



VALENCE

ELECTRICAL TRAINING SERVICES

Do you want to be a
better relay tester?



About Valence Electrical Training Services

About Our Relay Training Center

Most protective relay training falls into three categories:

- Engineering books written for design engineers, not relay testers
- Courses hosted by relay manufacturers specific to their relays
- Test-set manufacturer, or automated test software, training focused on how to get their solution to test the relay with minimum user input

We believe that:

- The power system is universal, and you can apply the same principles to any relay model or manufacturer
- All modern test-sets can test any modern relay
- A skilled relay tester will always test a relay more effectively and efficiently than a button pusher, while fixing problems the alternatives will never discover

All of our relay training material:

- Is written specifically for relay testers in plain language
- Is designed to be universal and can be applied to any relay or any test-set
- Includes the theory necessary to understand what is happening inside the relay, and why
- Has universal, step-by-step procedures so the relay tester knows how to apply the theory
- Uses the most efficient and effective relay testing techniques used today

The Relay Testing Handbook Series

Valence Electrical Training Services started with a paper presented at a major electrical testing conference that turned into *The Relay Testing Handbook* series, a comprehensive series of nine books, each of which covers a specific relay testing topic. Any technician who has ever been faced with a confusing or challenging situation in the field will appreciate that a relay tester, not an engineer, wrote these books. This practical resource will give you the tools you need to test almost any type of protective relay, no matter who the manufacturer is.

Some of the topics included in The Relay Testing Handbook series include:

- Basic electrical fundamentals
- Basic relay testing fundamentals
- Relay testing equipment options and how to use them
- Information about the most common protective elements (50/51/67/59/27/81/87/21 protection) including:
 - Theory behind the element
 - How and when the element is applied
 - Step-by-step test procedures
 - Tips and tricks to overcome common problems
- Relay testing approaches and how to select the best ones
- Test plans with real-world applications
- Examples from multiple manufacturers and test-set models

Online Training

Online Protective Relay Training

Today's relay tester has to perform more work in less time, and typically has very little support to help them test modern digital relays that become more complex every year. We created *The Relay Testing Handbook* series as a practical reference guide for the modern relay tester, but studies have shown that most people must apply multiple learning styles before they fully understand a topic.

Each course in this online protective relay training series is based on a topic in *The Relay Testing Handbook*, and hits three key learning styles to ensure you retain the information and can start using it immediately in your day-to-day activities.

- You can read about the topic with excerpts from *The Relay Testing Handbook*.
- You will listen to a narrator while watching videos that discuss the topic in greater detail. You can learn at your own pace with controls that can pause, rewind, fast-forward, etc.
- You will use our interactive exercises that simulate the topic using the most realistic situations possible to help you learn by doing.



Our online protective relay training courses are designed to:

- Allow you to choose the topics most important to you
- Complete the courses at a location and time convenient for you and your schedule
- Focus on the skills you need to become a better relay tester
- Be universally applied to any relay or test-set

Each of our online relay training courses has the following structure:

- An introduction to the course topic with excerpts from *The Relay Testing Handbook* series
- A video series describing the topic with animations and examples
- A series of exercises to help you master the topic through real-world examples
- A quiz with real-world questions to see how much you've learned taking the course
- A certificate of achievement that can be used for continuing education credits.

Online Training Seminars

How to Test Protective Relays, 15 CEUs

This online protective relay testing seminar follows Chris Werstiuk (author of *The Relay Testing Handbook*) as he shows you the basic skills you need to test any digital relay with any modern test-set. Watch this series of videos on any device with speakers or headphones, and a high-speed internet connection. The videos are broken down into logical chunks that you can watch at any time, and in any order, so that you can fit this series into your busy schedule.

What do I get when I enroll in the “How to Test Protective Relays Online Seminar” today?

- Download a simple flowchart you can follow to test any digital protective relay with any test-set.
- Unlimited access to over 14 hours of videos where Chris Werstiuk tests various relays using different test-sets and explains how he is performing the test, and why.
- Download content so you can follow along if you wish.
- Comment sections to ask Chris questions, and interact with other students.
- Ask for more content if you don't see your relay or test-set represented in the course.



Why should protective relay test technicians take this relay testing training course?

Traditional relay testing plans are laser focused on the relay's protective elements like inverse time overcurrent (51) or line distance protection (21). Many relay test plans start by re-configuring a digital relay to make it operate like an electro-mechanical relay, and then apply electro-mechanical relay test procedures to record a pickup and timing results. The relay is reconfigured during the test procedure for every element until all of the enabled elements are tested. This is a great way to get results for a test sheet and the test routines make sense in an electro-mechanical relaying world because electro-mechanical relays can be calibrated. Modern digital protective relays do not have these adjustments and simply do not fail in the same way that electro-mechanical relays do. So why are we performing the same kinds of tests?

Chris Werstiuk (author of *The Relay Testing Handbook*) spent most of his relay testing career finding mistakes in digital relays that, at best, caused confusion for operating personnel and, at worst, prevented the relay from operating at all for any fault. His testing procedures started like the ones described above, but they evolved over time as he found new mistakes that prevented a relay from operating correctly. Chris began finding more and more errors in relay settings as his test plans changed to become more realistic, and he often found problems in relays that were in-service for years that would never operate because they had been tested using electro-mechanical procedures. Most of these problems are obvious if you know where to look, and the test plan described in this seminar can be faster, more efficient, and more effective than traditional test plans.

Protective Relay Testing Training

How to Test Protective Relays, 15 CEUs (Continued)

This seminar explains how to test protective relays using Chris' decades of relay testing experience and nearly a decade of relay testing training to make smarter test plans that are more effective and more efficient than traditional test plans

What do you cover in this online protective relay testing seminar?

We cover the following information using a variety of relays and test-sets for every topic

Obtain and Review the Relay Settings, Drawings, and Application

- Obtain and Review the Relay AC Single-Line Drawings
- Obtain and Review the Relay AC Three-Line Drawings
- Obtain and Review the Relay DC Drawings
- Obtain and Review the Relay Main Settings
- Obtain and Review the Relay Logic Settings
- Obtain and Review the Relay Global and Port Settings

Create a Checklist of all Elements, Outputs, and Signals to be Tested

- Create a Checklist of All Elements to be Tested
- Create a Test Checklist of all Logic, Outputs, and Signals

Isolate the Relay From the System

- Understanding FT Style Test Switches
- Isolate the Relay From the System

Connect the Test Set to the relay

- Connect the Test-Set to the Relay
- Alternate DC Connections
- Alternate AC Connections

Upload the Relay Settings

- Upload Relay Settings

Perform an Acceptance Test

- Record the Relay Self-Test Results
- Check all Digital Inputs and Outputs
- Balanced Three-Phase Meter Tests
- Unbalanced Three-Phase Meter Tests
- Combined Meter Tests
- Perform a Meter Test – Open-Delta PTs

How to Test Protective Relay Elements

- Percent Error and Metering Specifications
- Relay and Element Specifications
- Understand the Basic Operation of the Element
- Understanding The Power System
- Choose the Appropriate Fault Type for the Test
- Perform Ramping Pickup Tests via Relay Setting Changes
- Perform Ramping Pickup Tests via HMI
- Perform Ramping Pickup Tests via Automatic Ramp
- Perform Ramping Pickup Tests via Hybrid Ramp
- Perform Manual Pulsing Pickup Tests
- Perform Automatic Pulsing Pickup Tests
- Perform Inverse Timing Tests
- Perform Instantaneous/Definite Time Timing Tests
- Perform Dynamic Pickup/Timing Tests

Perform a Commissioning Test

- Testing Physical Outputs
- Testing Virtual Outputs/Front Panel Display
- Testing Digital Logic
- Standard Pickup/Timing Tests
- Universal Pickup/Timing Tests
- Dynamic Pickup/Timing Tests

Perform Maintenance Tests

- Download All Settings, Events, and Meter Logs
- Perform Self-Test and Meter Tests
- Verify All External Inputs
- Verify that All Outputs Operate Correctly

Post Testing Tasks

- Clear Metering, Sequence of Event, and Oscillography
- Return The Relay to Service
- Submit Your Report

Online Training Courses

Course 1-1: The Three-Phase Electric Power System, 4 CEUs

A relay tester who understands the three-phase electrical system can build test plans that test the entire relay as a whole to make sure the relay operates when required for more effective and efficient test procedures.

We will cover the following topics in this lesson to give you a foundation in three-phase electrical theory to help you become a craftsman instead of a button pusher:

Introduction to Electrical Fundamentals and Frequency

- How electricity is created
- What is a cycle
- How to count cycles
- Understand how frequency and cycles are related
- Converting cycles to seconds
- Converting seconds to cycles
- Converting cycles to cycles



Three-Phase Electric Power Systems

- How three-phase electric power systems are created
- How to determine what kind of three-phase electric power system is being generated
- How to change one kind of three-phase electric power into another

Course 1-2: Phasor Diagrams, 4 CEUs

This course will introduce you to phasors and show you how to convert waveform drawings into phasor drawings so that you can understand what phasors are and how they are created. You will be able to understand what is happening inside your relay and test-set with these topics:

- What are Phasors?
- How to Draw Phasor Diagrams
- Drawing Phasors with Lagging Angles
- Drawing Phasors with Different Scales

In a perfect world, these four lessons would be all you needed to become a phasor drawing master. You would be a master at understanding and drawing phasor diagrams in Megger test-sets and GE SR relays but, unfortunately, it seems every manufacturer has a different system for the angles in phasor drawings. The remaining lessons in this course will help you understand all of the different angle systems used by test-sets from Doble, Omicron, and Manta Test Systems as well as the angle systems used by GE UR and SEL relays:

- Draw Phasors with Positive Angles
- Draw Phasors with Negative Angles

Protective Relay Testing Training

Effective, Hands-On Training for Relay Testers

Valence Electrical Training Services has shown its commitment to the high-voltage electrical testing industry with *The Relay Testing Handbook* series and our online training series. Many people we have met over the years have requested a complete training program so that their test technicians will be able to answer all of these questions:

- What is a protective relay?
- Where are protective relays used?
- Why do protective relays need to be tested?
- What are the most common protective relay functions?
- How do I test any protective relay or element?
- What are the most effective test techniques available?

Most protective relay training classes are equipment specific, include over 4 days of training, and are based on decades-old material. This means that the student only learns one way to test the relay, can become overloaded with too much or dated information, and requires overtime travelling to and from the training site.

We have combined all of our training experience to create a modern curriculum for today's relays and test equipment. Our class sizes, topics, and durations have been carefully planned to make sure our trainees actually retain the information they obtain in the class through a combination of theory and hands-on training. We use modern relays and techniques that can be applied to any modern test set from any manufacturer.

All of our in-person training classes include post-training services where students can ask those questions they didn't think of while attending the class and consult with relay testing experts to help them after the classes are complete.

While we focus on ensuring that students graduate with the knowledge and skills they need to become effective relay testers, we understand that recognition is also important. All of our graduates receive a certificate of completion that can be used with your regulating board, and each class has been pre-approved for the number of NETA Continuing Education Units (CTDs) listed in each class description.



Introduction to Modern Relay Testing

3-Day Class, 24 CEUs

Why do I want to take this class?

Modern protective relays can be extremely complex or relatively simple, depending on the relay model and design engineer. It is possible to use some testing techniques from previous relay generations, but these techniques only test individual elements which does not guarantee the relay is set correctly or will operate when required.

Most modern relay problems have nothing to do with the actual relay as supplied by the manufacturer. Today's relay problems occur when the relay has been incorrectly connected to the power system, or was set incorrectly by the design engineer. Unfortunately, these problems cannot be detected by traditional relay testing techniques that reprogram the relay in order to get the right test value for the test sheet. These techniques don't ask the right questions to find the problems that prevent the relay from operating and they are never discovered until the relay is needed most, and it fails to operate.



Modern relay testers must apply several different skill sets to effectively test digital relays so that they can get the test results they need for their reports, and make sure the relay is properly applied. This class will provide the basic skills every modern relay tester should have including:

- Understanding the power system
- Why and how protective relays are applied
- Understand phasors and phasor diagrams
- What do these numbers mean? (50/51/67/etc.)
- Compare single-line, three-line, manufacturer, and DC drawings
- Communicate with relays and test-sets
- Build effective and efficient test plans
- Apply basic relay testing procedures
- Digital relay logic

Day 1 Topics

1. Class Introduction
2. Power System Basics
3. Protective Relay Introduction
4. Phasor Diagrams

Day 2 Topics

1. Comparing Drawings
2. IEEE Designations
(50/51/67/etc.)
3. Communication Protocols
4. Communicating with relays

Day 3 Topics

1. Understanding relay settings
2. Relay Testing techniques
3. Digital Logic
4. Creating Test Plans
5. Applying Test Plans

Protective Relay Testing Fundamentals

3-Day Class, 24 CEUs

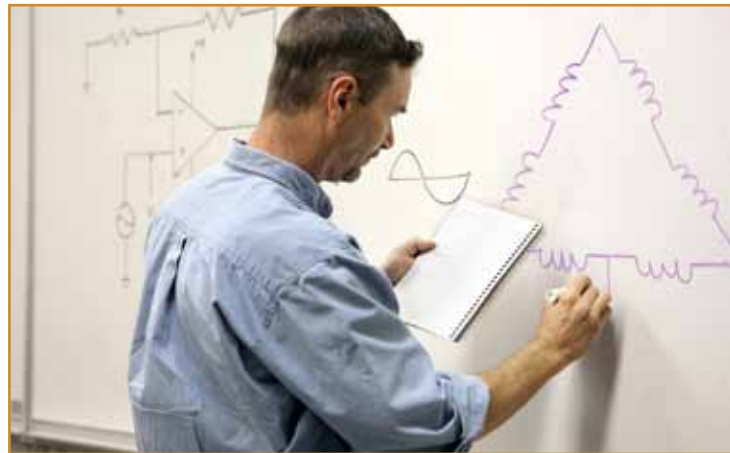
Why do I want to take this class?

Good relay testers need a solid foundation to build from, and the graduates from this program will understand and be able to test the most common functions enabled on any feeder relay such as:

- Time Overcurrent (51)
- Instantaneous Overcurrent (50)
- Overvoltage (59) / Undervoltage (27)
- CO-x or IAC-xx
- Schweitzer Engineering Laboratories SEL-351
- General Electric SR-750

Who should take this class?

We recommend that all relay technicians take the Protective Relay Testing Fundamentals class to ensure that they have a solid foundation before attending any of the other courses. We don't just discuss the mechanics of the topics above; we will review all of the fundamentals that every relay tester should know.



What prerequisites are required?

Prospective students should have a basic understanding of the power system such as Watts, VARs, Ohm's Law, etc.

Day 1 Topics

1. Introduction to relays
2. Introduction to test-sets
3. Introduction to the power system
4. How to perform a meter test
5. Overcurrent protection theory (51/51)
6. How to prepare for relay testing
7. Testing E-M overcurrent relays
 - a. 51 overcurrent pickup tests
 - b. 51 overcurrent time tests
 - c. 50 overcurrent pickup tests

Day 2 Topics

1. E-M relay target testing
2. Review E-M relay testing
3. Testing digital relays
4. Understanding fault types
5. Pickup testing options
6. Testing ground time overcurrent (51N/51G/50N/50G)
7. Testing phase time overcurrent (51P/50P)
8. Dynamic testing principles

Day 3 Topics

1. Digital relay testing review
2. Digital relay testing practice
3. Testing overvoltage elements (59)
4. Testing undervoltage elements (27)
5. Testing under/over frequency elements (27) **Optional
6. Testing directional overcurrent elements (67) **Optional
7. Testing synchronizing elements (25) **Optional

Advanced Protective Relay Testing Class

3-Day Class, 24 CEUs

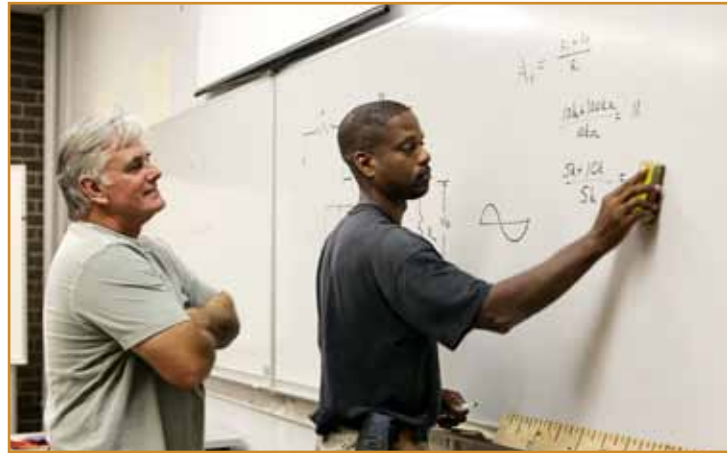
Why do I want to take this class?

Utility environments and transformer relays can be more complicated than the simple feeder relays usually found in industrial environments. This class will build on the Protective Relay Testing Fundamentals Class to create relay testers who can test transmission lines and transformer relays; such as:

- Directional Overcurrent (67)
- Impedance Protection (50)
- Transformer Differential Protection (87)
- Schweitzer Engineering Laboratories SEL-311x, 321, etc.
- General Electric UR Dx0, Fx0, Tx0, SR-745
- Beckwith Electric Co. M-33xx

Who should take this class?

Relay technicians who are comfortable testing overcurrent (51/51), over/under voltage (27/59), and over/under frequency (81) elements and want to test the majority of relays installed on the electrical system.



What prerequisites are required?

Day 1 Topics

1. Introduction
 - a. Power systems
 - b. Substation configurations
 - c. Zones of protection
2. Testing directional overcurrent elements (67)
3. Testing synchrocheck elements (25)
4. Introduction to distance protection (21)
 - a. Impedance diagrams

Day 2 Topics

1. Testing Zone-1 distance protection (21)
 - a. MTA tests
 - b. Reach tests
 - c. Timing tests
2. Testing Zone-2 distance protection (21)
 - a. Three-phase
 - b. Phase-phase
 - c. Phase-ground
3. Dynamic relay testing

Day 3 Topics

1. Introduction to differential protection (87)
 - a. Buss vs. transformer
2. Testing differential protection (87)
 - a. Single-phase/single taps
 - b. Single-phase/multiple taps
 - c. Three-phase/phase shifts
 - d. Minimum pickup
 - e. Slope 1 vs. slope 2
 - f. Harmonic restraint

Generator Protective Relay Testing Class

3-Day Class, 24 CEUs

Why do I want to take this class?

Generator relays are probably the most complex protective relays installed on the electrical system and have many different protection elements to protect the generator from various problems. Graduates of this class will build on the Protective Relay Fundamentals and Advanced class topics and will be able to test these additional elements and relays:

- Backup Overcurrent (51V)
- Reverse Power (32)
- Negative Sequence (46)
- Loss of Field (40)
- Volts per Hertz (24)
- Neutral Voltage (27TN/59N)
- Breaker Fail (50BF)
- Inadvertent Energization (50/27)
- Schweitzer Engineering Laboratories SEL-300G
- General Electric Multilin SR-489, G-x0
- Beckwith M-34xx



Who should take this class?

Relay technicians who are comfortable testing overcurrent (51/51), over/under voltage (27/59), over/under frequency (81), impedance (21), and differential (87) elements and want to test any generator relay.

What prerequisites are required?

Prospective students should have completed the Protective Relay Testing Fundamentals and Advanced classes, or been approved by a Valence instructor.

Day 1 Topics

1. Introduction to generators
2. Testing overvoltage (59)
3. Testing undervoltage (27)
4. Testing under/over frequency (81)
5. Testing impedance (21)
6. Testing voltage controlled / restrained overcurrent (51V)

Day 2 Topics

1. Testing negative sequence overcurrent (46)
2. Testing reverse power (32)
3. Testing loss of field (40)
4. Testing volts/hertz (24)
5. Testing inadvertent energization (50/27)
6. Testing breaker fail (50BF)

Day 3 Topics

1. Testing differential (87)
2. Testing neutral overvoltage (59N)
3. Testing 100% ground protection (27TN)
4. Testing out of step (78)
**Optional
5. Testing synchro relays (25)
**Optional

Motor Protective Relay Testing Class

2-Day Class, 16 CEUs

Why do I want to take this class?

Motor protection relays could be the most common relay found at any industrial site and they have very specific protection features because of the induction motor's unique operating characteristics. Graduates of this class will build on the Protective Relay Testing Fundamentals and/or Advanced class topics and will be able test these additional elements and relays:

- Overload (49)
- Start Blocking
- Mechanical Jam
- Acceleration Trip
- Unbalanced Overcurrent
- RTD Testing
- Schweitzer Engineering Laboratories
SEL-701, SEL-749
- General Electric Multilin SR-x69



Who should take this class?

Relay technicians who are comfortable testing overcurrent (51/51), over/under voltage (27/59), and over/under frequency (81) elements and want to test motor protection relays.

What prerequisites are required?

Day 1 Topics

1. Introduction
2. Meter testing
3. Overload trip protection (49T)
4. Overload alarm protection (49A)
5. Starts per hour / time between starts blocking
6. Mechanical jam protection
7. Acceleration trip protection

Day 2 Topics

1. Previous day review
2. Unbalance alarm
3. Unbalance trip
4. Short circuit protection (50)
5. Ground fault alarm protection (50G)
6. Ground fault trip protection (50G)

Day 3 Topics

1. Previous days review
2. Differential protection (87)
3. Overvoltage protection (59)
4. Undervoltage protection (27)
5. Over frequency protection (81)
6. Under frequency protection (81)
7. RTD protection

Frequently Asked Questions (FAQ)

Are your instructors qualified?

All of our instructors started in the field testing relays and have extensive experience with manufacturers, models, test-sets, and relays. They are industry leaders and have recurring instructor/presenter/author/contributor roles at major industry events and organizations such as:

- InterNational Electrical Testing Association (NETA)
 - Powertest Conference
 - NETA World Magazine
- Western Institute Hands-On Relay School
- TEGG
- Pacific Gas and Electric
- MidAmerican Energy
- Xcel Energy
- Transalta Utilities
- USACE
- Seattle City Light

How do I sign up for a class?

You can go to this link (<http://relaytraining.com/events/>) to see if we are going to be in a convenient location.

Use the online form to register or contact us at store@relaytraining.com or 303-250-8257, and we'll contact you.

If you don't see a convenient location and would like us to come to you, please contact us for a quote for training at your location. We can also offer discounts for hosting an open training class at your facility.

Are meals included?

We will supply coffee and water. We strongly recommend bringing a day's supply of your favorite beverage.

Is lodging or transportation included?

We do not supply lodging or transportation but will send you any discounts that we are able to obtain from local vendors.

Are taxes included?

We do not charge tax for training classes.

What kind of credits do I get?

You will get a certificate of completion after every class that you can use for continuing education credits from the appropriate organizations. We have been pre-approved for CTD credits from the InterNational Electrical Testing Association (NETA) as indicated in the header of each class page. We will work with you as much as we can to get approval from your accreditation organization.



VALENCE

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