

IEEE Power Engineering Society Entity 2016 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 2016 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 2017 are given in section 7.

1.1. Standards

Following 2015, where 4 standards were completed, there were no new standards completed in 2016. However, there are active working groups for the following standards:

- **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 WG9 [P1812]:** *Guide for Testing Permanent Magnet Machines*
- **MSC WG10:** *IEEE 112 – Standard Test Procedure for Polyphase Induction Motors and Generators*
- **MSC WG11:** *Condition Monitoring of Electric Motors*
- **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 were approved in 2016:

- **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*
- **P1812** (Revision): *Guide for Testing Permanent Magnet Machines*
- **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*
- **P110** (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).

1.4. Panel Sessions

At the 2016 General Meeting in Boston, 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 2016 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:

- V. Nasirian, A Davoudi, F Lewis, J Guerrero: Adaptive Droop Control for DC Distribution Systems, Transactions on Energy Conversion, Vol. 29, No. 4, December 2014, pp. 944-956

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

- E. Prieto-Araujo, Junyent-Ferré, D. Lavèrnia-Ferrer, O. Gomis-Bellmunt: Decentralized Control of a Nine-Phase Permanent Magnet Generator for Offshore Wind Turbines, Transactions on Energy Conversion, Vol. 30, No 3, September 2015, pp. 1103-1112.
- A. Chiba, K. Kiyota, N. Hoshi, M. Takemoto, S Ogasawara; Development of a Rare-Earth-Free SR Motor with High Torque Density for Hybrid Vehicles Transactions on Energy Conversion, Vol. 30, No. 1, March 2015, pp. 175-182.

CYRIL VEINOTT AWARD:

This year the Cyril Veinott Award was presented to **Bill McCown** (Generator Subcommittee) at the 2016 Awards Dinner.

EMC DISTINGUISHED SERVICE AWARD:

The distinguished Service Award went to **Alexsanda Jeremic** (Materials Subcommittee).

FELLOWS:

Two members of the EMC were recognized as IEEE Fellows: **Clyde Maughan** (Generator Subcommittee) and **Ping Zhou** (Motors Subcommittee).

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 current 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).

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. In April of 2016, technical experts and thought leaders from academia, industry and the U.S. government participated in a workshop co-sponsored by the IEEE, Grainger CEME and NASA, to generate a roadmap of transformational technologies for large electrical machines that can enable future electric/hybrid-electric airplanes and off-shore wind turbines.

7. Significant Plans for the Next Period:

In 2017 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:

- PES EMC is the lead sponsor of the 2017 IEMDC conference. The current Motor Subcommittee chair, and the past EMC chair, are co-chairs of the conference.
- To attract the next generation of volunteers, we will hold additional EMC meetings at venues other than the PES General Meeting. The ideas and planning will be elaborated in 2016; the first ‘event’ will be held during 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.
- Plan a joint conference with the IEEE Transportation Community and AIAA on electrification of commercial transport aircraft. Consider scheduling this next to an existing AIAA conference – e.g. the Power & Propulsion conference to bring together the aerospace and electric power communities together as electric propulsion technologies are advanced.