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Analyzing and Minimizing Distribution System Harmonic and Transient Disturbances

November 2–4, 2011
Madison, Wisconsin

Focus on understanding the voltage and current disturbances that commonly exist on electric power distribution systems and techniques for minimizing their impact.

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Analyzing and Minimizing Distribution System Harmonic and Transient Disturbances

November 2–4, 2011
Madison, Wisconsin

- Designed for utility, industrial plant, large commercial facility, and consulting engineers and senior technicians
- Emphasizes effective solutions to unwanted disturbances on electric power distribution systems

Analyzing and Minimizing Distribution System Harmonic and Transient Disturbances

November 2–4, 2011 in Madison, Wisconsin

Practical Course Content

Voltage disturbances can occur on electric power distribution systems that feed industrial plants, large commercial facilities, and even urban neighborhoods. These disturbances can be short-term (transient surges or impulses), longer-term (swells or sags), or very long-term (harmonics). Disturbances can result from natural events (lightning, wind, animals, contamination), or from normal operational events (switching of lines or capacitor banks, transformer energization).

The "quality of power" that is available to the customer can be influenced not only by events in the network, but also by characteristics of the load within the plant, facility, or home. With the now-common use of customer-owned computers, programmable-logic controllers, adjustable-speed drives, and other sensitive electronic circuitry, electric power quality continues to be an important issue. In today's competitive utility environment, power quality may become a deciding factor in a large customer's choice of an electricity supplier. Both customers and suppliers must understand the causes of disturbances and the means that are now available for minimizing their effects.

In this course you will become familiar with the voltage and current disturbances that commonly exist on electric power distribution systems. You will be introduced to harmonic and transient disturbance categories and standards. You will learn how to recognize and analyze them and how to minimize their impact. Included will be case studies and representative waveforms for commercial, industrial, and utility facilities. Examples from wind plant and renewable energy sources will be featured.

In-depth Presentations on Key Topics

- Harmonic and transient disturbance categories and standards
- Harmonics found in commercial buildings, industrial facilities, renewable energy systems
- Solutions to harmonic problems
- Wind plant temporary overvoltages
- High-frequency load switching
- Lightning
- Transformer energizing
- Ferroresonance
- Capacitor bank switching
- Mitigation of transients

Case studies and representative waveforms for commercial, industrial, utility, and renewable energy sources will be presented. These will include measured and simulated harmonic and transient waveforms for several wind plant facilities.

Who Should Attend

This course will be of great practical value to:

- Electric utility distribution and customer service engineers
- Plant electrical engineers, senior technicians, and facility managers especially in locations with adjustable speed drives and critical or sensitive loads
- Consultants, equipment manufacturers, electrical contractors, and senior technical personnel in electrical construction companies
- Technical staff concerned about the interface between power systems and wind plants or renewable resources

Comments from Previous Classes

"I have always found the UW short courses to be very valuable and having high quality of information."

"All presentations were very good—very professional. The instructors provided real-world solutions to real problems."

"I am now able to do a better job of helping our customers determine the root causes of their power quality problems."

"I can help understand and solve utility and customer power quality problems, especially harmonics, sags, and surges."

"Case studies, waveform recognition exercises gave me a good point to start from with my understanding."

"I understand that power system analysis must now incorporate multiple frequency response compared to the traditional power system 60 Hz only analyses."

"I appreciate seeing the effects and problems caused by VFD drives and other equipment on electrical systems."

Analyzing and Minimizing Distribution System Harmonic and Transient Disturbances

November 2–4, 2011 in Madison, Wisconsin

Course Outline

Wednesday, November 2

7:45 Registration
The Pyle Center
702 Langdon Street
Madison, WI

8:15 Introduction to the Program
- Welcoming remarks
- What you can expect to learn

Bill Long, Program Director

1 Introduction
- Review of Harmonic and Transient Power Quality Problems
- Harmonic and Transient Disturbance Categories and Standards
- Common Symptoms of Harmonic and Transient Problems
- Common Solutions for Harmonic and Transient Problems

2 Harmonics, Interharmonics, and Flicker
- Harmonics in Commercial Buildings
- Neutral Current Harmonics
- K-Factor Transformer Ratings
- Harmonics in Industrial Facilities
- Six-Pulse Drives
- Power Factor Correction and Resonance
- Harmonic Filters
- Harmonics in Renewable Energy Systems
- Interconnection Requirements
- IEEE and IEC Standards
- Resonance Considerations
- Interharmonics and Flicker
- Steel Plants
- Induction Furnaces
- Cycloconverters
- Renewable Energy Sources

3 Transient Disturbances
- Characterizing Transient Disturbances
- High Frequency Load Switching
- Vacuum Circuit Breaker Pre-strikes and Current Chopping
- Lightning
- Wind Plant Insulation Coordination
- Transformer Energizing and Dynamic Overvoltages
- Ferroresonance
- Utility Capacitor Bank Switching
- Normal Energizing Transients during Switch Closing
- Voltage Magnification
- Nuisance Tripping of Sensitive Power-Electronic Equipment
- Restrike Transients during Switch Opening
- Wind Plant Harmonic Filter Bank Energizing
- Voltage Notching
- Temporary Overvoltages (TOVs)
- Wind Plant TOVs during Collector System Single-Phase Faults
- Summary of Utility and Customer Transient Mitigation Alternatives

4 Summary and Review
- Waveform Recognition
- Case Studies
- Student Problems
- Q&A Session

12:00 Final Adjournment

Daily Schedule

7:45 Coffee and conversation
8:00 Class session
9:30 Break–coffee and rolls
9:50 Class session
10:50 Break
11:00 Class session
12:00 Lunch
1:00 Class session
2:15 Break–soft drinks
2:30 Class session
3:30 Break
3:45 Class session
4:30 Adjournment

Distinguished Course Faculty

Dave Mueller, PE manages Power Quality Projects and Studies for Electrotek Concepts in Knoxville, Tennessee. For over 20 years he has worked on a wide variety of power system projects to study and solve power quality problems for industrial, commercial, and utility clients.

Dave has worked on electric power problems on "both sides of the meter" as he has also performed many projects for electric utilities. In 1993-1995 he lived in Nottingham, England, starting the Power Quality Services group for East Midlands Electricity. In 1998-2001 he assisted PowerGrid Ltd. in Singapore to develop their power quality capabilities. He has also consulted with utilities in the USA, China, Malaysia, and Canada on their power quality concerns.

Dave is a registered PE. He received a BSEE from the University of Cincinnati, and a Master of Engineering from the Electric Power Engineering Department at Rensselaer Polytechnic Institute.

Tom Grebe, PE is a senior consultant with Electrotek Concepts in Knoxville, Tennessee. His primary responsibilities include consulting for electric utilities and their customers in the areas of power system and power quality analysis. Tom has over twenty years of application experience using the EMTP and PSCAD transient simulation programs. He has completed numerous transient studies dealing primarily with utility capacitor bank applications.

Tom has participated in a number of research projects including: Evaluation of Distribution Capacitor Switching (EPRI), An Assessment of Distribution System Power Quality (EPRI), Power Quality Manual (NRECA), and Practical Guidelines for Evaluating the Impact of Transients on Utility Customers (CEATI).

Tom received his BS in Electrical Engineering from the Penn State University. He is a Senior Member of IEEE, Chairman of the Capacitor Subcommittee and Chairman of the Harmonic Filter Working Group. He is registered as a Professional Engineer in the State of Virginia.

Program Director

Willis Long, PE is Professor Emeritus, Department of Engineering Professional Development and Department of Electrical and Computer Engineering, University of Wisconsin–Madison. His principal research interests are HVDC power transmission and the application of power electronics equipment in power systems. Previous industrial experience includes Hughes Research Laboratories and director, ASEA (now ABB) Power Systems Center. Bill is a Life Fellow of IEEE and recipient of the Uno Lamm HVDC Award and the CIGRE (Paris) Technical Committee Award. He is a registered Professional Engineer in Wisconsin.

Four Easy Ways to Enroll

Internet:
http://epd.engr.wisc.edu/webM636

ENROLL ONLINE TODAY!

Phone:
800-462-0876 or
608-262-1299 (TDD 265-2370)

Mail to:
Engineering Registration
The Pyle Center, Dept. 108
702 Langdon Street
Madison, Wisconsin 53706

Fax:
800-442-4214 or
608-265-3448

Course Information

❑ Please enroll me in **Analyzing and Minimizing Distribution System Harmonic and Transient Disturbances**
Course #M636 November 2–4, 2011 in Madison, Wisconsin Fee: $1295
Team discount: $995 each when three or more people enroll from the same organization.

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Related Courses

For information about the following courses, contact Willis Long, program director, 800-462-0876, or e-mail willis@engr.wisc.edu

National Electrical Safety Code IEEE C2-2012
September 13–15, 2011, in Madison, Wisconsin Course #L793

Electrical Distribution Principles and Applications
September 27–29, 2011, in Madison, Wisconsin Course #M485

Introduction to Electric Motors and Power Transformers, Applications and Principles of Operation
October 4–7, 2011, in Madison, Wisconsin Course #L795

Power System Analysis Skills for Engineers and Technicians
October 10–12, 2011, in Madison, Wisconsin Course #L796

Understanding Power Cable Characteristics and Applications
October 11–14, 2011, in Madison, Wisconsin Course #M515

Dynamic Reactive Power Control
October 25–28, 2011, in Madison, Wisconsin Course #M516

Need to Know More?

Call toll free **800-462-0876** and ask for

Program Director: Willis F. Long, PE
willis@engr.wisc.edu

Program Associate: Debbie Benell
benell@epd.engr.wisc.edu

Or e-mail **custserv@epd.engr.wisc.edu**

General Information

Fee Covers Notebook, course materials, continental breakfasts, two lunches, and certificate. We do not publish proceedings. Course materials are distributed only to participants.

Cancellation If you cannot attend, please notify us by October 26, and we will refund your fee. Cancellations received after this date and no-shows are subject to a $150 administrative fee. You may enroll a substitute at any time before the course starts.

Location The course will be held at the Pyle Center, 702 Langdon Street, Madison, Wisconsin. Phone messages: 608-262-1122.

Accommodations We have reserved a block of sleeping rooms (rates starting at $110, including airport shuttle) for course participants at the Madison Concourse Hotel and Governor's Club, One West Dayton Street, Madison, WI. To reserve a room, call 800-356-8293 or 608-257-6000 and indicate that you will be attending this course under group code 151094. Room requests made later than October 13 will be subject to availability.

Continuing Education Credits Earn 15 Professional Development Hours (PDH) or 1.5 Continuing Education Units (CEU) when you attend this course.