

## DEVELOPMENTS IN IEEE CAPACITOR STANDARDS: RESPONDING TO THE NEED FOR INFORMATION ON SPECIFICATIONS AND APPLICATIONS OF POWER CAPACITORS IN T&D SYSTEMS

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**B**enefits of power capacitors include var support, improved voltage control and power factor, increased system capacity, and reduction of system power losses. The continuing growth of electrical power systems, which are predominantly inductive in nature, has increased the need for and use of power capacitors in transmission and distribution systems. This has also increased the need for technical information, including standards and guides, on the application and specification of capacitors.

IEEE capacitor standards and application guides are developed primarily under the sponsorship of the IEEE T&D Committee's Capacitor Subcommittee. The scope of the IEEE Capacitor Subcommittee is: "Treatment of all shunt and series capacitor matters related to economics, technical design, theoretical and experimental performance, installation, application and service operation for use in power circuits of 60 Hz and below for the purpose of affecting performance or operating characteristics of those circuits." Application Guides for protection of shunt and series capacitors are developed under the



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sponsorship of the IEEE Power System Relaying Committee, usually with coordination between its working groups and the Capacitor Subcommittee.

Some significant developments have been taking place in IEEE capacitor standards over the last several years, which have, in part, been fueled by technology advancements in the manufacturing of capacitors and in power electronics. These advancements have led to relatively new applications of capacitors in the power industry. The development of the all-film high voltage capacitor unit allowed the concept of fuseless shunt capacitor banks to be implemented. The application of fuseless capacitor banks has risen significantly since the first demonstration projects in the late 1980's. Power electronics have been used for switching series capacitors and also shunt capacitors in static var compensators. And with the increased use in power electronics at all levels, there has been an increased need for harmonic filter capacitor banks. In response to these developments the IEEE Capacitor Subcommittee initiated several projects to update and develop technical documents in response to the industry's need for up-to-date information on the application of capacitors.

A revision to IEEE 18, "Standard for Shunt Power Capacitors," was approved and published in 2002. This standard previously only covered requirements for capacitor units used in externally fused capacitor banks. This revision added requirements for capacitor units used in fuseless capacitor banks and internally fused capacitors.

A revision to IEEE 1036, "Guide for the Application of Shunt Capacitors" is currently being balloted. The guide as is currently published only covers the application of capacitors in

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externally fused capacitor banks. This revision will expand the document to include the application of capacitors in fuseless and internally fused capacitor banks. The scope of the document covers the application of capacitors rated 2400 volt ac and above.

The first "Guide for Application and Specification of Harmonic Filters," IEEE 1531, has just completed balloting and has been submitted to the IEEE Standards Board for final approval. Many documents and technical papers exist which address allowable harmonic limits, harmonic analysis and harmonic measurements, but nothing existed to help the user specify a harmonic filter capacitor bank. IEEE 1531 focuses on the equipment used in low, medium and high voltage filter banks with the objective to define the criteria which should be considered in designing, controlling, and protecting a harmonic filter.

The Series Capacitor Working Group published a paper in 2001 on the application of series capacitors in distribution systems. "Considerations for the application of series capacitors to radial power distribution circuits," IEEE Transactions on Power Delivery, Volume: 16 Issue: 2, April 2001 Page(s): 306 -318. The Working Group is currently balloting a revision to IEEE 824, "Standard for Series Capacitors." This standard applies to capacitors and assemblies of capacitors, insulation means, switching, protective equipment, and control accessories that form a complete bank for inserting in series with a transmission line. The group has also begun work on a new application guide for the "Specification of Fixed Transmission Series Capacitor Banks."

The Thyristor Controlled Series Capacitor Working Group (joint WG with the Substations Committee Power

Electronics Stations Subcommittee) developed the first "Recommended Practice for Specifying Thyristor-Controlled Series Capacitors (TCSC)," IEEE 1534. The document was approved and published in 2002 and addresses issues that consider ratings for TCSC thyristor valve assemblies, capacitors and reactors as well as TCSC control characteristics, protective features, cooling systems, testing, commissioning, operation, and maintenance.

As previously stated, the documents concerning the protection of capacitors are sponsored by the IEEE/PES Power System Relaying Committee. In 2002 a revision to IEEE C37.99, "Guide for the Protection of Shunt Capacitor Banks," was approved and published. This revision added guidance for the protection of fuseless and internally fused capacitor banks to a document that previously only covered externally fused capacitor banks. The Relaying Committee is also currently developing a "Guide for Protection of Transmission Line Series Capacitors." Both of these documents have been developed in close cooperation with the Capacitor Subcommittee through circulation of drafts and common membership between the two groups.

The Capacitor Subcommittee meets twice a year, normally with the PES Annual General Meeting and with the new T&D Committee annual meeting. The meetings are open to anyone who wants to attend and there is always a need for new individuals to contribute to standards development, especially from the utility and industrial areas of the power industry.

The Capacitor Subcommittee has a web page available at <http://grouper.ieee.org/groups/td/cap/>.

Available on the Capacitor Subcommittee web page are descriptions of the Subcommittee activities, updates on meetings, and also bibliographies of shunt and series capacitor technical papers.

*Mr. Nelson is a Senior Member of IEEE. He is the current Chair of the IEEE/PES Capacitor Subcommittee, Vice-Chair of the IEEE/PES Switchgear Committee, Past-Chair of the IEEE/PES High Voltage Circuit Breaker Subcommittee, and a member of the Editorial Board for IEEE Transactions on Power Delivery. Mr. Nelson is currently employed by the Tennessee Valley Authority as a Senior Electrical Engineer in the Substation Projects Group. ET*

