Cigré and the University

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SUMMARY

Although I am sure that other CIGRE members more qualified than myself could present this subject, I will try to summarize my experience during the eighteen years that I have been a member of the CIGRE WG D1.33 (previously called WG 33.03). I will remark the conclusions obtained from each experience referring to the advantages that CIGRE has given to my University (Polytechnic University of Madrid) and to my professional career within the University and within the Spanish electrical sector.

KEYWORDS

University, CIGRE, Task Forces, WG, R&D, international projects, standards, utility, electrical sector.

1. Introduction

When I entered into the working group WG 33-03 I was already the head of the High Voltage Department of LCOE and I was also "catedrático" in the Electric Engineering Department of the University School of Industrial Technical Engineering of the Polytechnic University of Madrid. The LCOE is a testing centre founded by the Polytechnic University and the Spanish Industry Ministry that is placed within the University Campus. LCOE co-operates with electrical industry, especially with the local industry, in order to carry out reports, calibrations and tests in accordance with the standards.

My entrance into the working group WG 33.03 of CIGRE "High Voltage Test and Measuring Techniques" was due to an international comparison of high voltage measurements. It was a European Project [1] to establish the European trazability in lightning impulse measurements between testing laboratories in order to recognize the tests carried out by any laboratory belonging to the European Union. At the beginning, I did not want to participate because my university was not prepared, but finally I decided to participate. I was convinced that at this date 1989 nobody knew of LCOE. In spite of having more time than the other partners to prepare my laboratory I was a month late in sending my measurements, but the effort produced good agreement in the results (see figure 1). Consequently, the seven participants (PTB, EDF, CESI, CERL, KEMA, EDP and LCOE), were able to establish the European trazability in lightning impulses measurements. Since that time, LCOE was considered another laboratory of the working group. After this, four additional measurement comparisons were organised by means of European Projects [2] to [5] to establish references in h.v. direct current, switching impulses and partial discharge measurements, in which LCOE also participated.

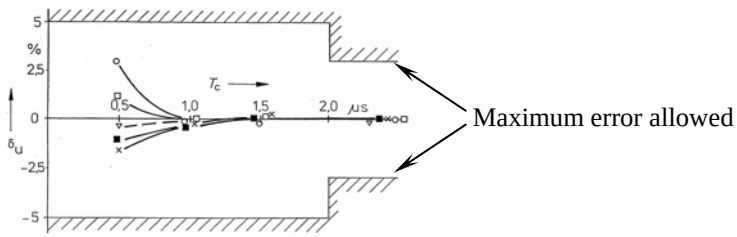

Figure 1. Differences between the peak values measured by the reference system of each participant laboratory and by the reference travelling measuring system for chopped impulses (0,5 µs, 1,0 µs, 1,5 µs and 2,0 µs) and full impulses.

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***1st conclusion**: The first time that a Department of the University participates in an international project can be considered a difficult challenge, but the University has powerful human and technical resources in order to get success in research and development projects.*

After several years of my participation in the WG 33.03, the chairman, Dr. Malewski, gave me the Task Force corresponding to the "evaluation of non standard lightning impulses when oscillations on the crest are superimposed". This Task Force was developed through another European Project [6], that was started in 1997 and ended in 2000. Five laboratories of the present WG D1.33 participated in this project (KEMA, Schering Institute, NGC, Graz University and LCOE).

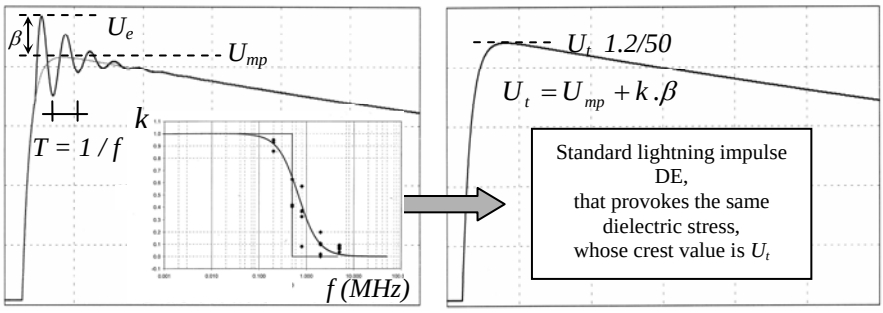


Figure 2. a) *K Factor Function* approach

The result of the project was the determination of the characteristic curve corresponding to the influence of the overvoltage, β, on the test voltage value, U_t, for several dielectric media (air, oil, XLPE and SF6). When the oscillation frequency of the overvoltage β, is less than 0.1 MHz the oscillation superimposed β, on the crest of an impulse U_{mp}, must be considered ($k \approx 1$) in the test voltage value, U_t,, but when the oscillation frequency is more than 5 MHz the influence on the test voltage U_t value is negligible ($k \approx 0$). Between both limits, the influence of the overvoltage β, on the test voltage value U_t, is defined by means of the experimental *k* curve shown in figure 2. On the basis of the work developed in this project more than 20 international papers have been written, two doctoral dissertations were performed, one in the University of Graz [7] and the other in the University of Madrid [8]. In addition, the *k* factor Function is being used as a relevant contribution in the new revision of the IEC 60060.1 [9].

***2nd conclusion**: The participation of the University in working groups of CIGRE creates the opportunity to establish contacts with other people belonging to research institutions. These contacts can lead to the carrying out of international Projects supported by International Research and Development Organisms.*

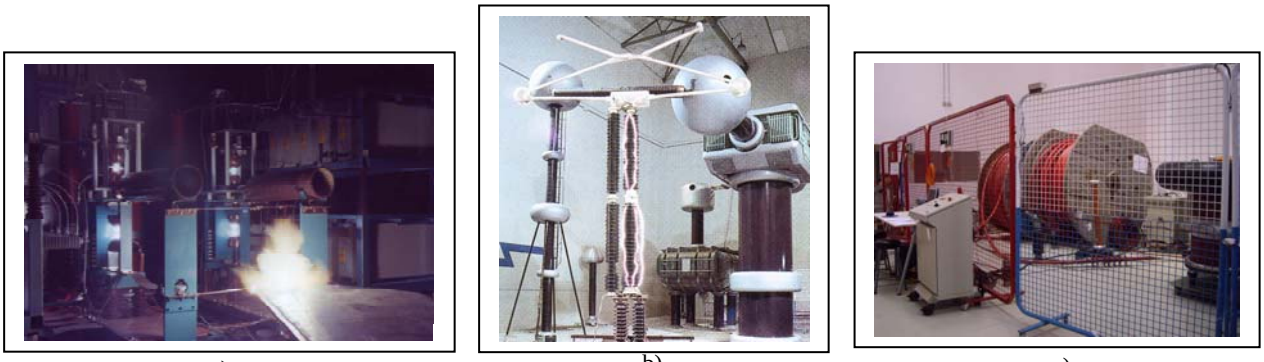
***3rd conclusion**: The results obtained by projects performed inside of Working Groups of CIGRE, in many cases, lead to new requirements or design criteria to be satisfied by electrical apparatus or by electrical installations that can be included within the international standards (e.g. IEC and EN). The University is proud to participate in international standardization improvements.*

2. Evolution of LCOE since my incorporation in CIGRE (1990)

The High voltage Laboratory of LCOE was created in 1949 to give technical services to the Spanish electrical sector by means of high voltage testing and measurements according to national and international standards. When I began leading the High Voltage Laboratory of LCOE in 1981 I was in charge of two people, a laboratory technician and a technician assistant to perform high voltage tests in the LCOE's high voltage lab. Today, eighteen years later, I lead five High Voltage Laboratories: the high voltage testing lab. in which I began, a high voltage calibration lab., a high current impulse testing lab., a set of h.v. mobile labs. and a Research and Development lab., where more than 25 people work (see figures 3 and 4). The most important LCOE's evolution took place several years

after my incorporation in CIGRE. Although it is not exactly correct to say that this growth was only caused by my incorporation in CIGRE, because other external factors could have also helped this growth (the Spanish economic growth, especially in the electrical sector, the increasing of the quality requirements for manufacturers, etc.), it is correct to say that my incorporation in CIGRE has been a relevant factor to promote this growth.

In the university's point of view the most important achievement of LCOE's growth has been the recent creation of a high voltage laboratory focused on R&D projects. In addition to the final career projects performed every year in this lab., different projects related to some Task Forces working lines of the CIGRE WG D1.33 (dielectric behaviour of insulating materials and PD measurements), are developed in there, many of them supported by the Spanish utilities (UFD, ENDES and REE).



a) b) c)

Figure 3. Inside labs. a) High current impulse lab. b) Main room of High Voltage lab. and c) R&D lab.

The five international projects related to the high voltage trazability described previously, [1] to [5], promoted the LCOE's development of a mobile high voltage calibration lab. to perform the calibration of approved measuring systems used by testing laboratories. In addition, thanks to these international projects LCOE was recognised by the Spanish Metrological Centre (CEM), by means of the Royal Decree 346/2001, as the high voltage reference centre in Spain to maintain the standards and to assure the trazability in h.v. measurements (direct current, alternating current, and transient impulses).

In addition, on site ratio and phase measurements are an efficient method to detect small short-circuits in the capacitors belonging to capacitive voltage transformers. A mobile standard transformer with an appropriate ratio bridge is a good system to obtain these measurements. I must thank Dr. Bergman from the Swedish calibration SP laboratory (member of the WG D1.03 of CIGRE), who developed his doctoral dissertation [10] about the design, implementation and the calibration uncertainty of a mobile reference measuring system for this subject, which has been the basis of LCOE's mobile calibration laboratory (see figure 4). This system allows also the performing of on site calibrations of inductive transformers used for energy measurement purposes.

a) b) c)

Figure 4 Mobile Labs: a) for on site ratio and phase measurements in CVTs up to 400/√3 kV, b) Resonant generator for testing of high voltage cables (240 kV, 83 A) and c) Resonant generator for testing of GIS (250 kV, 9 A).

After installation of medium and high voltage cables and GIS, it is convenient to verify the insulation condition by means of resonant high voltage generators. I would like to thank Dr. Hauschild, member of WG D1.33, for his papers related to the advantages of this testing installations that motivated LCOE to the buying of three resonant systems and to increase our knowledge of on site PD measurements.

***4th conclusion**: Utility problems are very similar in all countries throughout the world. Many solutions must be developed by means of research projects in which the university can play a very important role. When the university participates in CIGRE working groups R&D projects can be performed in co-operation with utilities. Through these projects new testing facilities can be acquired or developed by the university.*

3. Personal advantages since my participation in CIGRE

In parallel to the evolution of LCOE my professional trajectory has grown significantly after my entrance in CIGRE. Similarly to the explanation described for LCOE, it is not totally correct to say that my career evolution has been due only to my participation in CIGRE, but I am totally convinced that it has helped me very much. In the following paragraphs I will describe the responsibilities, appointments and considerations that the University, the Spanish Industry Ministry and the electrical sector has given me after my entrance in CIGRE.

- The papers published in international magazines and the international projects developed with members of CIGRE WG D1.33 were very useful to obtain from the Polytechnic University of Madrid a special appointment of my Research Capability.
- The five international projects about high voltage trazability referred in [1] to [5] together with other works performed with other members of the WG D1.33, helped me to be a designated member of the Scientific Committee of the Spanish Metrological Centre.
- The Spanish Accreditation Centre (ENAC) appointed me chairman of the Electrical Subcommittee of accredited laboratories taking into account, between others merits my participation in CIGRE.
- Also the Technical Subcommittee of High Voltage Testing Techniques of the Spanish Standardization Organism (AENOR) appointed me chairman of this Subcommittee.
- Finally, since 1993 I have been the coordinator of the Working Group of Technical Management in the High Voltage Sector of the Spanish Industry Ministry, in which the mandatory regulations are reviewed and developed. For example, in March of this year a new Spanish regulation about overhead electrical lines and underground electrical lines was published.

Consequently, I must recognise that these appointments have promoted my participation in any relevant Spanish electrical event or in any big electrical incident that happens in Spain, this shows my real connection within the Spanish electrical sector.

***5th conclusion:** The evolution of the professional careers of professors and lecturers in the University and in the electrical sector is very positively influenced by the participation in working groups of CIGRE.*

Conclusions

The five conclusions described in this paper from my personal experience in CIGRE show that CIGRE is a good way for professors and lectures to perform real and useful R&D projects in co-operation with the electrical sector, which besides solving the utilities problems, it can help to improve the university facilities and the curricular trajectory of the University educators.

Acknowledgements

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BIBLIOGRAPHY

[1] "International comparison of High Voltage Impulse Measurements 100 kV" supported by the E.U. Contract nº 3163/1/0/124/87/7-BCR-D(30). 1988-1990.

[2] "International comparison of software for evaluating high voltage impulses" supported by the E.U. Contract nº 3433/1/0/124/91/5-BCR-D(3). 1992-1993.

[3] "Intercomparison of Impulse Measuring Systems at 600 kV Level" supported by E.U:. Contract nº 3459/1/0/197/92/3-BCR-D(30). 1993-1994.

[4] "International comparison of 100 kV DC and SI Voltage Measuring System with DC/SI voltage Standard DWINA-100" 1996-97.

[5] "International comparison of Impulse Charge Measurements" supported by E.U.. Contract nº SMT4-CT95-7501. 1996-1998.

[6] "Digital Measurement of parameters of Lightning Impulses" supported by E.U.. Contract nº SMT4-CT95-7501. 1997-1999

[7] S. Berlijn, "Influence of lightning impulses to insulating materials" Ph. D. dissertation, Institut f. Elecktrische Anlagen u. Hochspannung-stechnik, Tech. Univ. Graz, Austria, 2000.

[8] P. Simón, "Research of the characteristic parameters of the dielectric media behaviour with h.v. non standard lightning impulses", Ph D. dissertation, Elect. Eng., Polytechnic Univ. Madrid. Spain, 2004.

[9] IEC 60060-1 "High Volt Testing Techniques. Part 1 General Definitions and Test Requirements".

[10] A. Bergman "In situ Calibration of Voltage Transformers on the Swedish National Grid" Uppsala Dissertation from the Faculty of Science and Technology, 1994.