SURGES AND TRANSIENTS

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Abstract - Introductory paper to the session "Surges and Transients" of the 12th International Zurich Symposium on Electromagnetic Compatibility

1. Introduction

Studies on surges and transients have been reported ever since the first Montreux EMC Symposium of 1975, and brought a long stream of significant contributions to our understanding of the root causes of transients on power and data lines, leading to more effective protection schemes.

This session continues the well-established tradition with seven papers ranging from an assessment of the surge threats to improved mitigation and protection. It is noteworthy that several of the papers involve computer modeling of the phenomena and mitigation mechanisms, a trend which has become more apparent in recent years, reflecting the development of better and more user-friendly computer hardware and software, and a growing body of evidence validating the use of such models.

Computer modeling of surge propagation and coupling can be successfully applied in the arena of surges and transients for several reasons:

- To simulate phenomena over which we have no control, typically lightning and nuclear electromagnetic pulses. On rare occasions, a lightning model can be compared to experimental measurements obtained from natural lightning. Recently, triggered lighting has provided a semi-controlled opportunity for validating computer models. In the case of nuclear electromagnetic pulse, the opportunity for validation of modeling has, hopefully, totally disappeared. However, the interest lingers, as evidenced by one paper in this session. Perhaps the information on this subject can be successfully transferred to peaceful concerns such as the fast transients associated with gas-insulated substations.
- To simulate phenomena which can be produced in the laboratory or by field tests, but which are expensive or place operating systems in jeopardy, so that the opportunity for validation must be limited to a few experiments -- after which the computer model can produce easily parametric variations with a high level of confidence.
- To predict the performance of nonlinear systems, where the intuition and "back-of-the-envelope" computations dear to pragmatic engineers can lead to erroneous conclusions. Such predictions also provide a reality check by showing how some assumptions or proposals made in the process of standards development can be on target or off the mark.

Five of the seven papers presented in this session will involve some of these forms and objectives of computer models. The last paper is an example of reality check based on combined field experience and laboratory measurements.

One subject where it has been found difficult to develop consensus is the modeling of lightning current distribution in installations. Part of the difficulty might be differences in the earthing practices postulated by the researchers, presumably reflecting the practices in their own country. Here also, the opportunity to apply computer modeling to the various postulated earthing practices should help the process of consensus-building.

Perhaps a solution to that problem might be to convene an international workshop devoted to the subject because it is an impossible challenge for any author to provide sufficient information when limited to a six-page paper and a twenty or less minute presentation. Nevertheless the papers in this session will offer an opportunity among the community of researchers to find out who is doing what, and perhaps plant the seeds for interest toward such a dedicated workshop.

2. Placing the papers in perspective

P2 - Coupling of a lightning wave to the internal wiring system of a Faraday shield

The motivation for this paper is to support the development of a test protocol concerning the effectiveness of a shield enclosure against the effects of a nearby lightning strike. The targeted end-users of the information are primarily the military and their hardware suppliers.

The three authors present a synthesis of experimental measurements on actual hardware, and a theoretical study of coupling mechanism, leading to an efficient data collection process.

P3 - Modelling of the current distribution generated by a direct lightning stroke in a low-voltage installation

This paper brings a new contribution to the consensus-building process presently underway among the developers of standards on surge protection and ratings of surge-protective devices. The question of how the lightning

current injected into a building by a direct strike will divide among the various available paths has been the subject of intense debate and speculation in technical committees and joint working groups of the IEC.

The authors present the case for adopting a more practical model of the lightning current, and apply it to a detailed study of a typical low-voltage installation with a variety of simulated loads and earth impedances.

P4 - Some results of an experimental study of high-intensity electromagnetic fields coupling to power line equipment

The digest of this paper proposes to present results of experiments conducted for assessing the effects of nuclear electromagnetic pulses on power system components. In that domain, surges in the nanosecond range are generally postulated, in contrast to other surges such as switching or lightning surges in the microsecond range.

The authors propose further investigations of nanosecond range phenomena on components as well as energized power systems.

P5 - Computer-aided design of nonlinear protection circuits

This paper addresses current concerns on the effectiveness of multi-stage protection schemes, in particular the issue of whether a cascade of surge-protective devices should feature descending or ascending limiting voltages as the wiring progresses from the service entrance toward the inside of a building.

The authors describe two models of numerical simulation, one based on a well-known circuit simulation software, the other on the direct solution by working backwards from the last stage of the cascade in iterative fashion. Applying these methods to practical cases will provide further insights in the consensus-building process.

P6 - A thermal and electrical model for MO-arrester degradation

This paper takes further the earlier contributions by the same team on the degradation process of metal-oxide varistors, a subject that has given rise to an range of concerns. It is an excellent example of how a model can take a device where no experiment has gone before because of inherent instability problems in actual hardware.

The authors also present a numerical example for determination of stability limit on a specific disc.

P-7 Lightning electric field data used for the design of surge protective devices

This paper presents an interesting combination of concerns on the coordination of cascaded surge-protective devices and experimental measurements of field intensity associated with remote lightning strike, in the context of negative versus positive return strokes.

From a large number of observations, the authors present conclusions on which parameters should be considered most significant to the design of an effective protection scheme

P8 - Using incandescent lamp failures for assessment of the surge environment

This paper provides the basis for one "reality check" on some of the current proposals for characterizing the surge environment. In a series of experiments in two separate laboratories, the authors identify the thresholds of surge-induced failures in common incandescent lamps, both the 120-V type and the 230-V type used in different countries.

Calling upon the common experience of observing normal end-of-life failure of light bulbs versus rare observations of lamp failures attributable to a surge, the authors propose empirical, realistic limits against which surges expectations can be assessed.