



## 2nd International Advanced Research Workshop on Modern Transformers - ARWtr2007.

29 -31 October 2007. Baiona, Spain

### Summary Report

The aim of the 2nd International Advanced Research Workshop on Modern Transformers - ARWtr2007 was to provide a meeting of specialists among industrial and academic world and promote an intense exchange of knowledge about new trends and issues on modern transformers as well as fruitful personal contacts which permit to establish interest of collaboration.

This time 2<sup>nd</sup> ARWtr2007 was held in impressive and charming medieval royal castle, transformed inside into luxury Hotel and convenient conference hall with all necessary arrangements and rooms.

In contradictory to typical crowded conferences, it was rather meeting of erudite experts, representatives of manufacturers, power utility and research groups - both from universities and independent.

Whereas 1st ARWtr2004 has had rather character of review of the state of the art in design, maintenance and monitoring of different contemporary transformers, from very small of high frequency "electronic" components, through biggest group of power units, to special instrument equipment. The 2<sup>nd</sup> ARWtr2007, on special request of power transformer companies, was limited to power transformers only. This approach, was more narrow, but assured more deep and high level of very professional and specialised discussion, immediately useful for practice and planning of more rational researches, both applied and fundamental.

Since market and power delivery is the decisive criterion and driver of this activity, the introductory lectures of leading personalities of international transformer community were very timely and helpful for planning both in manufacturing and reasonable researches.

They were lectures of Mr:

- *Pierre Boss* (Chairman CIGRE SC A2 Transformers): "Presentation of CIGRE A2 (Transformers) Technical Developments and Input from Current Activities"
- *Thomas Fogelberg* (ABB Transformers Ludvika): "Reliability of Power Transformers - Important Aspects to Dive the Industry to Focus and Quality", as well as that of:
- *G. Anderson* (Representative & Officer of IEEE Transformer Committee), *F. Soto* (CIGRE Spain), *J. Penedos*, (CIGRE Portugal), *H. Moore* and other recognized specialists.

Significant part of discussion was under impression of some common distinctive phenomenons (*Signum temporis*) of present time, like:

- 1) "...Demand for new power and distribution transformers has recently risen sharply with most factories with full order books, whilst at the same ...raw material prices have also risen rapidly (to 80% or more of total price) which together has lead to significantly higher prices. The stable environment of recent years - the buyers market has gone"... [1], [2], [3].
- 2) Demand for higher reliability and life time (To 40 years or more) have also risen [1], [2].
- 3) Growing demand for new products is accompanied by deficient in new qualified engineering human resources due to points (1) and (2), which forces to return to still very knowledgeable, retired specialists [2].



- 4) Unfortunately, students prefer nowadays to study rather “management and economics or computer science” than more “difficult” and “less profitable” “design” specialisation, based on higher mathematics and physics. It needs therefore special support of interested manufacturers for corresponding specialist departments at universities.
- 5) ... “Worldwide expertise and knowledge has increased significantly over the last 100 years and this has led to better understanding of the key issues, better designs and generally more reliable transformers” [2]. This opinion is right, but concerns mainly 2-D calculation of active parts of transformers. However, 3-phase, 3-D region outside core windows needs still use new, rapid approach [4]. This point in “Mechatronic terminology” can be called as “Knowledge Base” in “Expert System” [5].
- 6) Another feature of present time is an intensive, even if not always fully conscious, application of Mechatronics principles [5] at design and manufacturing process, especially the:  
Rapid Design, Simple design tools based on deep fundamental research, Expert system with more intensive fuse of corresponding directives of “Knowledge Experts” (3), supported by enthusiasm and energy of young “Knowledge engineers” [6], which often are a diploma students.

Also characteristic for this meeting was noteworthy participation of new generation of well informed young specialists, who shifted remarkable ahead our professional knowledge.

One of Mechatronic principle is also the seemingly paradoxical remark of *Negroponte* from MIT, USA, that “*Permanent improvements are the biggest enemy of innovativeness*”. It rightly says that big progress is possible only at brave innovations [7].

It is not so easy to create remarkable innovation in this traditional science. Also here, it was not so many revolutionary news. Such novelties like e.g. “Metglass” or superconductivity are still waiting for more broad application in regular power transformers. Only the work of Professor B. Grzesik et al. [P14] on “High Temperature Superconductor Transformer...” delivered some hope for progress in this field.

But instead, it appeared a big progress in broad application of computer science and automatisation.

The last decades have demonstrated enormous progress in the development of hardware and especially sophisticated software for solution of complicated, non-linear, 3-D fields.

However, one should select carefully a method most suitable for a given case. For instance, the traditional *Biot-Savart's* law has proved as one of the best for calculating losses and hot-spots in transformer covers [8]. At the same time, for tank walls, the most popular general method FEM-3D, is still considered as “*not useful for regular design use*” [9]. FEM-3D may need several dozens, if not hundreds, of hours of work of highly qualified specialist and expensive software. Albeit from that time a big progress was made in hardware, it is still some dozens hours. This is why in transformer works traditional two-dimensional models, as well as semi-empirical formulae are still used. Thanks to the introduction of semi-empirical correction coefficients, they can sometimes deliver results close to the real ones. Unfortunately, they are poorly justified and often comprise controversial information. The interesting reports from the Poster Session 2 on joint analysis of TEAM Benchmarks Problems only confirmed that factory designers continually, since Tianjin'00 and Shenyang'01 [10] ICEM Conferences, have not practical tool for 3D stray loss calculation and screen/shunts design.



In this case the hybrid, 3-D equivalent reluctance network method, based on expert-system approach [3]-[7], proposed already during those Conferences, seems still to be one of the most rapid, intelligible and convenient method for such class of problems.

The presentations and discussions at ARWtr07 involved many important aspects which can be classified as follows:

- Management of technical and power system developments (Lectures: 1 -J. Penedos, 2 -P. Boss, 3 -H. Moore, 5 -M. Oliva<sup>1</sup>)
- Reliability, quality and protection of transformers (Lectures: 4 -T. Fogelberg, 7 -M. Gubanski, 18 -E. Perez-Moreno, 19 -H. Gago Garcia , 14 -E. Lesniewska, P5 -R. Nowicz, P1<sup>2</sup> -J.C. Carneiro, P4 -C. Gonzalez, P7 -S.G. Otmorskiy, P8 -A.D. Shendge);
- Computation and problems of windings (Lectures 11 -R. Malewski, P16 -P.M. Joshi, 15 -S.V. Kulkarni);
- Computation and problems of cores (Lecture P10 -E. Ramaswamy, P13 -Z. Cheng);
- Computational methods and software (Lectures P9 -G. Joginadham, P11 -Z. Cheng, P12 -B. Cranganu-Cretu);
- Heating and cooling (Lecture 12 and 13 -P.J. Gomes);
- Life management and monitoring of transformers (Lecture 17 -A.J. Kachler, 16, P2 -J.L. Velasquez Contreras, P3 -E. Rivas);
- Noise and vibration (Lecture 10 -J. Puri);
- Optimal selection between different power transformers and core types (Lecture P6 -M. Stepień);
- Stray losses, screening and local excessive heating hazard (Lectures 8 -J. Turowski, 9 -X.M. Lopez-Fernandez);
- Materials (Lecture 6 -B. Heinrich, P14 -B. Grzesik);
- Replacement and Refurbishments (Lecture 16 -J.F. Martins).

All these aspects and papers overlaps often each other and sometimes cover several area of design, maintenance and management. However all of them are extremely interesting and valuable contribution to our current and future work and study.

During the heavy activity, the Organiser and Sponsors delivered us also unforgettable attractions of Spanish and Portuguese national see-food kitchen and wine caves.

Both organisers, sponsors and every of us, each-other, express the warmest thanks for this fantastic meeting and discussions, which will profit to our work till next similar meeting.

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<sup>1</sup> Here and next only first of Authors is cited. Numbers after order in the Program.

<sup>2</sup> P1, P2, etc. means Poster Papers



## References

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