

IEEE Power Engineering Society

EMC - 2017 Annual Report

Entity: ELECTRIC MACHINERY COMMITTEE

Chair: Kiruba HARAN
Vice-Chair: Kay CHEN
Secretary: John YAGIELSKI

1. Significant Accomplishments

The activity and accomplishments of the Electric Machinery Committee continued in 2017 at a high level with contributions in terms of industrial standards, panel sessions, paper submissions, liaisons, and engagement in new initiatives. The significant items are listed below, and the plans for 2018 are given in section 7. Highlights for 2017 include PES EMC lead sponsorship of the highly successful 2017 IEMDC conference. To attract the next generation of volunteers, the first EMC meeting outside of the General Meeting in several years was held at IEMDC as well.

1.1. Standards

In 2017, the update to standard "IEEE 112: Test Procedure for Polyphase Induction Motors and Generators." was approved. There are active working groups for the following standards, with several expected to complete in 2018:

- **GSC WG3 [P1665]:** *Guide for the Rewind of Synchronous Generators, 50 Hz and 60 Hz, Rated 1 MVA and Above*
- **GSC WG7 [P115]:** *Guide for Test Procedures for Synchronous Machines Part I--Acceptance and Performance Testing Part II--Test Procedures and Parameter Determination for Dynamic Analysis*
- **GSC WG8:** *Harmonization of IEC and IEEE Concerning IEEE C50.13*
- **GSC WG10 [P1110]:** *Guide for Synchronous Generator Modeling Practices and Parameter Verification with Applications in Power System Stability Analyses*
- **MSC WG12:** *Discussions/Revision of 1415*
- **MC [P56]:** *IEEE Guide for Insulation Maintenance of Electric Machines Rated 35 kVA and Higher*
- **MC WG1434:** *IEEE Guide to the Measurement of Partial Discharges in Rotating Machinery*
- **MC WG1553 [P1553]:** *IEEE Test and Acceptance Criteria for Voltage-Endurance Testing of Form-Wound Coils and Bars used in Hydroelectric Generators and Large Pumped Storage Motors*
- **MC WG1719:** *IEEE Guide for Evaluating Stator Cores of AC Electric Machines Rated 1 MVA and Higher*
- **MC WG1812:** *Working Group IEEE 1812 Request*

1.2. PARS

The following PARS are active in 2017:

- **P62.2** (Revision): *IEEE Guide for Diagnostic Field Testing of Electric Power Apparatus - Electrical Machinery*
- **P112** (Revision): *IEEE Standard Test Procedure for Polyphase Induction Motors and Generators*
- **P433** (Revision): *Recommended Practice for Insulation Testing of AC Electric Machinery with High Voltage Rating up to 30 kV at Very Low Frequency*
- **P1665** (Revision): *Guide for the Rewind of Synchronous Generators, 50 Hz and 60 Hz, Rated 1 MVA and Above*
- **P11** (Revision): *Standard for Rotating Electric Machinery for Rail and Road Vehicles*
- **P115** (Revision): *Guide for Test Procedures for Synchronous Machines Part I--Acceptance and Performance Testing Part II--Test Procedures and Parameter Determination for Dynamic Analysis*
- **P1110** (Revision): *Guide for Synchronous Generator Modeling Practices and Parameter Verification with Applications in Power System Stability Analyses*
- **P1553** (Revision): *Standard for Voltage Endurance Testing of Form-Wound Coils and Bars for Hydrogenerators*

1.3. Task Forces

Due to the continued high level of discussion on the topic of evolving grid codes, their impact on large machine design and performance, and the alignment of the associated IEEE standards, a task force was launched in 2015 to review the topic and make recommendations for further activity.

- ***IEEE Task Force on the Impact of Grid Codes on Generator Design and Standards***

This task force is making extremely good progress with regular online meetings, and effective use of the IEEE *Collabratec* platform for document sharing and collaborative work. The WG ran a well-attended Panel Session on the Coordination of Grid Codes and Generator Standards (see section 1.4 below). The work is expected to complete in 2018.

1.4. Panel Sessions

At the 2017 General Meeting in Chicago, the EMC subcommittees held several successful and well-attended panel sessions on a variety of topics:

- Coordination of Grid Codes and Generator Standards
- Advanced Topics in Electrical Machines
- Advanced Motors and Drives for Transportation
- Operating the power system without synchronous machines
- Marine Hydrokinetic Generation
- Condition Monitoring of Electrical Machines
- Reactive power capabilities of wind turbine

2. Benefits to Industry and PES Members from the Committee Work:

The IEEE PES Electric Machinery Committee constitutes a forum of experienced, well-qualified engineers active in all walks of industry where electrical machines constitute an integral element in their successful operation and development.

Specifically, the EMC provides the following benefits:

- Provision and maintenance of standards that set benchmarks and define requirements for consistent design, quality and performance of electrical machines from a power of 10 MVA up to the largest electrical machines in the world at 2000 MVA.
- Set-up task forces and study groups to constantly review the scope, alignment and applicability of the standards to the evolving industry needs.
- Organize panel sessions at the IEEE PES General Meetings to present new developments in the field of electrical machines, and promote active discussion on evolving topics of interest and concern to both academia and industry.
- Contribute to technology roadmap activities as new electrical machines and drives technologies are adopted in multiple industries – including transportation, renewable energy, and the oil & gas sector.
- A forum of engineers providing a resource of broad and deep knowledge and experience in the field of electrical machines, from which both young and experienced engineers can draw inspiration in their work and career development.

3. Benefits to Volunteer Participants from the Committee Work:

The work of the IEEE provides the opportunity for engineers, both young and old, to share technical knowledge, experience, opinions and concerns on a huge variety of topics within the field of electrical engineering.

Additionally, by participating in the development and revision of standards, volunteers can actively contribute to the very documents that determine the design and performance of the equipment they design and study, and provides the opportunity to advance their knowledge and understanding of the underlying concepts, reasoning and criteria.

In contributing to the papers and presentations, volunteers can enhance and promote their own knowledge and expertise to a wide audience of like-minded professionals.

4. Recognition of Outstanding Performance:

In 2017 the following awards were presented within the Electric Machinery Committee as recognition of the contributions made to both the IEEE PES and the EMC in particular.

EMC PRIZE PAPER AWARDS:

- X. Chen, J. Wang, V. Patel & P. Lazari, “A Nine-Phase, 18-slot, 14-pole Interior Permanent Magnet Machine with Low Space Harmonics for Electric Vehicle Applications,” in Transactions on Energy Conversion, Vol 31, No. 3, September 2016, pp. 860-781.

This paper was also recognized as the Best Paper at the Power & Energy Society level.

- J. Bayless, N. Kurihara, H. Sugimoto and A. Chiba, “Acoustic Noise Reduction of Switched Reluctance Motors with Reduced RMS Current and Enhanced Efficiency,” in Transactions on Energy Conversion, Vol 31, No. 32 June 2016, pp. 627-636.
- R. Wang, S. Pekarek, M. Bash, A. Larson & R. Van Maaren, “Incorporating Dynamics in Mesh-based Magnetic Equivalent Circuit Model of Synchronous Machines,” in Transactions on Energy Conversion, Vol. 30, No. 3, September 2015, pp. 821-832.

EMC DISTINGUISHED SERVICE AWARD:

The distinguished Service Award went to **Robert Thornton-Jones**.

FELLOWS:

Two members of the EMC were recognized as IEEE Fellows: **Juri Jatskevich** (EMC) and **Sang Bin Lee** (AIS).

Congratulations for all for their continued commitment and contribution to the work of the EMC.

5. Coordination with Other Entities (PES Committees, CIGRE, standards, etc.):

The Electric Machinery Committee liaises with the following IEEE committees and institutions which share common fields of interest:

- ***IAS: Industry Applications Society***
Related topics on the applications of electrical machines. Additionally, the IAS and PES are sponsors of The International Conference on Electrical Machines and Drives (IEMDC) in which the EMC is actively involved.
- ***PSRD: The Power System Relay Committee***
The PES has responsibility for relay protection tasks, some of which are of interest to the Electric Machinery Committee in that they provide protection and control functions for electric machines.
- ***ISO: International Organization for Standardization***
The ISO issues several technical standards which are of relevance to electric machines, e.g. regarding the measurement of noise and vibration, and recommended vibration limits.
- ***IEC: International Electrotechnical Commission***
CIGRE: International Council on Large Electrical Systems
The IEC issues standards on the design and performance of electrical machines which complement those of the IEEE. There is a strong liaison with common participants who work to align the requirements of these standards where conflicts and unnecessary deviations are evident.
CIGRE does not issue standards, but has Study Committees and Advisory Groups in the field of rotating machines that survey current industry practices and experience, and issue reports, guidelines, brochures and tutorials. Several EMC members participate in both CIGRE and IEEE working groups and conferences.
- ***IEEE Transportation Electrification Community***
The IEEE Transportation Electrification Community coordinates broad activities throughout the IEEE in the growing electrification revolution across transportation domains, including advances in electric and hybrid cars, more-electric ships and aircraft, rail systems, personal transport, and the motive, storage, power grid, electronic intelligence, and control technologies that make them possible. The outgoing EMC Chair, Kiruba Haran, represents PES in the TEC Steering Committee.

6. New Technologies of Interest to the Committee:

In past years ‘new technologies’ have focused predominantly on superconducting machines, and the EMC ran a working group on this topic for some years. Whilst this remains a topic of interest, the introduction of the technology into rotating equipment has been limited due to commercial viability (material costs, performance and reliability) and technical challenges (winding design and cooling technologies when used in rotating equipment). It continues to be of interest in special applications where space is at a premium.

On large machines, there is an increasing focus on better availability through reduced down-time facilitated by developments in on-line monitoring and predictive maintenance. The EMC has responded to this with an updated guideline on monitoring (IEEE Std.

1129), and follows technology developments in related instrumentation, measurement and diagnostic techniques (e.g. fiber optic devices), for inclusion into the appropriate testing guides (IEEE 112 & IEEE 115).

With the advent of renewable energy initiatives around the world, the EMC new technology focus has shifted towards the understanding and mitigation of the impact of these fluctuating power sources on both machine and grid performance. In particular:

- Increased performance of thermal plant demanded by evolving grid codes across the world (see task force in clause 1.3)
- Higher variations in load, and a more rapid ramping of load changes, leading to greater thermal and mechanical cycling of components
- Greater resilience in withstanding grid faults and loss of power to avoid complete plant shutdown
- The use of power electronics to enhance stability

Another emerging application of electric power technologies is in electric aircraft, and IEEE PES is helping to shape this space. Experts from EMC are partnering with NASA to chart out a technology roadmap for MW scale machines and drives. Initiated in 2016, this collaboration continued and expanded in 2017. This has led to a partnership between IEEE and AIAA, with a joint Symposium to be held in Cincinnati in July 2018.

7. Significant Plans for the Next Period:

In 2018 the EMC will continue to work on the standards that are the mainstay of its contribution to industry, but will also strive to bring the work carried out within the EMC and the benefits to a wider audience, and broaden its appeal to younger engineers.

Specifically:

- To attract the next generation of volunteers, we hope to hold additional EMC meetings at venues other than the PES General Meeting. The effort was initiated in 2016, with the first session at the IEMDC conference in 2017.
- Closer cooperation with the Excitation Subcommittee of Power Generation related to the work on grid codes, and NERC / FERC regulation changes.
- Pursue collaborative opportunities with EPRI.
- Continue joint conferences with the IEEE Transportation Community and AIAA on electrification of commercial transport aircraft.