lightning Protection), as well as with other parties involved in lightning studies. These efforts will help to ensure greater credibility and worldwide acceptance of both IEEE and IEC standards.

Expanded Scope

In earlier versions of the standard, surge environment descriptions were limited to compilations of surge measurements in the field. The data were gathered either by systematic monitoring or through staged tests during equipment failure investigations. As development of Guide C62.41.1 progressed, it became clear that more information on the surge environment could be gained by incorporating other data. The standard now includes additional data from recordings of surge events in the field, numerical simulations and laboratory research, and inferences on the surge environment drawn from analysis of equipment failures.

The proposed waveforms and associated stress levels in Recommended Practice C62.41.2 required no major change during the updating process. The waveforms should not be construed as specifications—a misconception noted in the use of earlier versions of C62.41—but rather as a menu from which equipment manufacturers and users can select stress levels, as determined by the test waveform(s) and amplitude(s) best suited to their own applications. The menu offers a set of two standard waveforms for general applications and a set of two additional waveforms for special applications.

The first standard waveform, the "Ring Wave," was constructed in 1980 on the basis of the then-novel recognition that traditional test waveforms used in high-voltage laboratories might not provide accurate representations of the environment in low-voltage ac power circuits. The second standard waveform, the "Combination Wave," defines two stress types. It is used for subjecting equipment to voltage stress, when the equipment presents a high impedance, or to current stress, when the equipment presents a low impedance.

The additional waveforms are the "Electrical Fast Transient Burst," first developed within IEC for electromagnetic compatibility purposes and adopted by IEEE in 1991, and the "Long Wave," which reflects field observations of surge occurrences. The 1991 version of C62.41 also included a 5-kHz ring wave to emulate capacitor-switching surges. This wave was removed from the menu, as data on the wide range of capacitor-switching surges made it clear that only case-by-case applications would be reasonable.

Equipped with these waveforms, Recommended Practice C62.45 provides information on instrumentation, considerations on tolerances in the output of surge generators, and descriptions of test procedures, including coupling of surges into test circuits. This enhanced version addresses issues raised by the shift from analog to digital instruments as well as the possible effects of aliasing, insufficient resolution, and transducer saturation. It also includes precautions for avoiding artifacts.

With the implementation of the new IEEE standards trilogy, designers and users of next-generation devices will be well equipped to tackle the surge environment of the future in low-voltage ac power circuits. Among the benefits they will realize are more cost-effective use of resources and greater reliability of electrical and electronic equipment. ■

François Martzloff is an Electronics Engineer at the National Institute of Standards and Technology (NIST) (www.nist.gov) in Gaithersburg, Maryland. He has been at NIST since 1985, after 29 years at General Electric, and has contributed to the development of IEEE and IEC standards since the late 1960s. He can be reached at f.martzloff@ieee.org.