DISTRIBUTION NEUTRAL GROUNDING AND STRAY VOLTAGE

September 19-20, 2016
San Diego Marriott La Jolla
San Diego, CA

EUCI is authorized by IACET to offer 1.0 CEUs for the course.

Photo Credit: Keith Malmedal
OVERVIEW

Grounding is one of the most misunderstood areas of distribution engineering. Although good grounding is generally helpful, sometimes improving grounds does little – if anything – to improve system performance, and it may actually have a negative effect. With the widespread addition of renewable and conventional distributed generation, it is important for the practicing engineer to understand the effects of grounding these sources will have on the distribution system. The meaning of the term “stray voltage” is also confusing to some, and is costing the industry millions of dollars in litigation. The purpose of this two-day course is to give the distribution engineer an understanding of the common methods of grounding, when they are commonly used and why, how they are designed and installed, as well as to address current concerns with stray voltage.

LEARNING OUTCOMES

- Review distribution systems, including voltage levels, substation and feeder design, equipment ratings and protection philosophies
- Review basic concepts, including Earth as a conductor, mathematical models, step and touch potentials and the impact of good grounding on stray voltage
- Describe system grounding choices and grounding criteria
- Assess substation grounding, including reasons for substation grounding, permissible body current limits, step and touch voltages, use of IEEE Std. 80, and substation fence grounding
- Describe grounding standards and practices
- Demonstrate system grounding principals
- Evaluate the effect of grounding on abnormal voltages, overcurrent protection, lightning and overvoltage protection and electromagnetic interference
- Analyze the causes and effects of stray voltage and mitigation techniques
- Analyze the effects of grounding on renewable and conventional generation and power production facilities

INSTRUCTOR

Keith Malmedal Ph.D, P.E. P.Eng / Senior Member / IEEE

Keith Malmedal has over 25 years combined experience in electrical power system design and system study, teaching, and research, and is presently the President of NEI Electric Power Engineering, Arvada, Colorado. He has published over 30 technical papers in subjects ranging from system grounding to distributed generation. He holds masters degrees in both electrical and civil engineering and his Ph.D research at the Colorado School of Mines was on the effects of renewable energy distributed generation on existing distribution systems in the United States. He teaches undergraduate and graduate classes at Metropolitan State University of Denver and the University of Colorado at Denver, and has taught short courses related to power systems, machines, protection, renewable energy, and energy policy issues for various IEEE chapters and conferences.
AGENDA

Monday, September 19, 2016

8:00 - 8:30 a.m.  Registration and Continental Breakfast

8:30 a.m. – 4:30 p.m.  Course Timing

12:00 – 1:00 p.m.  Group Luncheon

Distribution System Overview
• Voltage levels
• Substation design
• Feeder designs
• Equipment ratings
• Protection philosophies

Basic Concepts
• Biological effects of electricity
• Safe limits of currents and voltages
• Resistance of human body

Grounds
• Earth as a conductor
• General requirements
• Mathematical models (Carson’s formulas)
• Ground fault voltage and current calculations (symmetrical components review)
• Step and touch potentials
• Impact of good grounding on safety

System Grounding Classifications
• Definition
• Characteristics
• Ungrounded systems
• Low resistance grounded systems
• High resistive grounded systems
• Solidly grounded systems
• Effectively grounded systems
• Multi-grounded systems and stray voltage

Substation Grounding
• Reasons for substation grounding
• Permissible body current limits
• Step and touch voltages
• Ground grid design using IEEE Std. 80
• Substation fence grounding

Distributed Generation Grounding
• Conventional generator grounding (synchronous generator)
• Renewable power plant grounding (solar, wind, fuel cell, microturbine)
• Use of grounding transformers in power plant grounding
• Grounding effect on harmonic current flow
Tuesday, September 20, 2016

7:30 – 8:00 a.m.    Continental Breakfast

8:00 a.m. – 4:00 p.m.  Course Timing

12:00 – 1:00 p.m.  Group Luncheon

Grounding Standards and Practices
- Neutral grounding rules
- Substation grounding rules and calculations
- Ground electrode rules and calculations
- Pole grounds
- Concrete foundations as pole grounds
- Customer grounds as require by the National Electrical Code
- Underground grounds
- Metallic pipe grounds
- Arrester grounds

Ground Resistance Testing
- Soil resistivity testing
- Four-point resistivity measurements (Wenner and Schlumberger-Palmer Methods)
- Grounding electrodes
- Ground resistance values
- Ground electrode resistance testing methods (fall of potential and clamp-on methods)
- Stray voltage measurements
- Touch potential

Effect of Grounding on Swells
- System temporary overvoltages
- Effect of neutral wire size
- Swell levels
- Division of current
- Effect of number of grounds
- Effect of fault resistance
- Effect of broken neutral
- Effect of ground mat

Effect of Grounding on Overcurrent Protection
- Impact of neutral conductor
- Fault impedance
- Effect of the multi-grounded system
- Special protection problems with distributed generation
- Effect on fault current levels

Effect of Grounding on Lightning and Overvoltage Protection
- TOV
- System overvoltages
- Capacitor switching
- Ferroresonance
- Line protection

Stray Voltage
- Causes
- Effects on humans and animals
- Mitigation techniques
- Definition and cause of stray voltages

Impact of Grounding on Electromagnetic Fields
- Cause of magnetic fields
- Effect of ground current flow

Special Considerations
- European systems
- Grounding sensitive equipment
- Maintenance grounding
INSTRUCTIONAL METHODS

Case studies and PowerPoint presentations will be used.

REQUIREMENTS FOR SUCCESSFUL COMPLETION OF PROGRAM

Participants must sign in/out each day and be in attendance for the entirety of the course to be eligible for continuing education credit.

IACET CREDITS

EUCI has been accredited as an Authorized Provider by the International Association for Continuing Education and Training (IACET). In obtaining this accreditation, EUCI has demonstrated that it complies with the ANSI/IACET Standard which is recognized internationally as a standard of good practice. As a result of their Authorized Provider status, EUCI is authorized to offer IACET CEUs for its programs that qualify under the ANSI/IACET Standard.

EUCI is authorized by IACET to offer 1.5 CEUs for the course.

EVENT LOCATION

A room block has been reserved at the San Diego Marriott La Jolla, 4240 La Jolla Village Dr, La Jolla, CA 92037, for the nights of September 18-19, 2016. Room rates are $169, plus applicable tax. Call 1-858-587-1414 for reservations and mention the EUCI course to get the group rate. The cutoff date to receive the group rate is August 18, 2016, but as there are a limited number of rooms available at this rate, the room block may close sooner. Please make your reservations early.

PROCEEDINGS

The proceedings of the course will be published, and one copy will be distributed to each registrant at the course.

REGISTER 3 SEND 4TH FREE

Any organization wishing to send multiple attendees to these conferences may send 1 FREE for every 3 delegates registered. Please note that all registrations must be made at the same time to qualify.
Mail Directly To:
Electric Utility Consultants, Inc. (EUCI)
4601 DTC Blvd., Ste. 800
Denver, CO 80237
OR, scan and email to: conferences@euci.com

PLEASE REGISTER THE FOLLOWING

☐ DISTRIBUTION NEUTRAL GROUNDING AND STRAY VOLTAGE, SEPTEMBER 19-20, 2016: US $1495, EARLY BIRD ON OR BEFORE SEPTEMBER 2, 2016: US $1295

How did you hear about this event? (direct e-mail, colleague, speaker(s), etc.)

Print Name                                                                 Job Title

Company

What name do you prefer on your name badge?                                                  Address

City                                                   State/Province          Zip/Postal Code          Country

Telephone                                                                 Email

List any dietary or accessibility needs here

CREDIT CARD

Name on Card                                                                 Account Number

Billing Address                                                  Billing City          Billing State

Billing Zip Code/Postal Code                                                  Exp. Date

OR Enclosed is a check for $ ___________________ to cover ___________ registrations.

Substitutions & Cancellations
Your registration may be transferred to a member of your organization up to 24 hours in advance of the event. Cancellations must be received on or before August 19, 2016 in order to be refunded and will be subject to a US $195.00 processing fee per registrant. No refunds will be made after this date. Cancellations received after this date will create a credit of the tuition (less processing fee) good toward any other EUCI event. This credit will be good for six months from the cancellation date. In the event of non-attendance, all registration fees will be forfeited. In case of conference cancellation, EUCI’s liability is limited to refund of the event registration fee only. For more information regarding administrative policies, such as complaints and refunds, please contact our offices at 303-770-8800. EUCI reserves the right to alter this program without prior notice.