

29<sup>TH</sup> ANNUAL

# HANDS-ON Relay School

MARCH 12-16, 2012



**WASHINGTON STATE UNIVERSITY  
PULLMAN, WASHINGTON**

**SPONSORED BY:**

Western Energy Institute | Washington State University

**ONE WEEK FOR ONLY \$625**

Applications Accepted Nov. 1, 2011 - Jan. 25, 2012



CONFERENCE MANAGEMENT

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# HANDS-ON Relay School

“ This school offers the best blend of classroom instruction, manufacturer variety, and relay testing for one week that your training dollar can buy.”

“ The classes are directly related to a relay technician’s duties and enhance his/her skill level.”

“ Excellent training for any level of technician.”



CONFERENCE MANAGEMENT

## OBJECTIVES OF THE HANDS-ON RELAY SCHOOL

The Hands-On Relay School is a professional development short course to train protective relay technicians, electrical/power plant technicians, engineers, and protective relay test specialists.

Students are enrolled in one of seven tracks for the duration of the school.

- Basic
- Distribution
- Transmission
- Generation
- Electromechanical
- Automated Relay Testing
- Theory

Students participating in these tracks will:

- Become familiar with manual or automated test methods for a variety of protective relays and test equipment.
- Gain valuable knowledge relating to relay applications and operating characteristics.
- Exchange ideas and resolve problems in an open forum.
- Learn preventative and corrective maintenance methods.

### Application

School enrollment is limited, and priority is given to organizations providing Lab Facilitators, Lecturers, Steering Committee support, and Western Energy Institute member utilities. Refer to important application and enrollment procedures at the rear of this brochure.

### Call for Lab Facilitators

If you are an experienced relay technician who is willing to share your knowledge with others, you can attend the Hands-On Relay School as a lab facilitator. Lab facilitators work with groups of three students in the hands-on labs testing relays and may attend all classroom lectures and school activities. Lab facilitators are not required to pay the application fee and their company receives priority points for students applying for the school. If you are interested, contact WSU Conference Management at **800-942-4978** or **509-335-3530**.

**BASIC TRACK**

**This track is for those students who wish to focus on the calibration, maintenance, testing, and understanding of basic relays. The selection of relays may include overcurrent, differential, reclosing, voltage, or frequency relays. This track is an excellent choice for beginning technicians. [ 48 students maximum ]**

**Students in this track will:**

- Attend the "Introduction to System Protection" lecture series.
- Choose four Concurrent Open Lectures to attend.
- Attend the Friday Panel Discussion and Feature Presentations.
- Wire an overcurrent and a reclosing relay to a breaker simulator to test and troubleshoot an entire protection circuit.
- Perform hands-on testing in the lab on the following relays:

ABB: CO-11, RC, HU  
 Basler: BE1-51, BE1-79M, BE1-810/U  
 GE: IAC53, JBCG  
 SEL: 551

**Introduction to System Protection Lecture Series**

This lecture series is for beginning relay technicians, newcomers to the relaying field, or anyone who needs the basics. We start with the very basics of relaying to provide a foundation of knowledge upon which to build. The closest thing to "Relaying for Dummies" that Hands-On Relay School has to offer! Taught by experienced utility personnel, this lecture series will be presented on **Monday morning only** from **7:45am – Noon**.

**Topics include:**

- Protection Basics and Terminology  
*Cliff Harris, Idaho Power Company*
- Introduction to Relay Test Equipment  
*Darryl Walker, Salt River Project*
- How to Read Substation Control Prints and Schematics  
*Rich LeVee, Tri Sage Consulting*
- How to Test and Safely Work with Current Transformers  
*Steve Laslo, Bonneville Power Administration*

**DISTRIBUTION TRACK**

**This track is for those students who wish to focus on the testing and understanding of multifunction microprocessor relays and recloser controllers used for distribution protection. The selection of relays may include overcurrent, transformer differential, reclosing, synch-check, and frequency protection. This track does not cover electromechanical relays or relay fundamentals. [ 18 students maximum ] [ Laptop Computer Required ]**

**Students in this track will:**

- Attend the "Distribution Overview" lecture.
- Choose six Concurrent Open Lectures to attend.
- Attend the Friday Panel Discussion and Feature Presentations.
- Perform hands-on testing in the lab on the following relays:

ABB: REF615  
 Basler: BE1-11F  
 Cooper: Form 4D  
 GE: 745  
 SEL: 387, 351R

**Distribution Protection Overview Lecture**  
*Mike Diedesch and Kevin Damron, Avista, Spokane, WA*

This lecture will review fundamental principles of distribution system protection, including IEEE device designations, fault current calculations, coordination of overcurrent protection, and reclosing schemes.



**TRANSMISSION TRACK**

**This track features both electromechanical and microprocessor-based multi-function relays used for protection of transmission equipment, including distance and line current differential protection.**

[ 24 students maximum ] [ Laptop Computer Required ]

**Students in this track will:**

- Attend the “Transmission Overview” lecture.
- Choose six Concurrent Open Lectures to attend.
- Attend the Friday Panel Discussion and Feature Presentations.
- Perform hands-on testing in the lab on the following relays:

ABB:	KD-10
Schneider	
Electric / MiCom:	P544
RFL:	8387
SEL:	311L, 421

**Transmission Protection Overview Lecture**

*Brian Smyth, SEL, Pullman, WA*

This lecture will review fundamental principles of transmission line protection. Concepts of distance protection, directional overcurrent, line differential, and pilot protection schemes will be discussed.

**GENERATION TRACK**

**This track features multifunction microprocessor relays used for transformer and generator differential, over-excitation, stator ground, reverse power, synch-check, negative sequence, and loss of field protection of generators.**

[ 18 students maximum ] [ Laptop Computer Required ]

**Students in this track will:**

- Attend the “Generation Protection Overview” lecture.
- Choose six Concurrent Open Lectures to attend.
- Attend the Friday Panel Discussion and Feature Presentations.
- Perform hands-on testing in the lab on the following relays:

ABB:	REG650
Beckwith:	3425A
GE:	G60
SEL:	300G

**Generation Protection Theory and Application**

*Charles Mozina, Beckwith, Largo, FL*

This lecture will review fundamental principles of generation protection theory and application with a focus on industry standards and best practices. This lecture is attended by both the Generation Track students and Theory Track students.



## ELECTROMECHANICAL TRACK

**This track focuses exclusively on electromechanical relays used for line, bus, transformer, or generator protection. More hands-on effort is spent on troubleshooting relay problems, calibrating relays, repairing relays, and verifying results. [ 12 students maximum ]**

**Prerequisite:** Basic track or related experience.

### Students in this track will:

- Attend their choice of Distribution, Transmission, or Generation Protection Overview lecture.
- Choose six Concurrent Open Lectures to attend.
- Attend the Friday Panel Discussion and Feature Presentations.
- Perform hands-on testing in the lab on the following relays:  
 ABB: HU, KD-10  
 GE: JBCG, CEY51, IJS, BDD, CEH51



## AUTOMATED TESTING TRACK

**This track is intended for technicians who already understand relay operating principals, have experience in manual testing, and are ready to learn automated testing methods. [ student maximum varies ]**

**Note:** This track is NOT recommended for those relay technicians who are just starting out. The emphasis of this track is on the test equipment and software, not on the relays. The hands-on labs are taught by the test equipment and software manufacturers, not by the relay manufacturers.

**Prerequisite:** Experience in manual relay testing and computer use. A laptop computer will be used to communicate with the relays and/or the test set. All students must have administrative rights to their laptop, with the appropriate software pre-loaded.

### Students in this track will:

- Attend an Overview Lecture provided by the Test Equipment or Software Manufacturer.
- Choose six Concurrent Open Lectures to attend.
- Attend the Friday Panel Discussion and Feature Presentations.
- Perform hands-on testing in the lab using one of the following testing software programs:  
 Doble ProTest  
 Enoserv RTS  
 Manta Test Systems  
 Megger AVTS  
 Omicron

Some test software vendors will offer both a Beginning and an Advanced section, depending on enrollment and skill level of the students. Beginning automated testing still requires a prerequisite understanding of manual testing.

## THEORY TRACK

**This track provides more in-depth training on protective relays and their associated roles in a power system. This track will not include any hands-on training with relays, but will include some hands-on use of your laptop to study generation protection, relaying CT theory, and symmetrical component analysis.**

Emphasis this year will be on Generation Protection concepts and applications.

**Note:** The theory track is for the journeyman relay technician and relay engineer. It is NOT recommended for those relay technicians who are just starting out. Instructors and lecturers for the theory track are considered to be experts in their field.

Students are expected to bring their own laptop PC with administrative privileges over the operating system sufficient to load vendor software and allow running of JAVA based applications.

**Students in this track will:**

- Attend the "Generation Protection Overview" lecture.
- Choose six Concurrent Open Lectures to attend.
- Attend the Monday and Tuesday PM and all day Wednesday and Thursday Lectures.
- Attend the Friday Panel Discussion and Feature Presentations.
- Attend the advanced topic lectures on the following page.



## THEORY TRACK

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**Symmetrical Components**

*Stephen Marx, Bonneville Power Administration*

Analysis of power system elements with symmetrical components networks and network connections for each power system fault type. Samples of protective relay applications using the symmetrical component method.

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**Relaying CT Theory**

*Steve Laslo, Bonneville Power Administration*

This course will cover essential topics regarding relaying CT applications. Topics include delta and wye connection circuit analysis, normal CT loading, open circuit CT case study and demonstration, and CT field testing.

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**Synchronous Generator Protection**

*Charles Mozina, Beckwith Electric*

The IEEE Tutorial on the Protection of Synchronous Generators will be presented. This tutorial addresses the methods, practices, and industry standards used to provide the electrical protection of generators.

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**Generator Protection Theory**

*Rogério Scharlach, Schweitzer Engineering Laboratories*

This course covers basic principles of power generation with steam, gas, hydraulic and wind turbines. Also covered are the basic mechanical and electrical principles and failure mechanisms of synchronous condensers, abnormal operating conditions of synchronous generators, and basic principles of generator protection.

## CONCURRENT OPEN LECTURES

The Hands-On Relay School offers twelve lectures on a wide range of topics relevant to the trade. Each lecture is one hour long and given a total of three times. Students can attend up to six of the lectures of their choosing.

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### Application and Testing of Substation Control Circuitry

*Greg Butler, Bonneville Power Administration, Port Angeles, WA*

A relay is only as good as its wiring. This lecture presents an overview of typical AC and DC substation control wiring components and practices, physical and functional verification testing, maintenance practices, common problems, and troubleshooting tips.

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### Breaker Failure Protection

*Brent Carper, Relay Application Innovation Inc. (RAI), Pullman, WA*

This lecture will review different types of breaker failure protection systems, relays, and logic, including general considerations for determining relay pickup and timing settings.

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### CT Saturation and Residual Magnetism

*Will Knapek, OMICRON, Adams, TN*

High fault currents or DC components can saturate current transformers and result in residual magnetism left in the CT. This lecture will explore this phenomenon and the consequences of residual magnetism. Techniques of how to measure residual magnetism will also be discussed.

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### Dynamic Relay Testing

*Tony Giuliante, ATG Consulting, Galloway, NJ*

Dynamic testing is an alternative system testing technique that provides advantages over traditional steady state calibration of individual relay functions. This approach eliminates common testing problems and provides better understanding of relay design and operation.

## CONCURRENT OPEN LECTURES

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### End to End Testing

*Chris Werstiuk, Manta Test Systems, Mississauga, ON*

End-to-end testing is considered the ultimate test for any protective relay scheme using communications and can seem like a daunting task. This lecture will provide a step-by-step introduction of a typical end-to-end test to demystify the process.

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### Fundamentals of Bus Protection

*Kevin Wright, Sacramento Municipal Utility District, Sacramento, CA*

Bus protection comes in many different forms including high impedance or low impedance differential, overcurrent, distance, linear coupler, trip blocking schemes, and communication-based schemes. This lecture will provide an overview of the different types of bus protection and the advantages and disadvantages of each.

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### NERC PRC-005 Standard

*Eric Udren, Quanta Technology, Pittsburgh, PA*

The NERC Drafting Team has just developed the new PRC-005-2 Protection System Maintenance Standard, with specific requirements for maintenance activities and maximum time intervals. This lecture will discuss the new requirements and also new options for system maintenance programs.

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### Phasor Diagrams

*Ron Alexander, Bonneville Power Administration, Salem, OR*

Phasors are the universal language of system protection technicians and engineers. This lecture emphasizes the need for a basic knowledge of phasor diagrams and their use in understanding the power system. Topics include load flow phasor analysis, fault phasor analysis, and using phasors to determine the phase angle across delta-wye transformer banks.

## CONCURRENT OPEN LECTURES

### Symmetrical Components 1 & 2

*Stephen Marx, Bonneville Power Administration, Malin, OR*

**Part 1:** Symmetrical components with explanation of phasors, per unit system, and basic symmetrical component equations using sequence networks.

**Part 2:** Analysis of power system elements with symmetrical components network and network connections for each power system fault type. Samples of protective relay applications using symmetrical component method.

### Testing Microprocessor Relays

*Chris Werstiuk, Manta Test Systems, Mississauga, ON*

Microprocessor relays are far more complex than previous generations of protective relays, but many of us still use the same old test procedures designed for variacs and phase shifters. This lecture discusses how to use modern test equipment and techniques for more effective and efficient relay testing.

### Transformer Protection

*Scott Cooper, Manta Test Systems, St. Petersburg, FL*

An overview of power transformer protection practices. Emphasis is placed on solutions to the challenges of effective protection including transformation ratio, transformer connection, current transformer connections, zero sequence current elimination, inrush, and over excitation. Analysis of differential relay operation for various types of faults and fault locations is discussed.

## FRIDAY FEATURE PRESENTATIONS

### The Future of Nuclear Power in the Wake of Fukushima

*Kris Nielson, Pegasus-Global, Cle Elum, WA*

The events at the Fukushima complex following the 2011 earthquake and tsunami resulted in international concerns about nuclear power. This lecture will discuss the event, public reactions, and explore what it means for the nuclear power industry.

### Event Analysis for Relay Techs

*Charlie Wagner, PacifiCorp, Klamath Falls, OR*

Often what appears to be a legitimate fault trip or even a misoperation may not be so, and a good investigation requires correlating multiple sources of data and information from all of the tools at a technician's disposal. This lecture will use real occurrences and interesting situations to demonstrate how an experienced tech investigates, analyzes, and evaluates an event.



## 2012 SCHEDULE

The Hands-On Relay School is held on the Washington State University campus in Pullman, Washington. Evening events and Sunday check-in registration are held at the University Inn Best Western in Moscow, ID, or as noted.

### Sunday, March 11

5:30-7:30 PM **Registration & Reception** (University Inn)  
7:30-8:30 PM **Lab Facilitator Meeting** (University Inn)

### Monday, March 12

6:45-7:30 AM **Registration**  
7:30 AM – Noon **Opening Announcements**  
**Overview Lectures**  
**Concurrent Open Lectures**  
**Introduction to**  
**System Protection Lecture Series**  
1:00-5:00 PM **Hands-on Lab Instruction**  
5:00 PM **Optional Social Event**  
(Zeppos)

### Tuesday, March 13

7:30 AM– Noon **Concurrent Open Lectures**  
1:00-5:00 PM **Hands-on Lab Instruction**  
6:30-9:00 PM **Suppliers Showcase** (University Inn)

### Wednesday, March 14

7:30 AM – Noon **Hands-on Lab Instruction**  
1:00-5:00 PM **Hands-on Lab Instruction**  
6:30-9:00 PM **Banquet & Entertainment** (University Inn)

### Thursday, March 15

7:30 AM – Noon **Hands-on Lab Instruction**  
1:00-5:00 PM **Hands-on Lab Instruction**

### Friday, March 16

7:30 – 8:00 AM **Open Panel Discussion**  
8:00-11:30 AM **Friday Feature Presentations**

## SPONSORS



CONFERENCE MANAGEMENT



**WesternEnergy**  
**INSTITUTE**

## STEERING COMMITTEE

**Cliff Harris** *Committee Chair, Idaho Power Company*  
**Rodger Allen** *U.S. Bureau of Reclamation*  
**Rick Asche** *Portland General Electric*  
**Bob Byrne** *NV Energy*  
**Brent Carper** *Puget Sound Energy*  
**Bryan Focht** *PacifiCorp*  
**Tamara Kirk** *Washington State University*  
**Sonny Langhurst** *Douglas County PUD*  
**Jeff Marsh** *Avista Utilities*  
**Joe Matsuoka** *Bonneville Power Administration*  
**Pat Modrell** *Seattle City Light*  
**Kelly Newell** *Washington State University*  
**Mike O'Neal** *NV Energy, Retired*  
**Becca Petersen** *Western Energy Institute*  
**Gilbert Salcido** *Salt River Project, Retired*  
**Randy Turnley** *Puget Sound Energy*  
**Bill Unbehaun** *Tacoma Power*  
**Darryl Walker** *Salt River Project*  
**John Yates** *Washington State University*

**CONTRIBUTING ORGANIZATIONS**

**The Hands-On Relay School Steering Committee gratefully acknowledges the following organizations for their generous contributions of equipment and support personnel.**

- |                                      |  |
|--------------------------------------|--|
| ABB Power T&D Company Inc.           | OMICRON                                  |
| ATG Consulting                       | PacifiCorp                               |
| Avista Utilities                     | Peak Measure                             |
| Basler Electric Company              | Pegasus–Global                           |
| Beckwith Electric Company            | Portland General Electric                |
| Benton County PUD                    | Power Testing and Energization<br>Inc.   |
| Bonneville Power<br>Administration   | PPL Montana                              |
| BSC Engineered Systems               | Puget Sound Energy                       |
| Central Electric Cooperative<br>Inc. | Quanta Technology                        |
| Central Lincoln PUD                  | Relay Application Innovation             |
| Chelan County PUD                    | RFL Electronics Inc.                     |
| Clark Public Utilities               | RuggedCom                                |
| Cooper Power Systems                 | Sacramento Municipal Utility<br>District |
| Doble Engineering Company            | Salt River Project                       |
| Douglas County PUD                   | San Diego Gas & Electric                 |
| Emerson                              | Schneider Electric / M:Com               |
| Energy Northwest                     | Schweitzer Engineering<br>Laboratories   |
| ENOSERV                              | Seattle City Light                       |
| Eugene Water & Electric              | Siemens                                  |
| Franklin County PUD                  | SMC Inc.                                 |
| GE Digital Energy – Multilin         | Snohomish County PUD                     |
| Grant County PUD                     | Tacoma Power                             |
| Idaho Power Company                  | Tri-State G&T                            |
| Manta Test Systems                   | Trivetti and Associates                  |
| Matanuska Electric<br>Association    | U.S. Army Corps of Engineers             |
| Megger                               | U.S. Bureau of Reclamation               |
| Murray Power                         | Washington State University              |
| NorthWestern Energy                  | Western Area Power<br>Administration     |
| NV Energy                            | Western Energy Institute                 |

**SCHOOL INFORMATION**

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**Application Process and Fees**

- Application is online at <http://cm.wsu.edu/hrs>.
- School fee of \$625 includes electronic copies of lecture notes, Sunday night reception, Tuesday night Vendor Showcase, Wednesday night banquet meal, break refreshments, and parking fees.
- Priority is given to utilities providing lab facilitators, lecturers, steering committee support, and Western Energy Institute member utilities, if the application is received by January 25, 2012. Remaining slots will be filled on a first-come, first-served basis.
- Applicants select which track they wish to attend in order of preference. Every effort will be made to place students into their preferred track, but track placement is by availability and subject to the priorities as described above. Many tracks will fill up and students may not be able to get their preferred track. If we are unable to place you in a track you have selected, or in an acceptable substitute track, your full application fee will be refunded.
- Students will be notified in writing no later than February 10, 2012, of their acceptance into the school and track placement. You are not accepted to attend unless you receive the confirmation of acceptance from WSU.
- Questions? Call **800-942-4978** or **509-335-3530**, or e-mail us at [tlkirk@wsu.edu](mailto:tlkirk@wsu.edu). Visit our website at [conferences.wsu.edu](http://conferences.wsu.edu).

## SCHOOL INFORMATION

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### Accommodations and Travel

Please make your own travel and hotel reservations once you have received registration confirmation. The Pullman/Moscow Airport is served by Alaska/Horizon Airlines. Spokane International Airport is 80 miles north of Pullman. Link Transportation System Inc. serves Spokane to Pullman (208-882-1223). The Quality Inn (509-332-0500) and Holiday Inn Express (509-334-4437) in Pullman, and the University Inn (208-882-0550) in Moscow, Idaho, have rooms blocked for this event and all will provide local transportation upon request.

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### Cancellation Policy

Your complete application fee will be refunded if WSU receives your written cancellation notice by **February 25, 2012**. Cancellations made after February 25 are subject to a processing fee of \$310. Students who do not attend and have not cancelled by March 9 are responsible for the full application fee. Substitutions may be made at any time.

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### Program Changes and Cancellations

WSU reserves the right to make changes in programs or speakers or to cancel programs if enrollment criteria are not met. In the unlikely event that this school is cancelled, Washington State University's liability is limited to refund of registration fees. If we are unable to place you in a track you have selected or an acceptable substitute track, your full registration will be refunded.

## SCHOOL INFORMATION

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### Americans with Disabilities Act

Accommodations for individuals who qualify under the Americans with Disabilities Act are available upon request. Please contact us at least ten days before the school at **800-942-4978** or **509-335-3530**, fax **509-335-7781**.

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### Continuing Education Units (CEUs)

CEUs are available to participants who complete a CEU enrollment form prior to the start of the school and satisfactorily complete the requirements for the class. CEUs are nationally recognized units of achievement that may be used as evidence of professional development and for job advancement. One CEU is awarded for every 10 hours of instruction, totaling 3.6 for this school. A fee of \$10 must accompany the registration fee to receive the CEU credits.

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### Promotional Video

Need help convincing your organization about the benefits of attending the Hands-On Relay School? Contact us today to request your copy of our promotional video that demonstrates the invaluable training experience of attending this school or view the video at <http://youtu.be/Tu5GmeJg7r0>.

Call **800-942-4978** or **509-335-3530**, or e-mail us at [wsuconf@wsu.edu](mailto:wsuconf@wsu.edu) for more information.

# HANDS-ON Relay School

MARCH 12-16, 2012



**BY MAIL:**

Washington State University  
Conference Management  
PO Box 645222  
Pullman, WA 99164-5222

**By fax: 509-335-7781**

**Online: [conferences.wsu.edu/hrs](http://conferences.wsu.edu/hrs)**

Please print or type. For additional applicants, please duplicate this form. To significantly increase your chances of being accepted, send a facilitator.

**Name:** \_\_\_\_\_

**Organization:** \_\_\_\_\_

**Title:** \_\_\_\_\_

**Address:** \_\_\_\_\_

**City:** \_\_\_\_\_

**State/Province:** \_\_\_\_\_

**Zip/Postal Code:** \_\_\_\_\_

**Country:** \_\_\_\_\_

**Phone:** \_\_\_\_\_

**Fax:** \_\_\_\_\_

**Attendee e-mail (required):** \_\_\_\_\_

**TRACK SELECTION**

NUMBER only the tracks you will accept in order of preference (1 being your first choice). Confirmation of your application and track assignment will be e-mailed on February 10, 2012. Students will not be allowed to switch tracks once the school has begun.

**Manual Relay Testing**

- Basic
- Distribution M/P
- Transmission
- Generation
- Electromechanical
- Theory

**Automated Relay Testing**

- Doble (Beginning ProTest)
- Doble (Advanced ProTest)
- Enoserv RTS (Beginning)
- Enoserv RTS (Advanced)
- Manta
- Megger AVTS
- Omicron

**SCHOOL FEE**

- \$625.00 Please register me for the school (Checks payable to Washington State University, payment in U.S. funds drawn on a U.S. bank.)
- \$10.00 I would like Continuing Education Units (CEUs).

**PAYMENT METHOD**

- Check enclosed
- VISA or MasterCard no. \_\_\_\_\_
- Exp. Date \_\_\_\_\_ CVV# \_\_\_\_\_
- Bill my company, purchase order no. \_\_\_\_\_
- Bill to e-mail \_\_\_\_\_





CONFERENCE MANAGEMENT

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Pullman, WA 99164-5222

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