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Editorial for the Special Issue "Transformer Research and Asset Management"

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***Summary* — Welcome to this Special Issue, which features selected papers presented at the 7th International Colloquium CIGRE SC A2 – "Transformer Research and Asset Management", held in Cavtat, Croatia, from May 6–9, 2026. The primary goal of the Colloquium was to share the latest research and developments in the fields of distribution, power, and instrument transformers. The technical program was divided into three core thematic sessions: Modelling and Simulation (M&S), Transformer Life Management (TLM), Materials, Components and New Technologies (MC&NT). Out of the 75 papers presented at the Colloquium, 28 belonged to the M&S category, 17 to the TLM category, and 30 to the MC&NT category. This Special Issue proudly presents 12 carefully selected and extended papers originating from the Modelling and Simulation (M&S) category.**

***Keywords* — Transformers, Computational modeling, multi-physics simulations, Transients, Frequency response**

I. Introduction

The 7th International Colloquium CIGRE SC A2 – "Transformer Research and Asset Management", held in Cavtat, Croatia, from May 6–9, 2026, was organized by the Croatian CIGRE National Committee in cooperation with the University of Zagreb Faculty of Electrical Engineering and Computing and the Centre of Excellence for Transformers in Zagreb, with the support of the CIGRE A2 Study Committee.

The main objective of the Colloquium was to exchange cutting-edge research and advancements concerning distribution, power, and instrument transformers. Participants representing manufacturers, utilities, and universities engaged in fruitful discussions across 75 presentations, consisting of 27 oral presentations—including 3 invited keynote lectures—and 48 poster presentations. The technical program of the Colloquium was divided into the following three thematic sessions:

The Modelling and Simulation (M&S) session featured 28 presentations on the topics:

- Numerical modeling in design, multi-physics and coupled problems
- Transients, harmonics, lumped and distributed parameter models
- Machine learning and hybrid models, models for digital twins
- Transformer Life Management (TLM) session featured 17 presentations covering the topics:
- Transformer components, insulating and magnetic materials
- New concepts and technologies in the transformer industry
- Digitalization and smart grid applications.
- The Materials, Components and New Technologies (MC&NT) session featured 30 presentations on the topics:
- Monitoring, diagnostics and condition assessment
- In-service experiences and case studies
- Environmental aspects and resilience.

Out of the 28 papers presented in the Modelling and Simulation (M&S) category, this Special Issue brings together 12 peer-reviewed papers.

II. Themed Overview

A significant portion of the 12 selected papers focuses on the interaction between power transformers and the grid, particularly during high-frequency transients. One paper, in line with the CIGRE WG A2.63 research objectives, emphasizes that non-standard overvoltages, often caused by switching or lightning, differ significantly from standard test impulses and can lead to internal resonance and unexpected dielectric failures [1]. Expanding on this, another paper addresses the challenge of Very Fast Transient Overvoltages (VFTO) originating from gas-insulated substations (GIS), outlining state-of-the-art dielectric design methodologies to ensure transformers can withstand these unique high-frequency waveforms [2]. To accurately assess the impact of transformer transients, advanced modelling of transformer windings is required. One study proposes enhancing constant inductance models by incorporating frequency-dependent inductance matrices, which significantly improves the accuracy of internal winding resonance predictions [3]. Similarly, another paper introduces a detailed and computationally efficient model, as a practical alternative to complex Multi-Transmission Line (MTL) models, that uses simple RLCM elements to accurately represent each turn of a disc winding up to 2 MHz for fault detection [4]. Furthermore, another paper evaluates the severity of non-standard overvoltages using both Frequency Domain Severity Factors (FDSF) and Time Domain Severity Factors (TDSF) across various disc winding

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arrangements, concluding that a combined metric approach offers a more robust assessment of the impact on transformer insulation [5]. The impact of alternative dielectric liquids, such as natural esters versus mineral oil, on ultra-high frequency (UHF) partial discharge signal propagation is investigated, revealing how different propagation paths affect PD source localization [6]. One paper proposes a hybrid multi-criteria decision-making algorithm that unifies multiple time-domain dielectric response measurements and 2-furaldehyde levels into a decision tree framework for accurate insulation health assessment [7].

Thermal, mechanical and electromagnetic analyses also play a crucial role in modern transformer design. Based on loss distributions obtained from electromagnetic simulations, a coupled thermal-hydraulic and thermal network approach is presented to predict three-dimensional temperature distributions, capturing both radial and axial gradients to accurately identify hotspot locations [8]. The influence of geomagnetically induced currents (GIC) on power systems is analyzed in [9], demonstrating how these quasi-direct currents lead to transformer saturation, excessive heating, and the generation of harmonics. Another paper highlights the necessity of using sophisticated hysteresis models, such as the Preisach model, to calculate magnetic fields in the ferromagnetic material when excitation deviates from a pure sine wave [10]. The mechanical and acoustic behavior of transformers is addressed through a comprehensive numerical vibroacoustic analysis of a 380 MVA transformer. By coupling the structural components with the acoustic fluid, the authors successfully evaluated pressure distribution and tank vibrations, offering optimization solutions to prevent local resonance modes [11]. Finally, to accelerate transformer development lifecycles, a scalable web-based application developed in Python is introduced, democratizing access to complex multi-physics simulations and 3D result visualizations across various devices [12].

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References

[1] E. Rahimpour, Á. Portillo, and B. Jurišić, "Non-standard, high frequency power system transients," *Journal of Energy (Energija)*, vol. 75, no. 3, 2026, doi: 10.37798/2026753752.

[2] Á. Portillo, "Design of transformers for very fast transient overvoltages," *Journal of Energy (Energija)*, vol. 75, no. 3, 2026, doi: 10.37798/2026753753.

[3] M. Eslamian, E. Rahimpour, and K. Sethi, "An investigation on the effect of frequency dependent inductance calculation on high frequency modeling of transformer winding," *Journal of Energy (Energija)*, vol. 75, no. 3, 2026, doi: 10.37798/2026753754.

[4] J. Piri, H. R. Mirzaei, M. B. Ghorbal, and E. Rahimpour, "An accurate detailed model for transformer disc windings suitable for medium frequency range," *Journal of Energy (Energija)*, vol. 75, no. 3, 2026, doi: 10.37798/2026753779.

[5] M. Meuser, E. Rahimpour, and M. Eslamian, "The abilities of TDSF and FDSF in analysing voltage distribution in different types of disc windings of power transformers," *Journal of Energy (Energija)*, vol. 75, no. 3, 2026, doi: 10.37798/2026753781.

[6] D. Dukanac, "Impact of alternative dielectric liquids on UHF partial discharge signal propagation and source localization in power transformers," *Journal of Energy (Energija)*, vol. 75, no. 3, 2026, doi: 10.37798/2026753790.

[7] M. Teruvai and S. V. Kulkarni, "Assessment of transformer insulation by decision trees using a combinational weighting model," *Journal of Energy (Energija)*, vol. 75, no. 3, 2026, doi: 10.37798/2026753763.

[8] A. Al-Abadi, W. Wu, and I. Woyna, "A coupled thermal-hydraulic-electromagnetic network approach for three-dimensional hotspot calculation of transformers," *Journal of Energy (Energija)*, vol. 75, no. 3, 2026, doi: 10.37798/2026753770.

[9] A. Gloc, B. Jurišić, and B. Filipović-Grčić, "Geomagnetically induced currents and influence on power transformer saturation," *Journal of Energy (Energija)*, vol. 75, no. 3, 2026, doi: 10.37798/2026753768.

[10] S. Frljić, B. Trkulja, and A. Drandić, "The influence of hysteresis modeling on the calculation of magnetic fields," *Journal of Energy (Energija)*, vol. 75, no. 3, 2026, doi: 10.37798/2026753789.

[11] M. Gillet, B. Bosnjak, H. Landes, and N. Kewat, "Numerical vibroacoustic analysis of a large transformer tank including structural and noise optimization," *Journal of Energy (Energija)*, vol. 75, no. 3, 2026, doi: 10.37798/2026753755.

[12] H. Dodiya, I. Woyna, and L. D. Mercato, "Advanced scalable WebApp approach for automated simulation of transformer components using Python," *Journal of Energy (Energija)*, vol. 75, no. 3, 2026, doi: 10.37798/2026753791.

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