NERC CE COURSE CATALOG 2023

Dated: 01/24/2023

Accelerate your experience.

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Introduction

Incremental Systems Corporation (IncSys) and PowerData Corporation (PowerData) are industry leaders in developing the competency of power system operators and satisfying NERC Requirements for Continuing Education. They have jointly developed PowerSimulator®, the world's most flexible, realistic and easily deployable simulator for training power system operators. PowerSimulator® uses the EPRI OTS simulation engine. Organizations that have stringent training standards and challenging operation requirements consistently select PowerSimulator®.

The IncSys and PowerData team bring unique experience and qualifications to helping companies develop and verify the competence of its systems operators in a very timely manner. Our track record includes the following:

- Most successful commercializer of the EPRI Operator Training Simulator Software. We work with 140 utilities and power organizations to aid in the safe & reliable delivery of electricity on six different continents.
- Developer of the Power4Vets program for recruiting, training NERC certifying and placing military veterans in mission critical system operator jobs throughout North America.
- Developed and delivered training in Baghdad for the Iraq Ministry of Electricity operators during 2008 and 2009 when the Iraq system was under attack and required continuous brownouts.
- Developer of the IncSys Academy with a unique blend of on-line tutorials and engaging self-paced on-line simulations.
- Delivered over 10,000 NERC CE and EO hours to system operators in North America to Northwest APDA, Southwest APDA, WUMS APDA, Southeast APDA, Wisconsin System Operator Training Seminars, Florida Reliability Council and Department of Energy at the PNNL Electricity Infrastructure Operations Center.
- Have provided System Operator training for Kenya System Operators to support integration of the 300 MW Lake Turkana Wind Farm.
- Supporting the RC West Wide Area Simulation Based 2020 System Restoration Drills.

More and more companies that have commissioned simulators from their Energy Management System (EMS) provider are finding it very useful to have PowerSimulator® as a complementary tool for expanding and enhancing their system operator training program. Examples include ISO New England, Pacific Gas and Electric, Southern California Edison, CAISO and Sempra. With PowerSimulator®, Reliability Coordinators and Transmission Operators can maximize the use of system-specific models for operator training and limit the use of generic systems for new system operators.

IncSys Academy System Operator Training Program

"An expert is a person who has found out by his own painful experience all the mistakes that one can make in a very narrow field." – Niels Bohr

The beauty of PowerSimulator® is that operators, engineers, managers and students can make mistakes in a realistic simulated environment. These mistakes provide indelible lessons without compromising crew safety, damaging any equipment, incurring excessive operating costs, or losing customer load.

IncSys and PowerData, using PowerSimulator®, have a track record of working with utilities around the world that are undergoing rapid change and urgently need innovative solutions to accelerate the experience of their power system operators and adapt their operating practices.

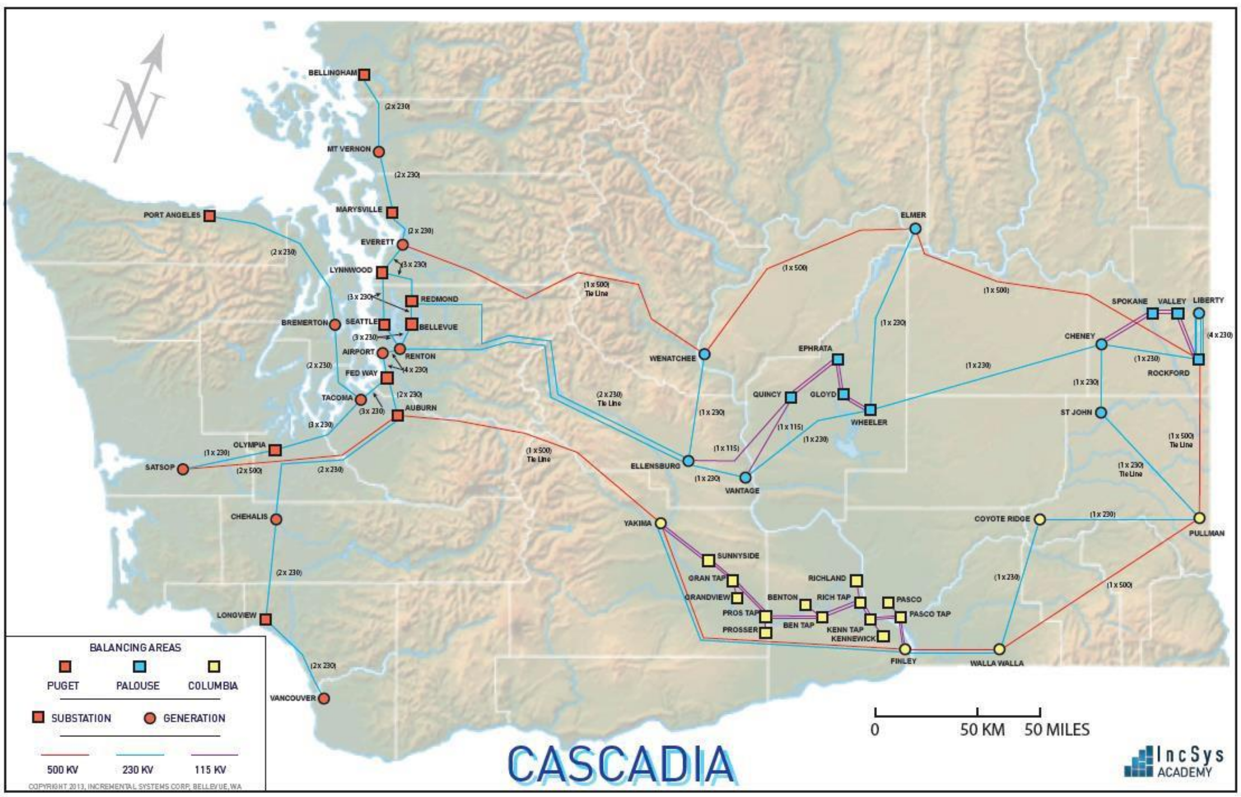
IncSys and PowerData have pioneered innovative solutions for all aspects of recruiting, certifying, placing, initial training and verifying competence of power system operators.

Through simulations, cognitive task analysis, interviews of subject matter experts, story-telling, video recording, speech recognition and learning management we work with our customers to build engaging educational and empowering training curriculum.

The Cascadia System

The main tool for supporting the Generic PowerSimulator® Training Program is the generic Cascadia System. IncSys has been developing and testing operator training materials and scenarios for the Cascadia System since 2012.

The Cascadia System includes a combination of hypothetical rural, commercial, residential, light load industrial and heavy industrial loads. The system includes different mixes of hypothetical generating plants (coal, gas, nuclear, hydro, CTs, wind farms and PV solar farms) and substations and transmission lines layered on the actual geography of Washington State. The power is delivered to customers through 52 hypothetical substations and 2700 miles of high voltage 500, 230 and 115 kV transmission lines. This system provides a much higher degree of realism in the training scenarios compared to the older PALCO system, but it does not use or compromise any actual utility Critical Energy Infrastructure Information (CEII). This allows Cascadia training to include employees who lack the clearance required to view details of your specific system.



The Cascadia System map.

IncSys Academy 2023 NERC CE Online Courses

CEH Summary

IncSys Academy course development follows the Systematic Approach to Training, and faculty are continuously reviewing and updating our online CEH material.

Below is a list of courses approved for CEH's.

CASCADIA NERC CE COURSES					
Course Code	**Course Title**	**OT**	**STD**	**SIM**	**EO**
3010	Introduction to Frequency Control	2	0	1.5	0
3020	Governor Components and Operation	2	0	1.5	0
3030	System Frequency Response	1.5	0	1	0
3040	Automatic Generation Control	2	0	0.5	0
3060	DCS and Contingency Reserve Monitoring	2	2	1.5	2
4010	SOLs and IROLs	3	0	2	3
4020	MW Flow Basics	5	1.5	4	5
4030	Power Transfer Distribution Factors	2	0	1.5	2
4040	Generator Re-dispatch	2	2	2	2
4050	Line Outage Distribution Factors	2	0.5	1.5	2
4060	Managing a Bus Outage	2.5	1.5	2	2.5
4070	Standing Phase Angles	1	0.5	0.5	1
4080	Phase Shifter Operation	2	1	1.5	2
5010	Reactive Power and Voltage Operating Limits	2	0	0.5	0
5030	Reactive Power in a Simple Power System	3	0	1.5	0
5040	Pole and Beam Analogy	2.5	2	2	2.5
5060	Transmission Lines	2	1.5	1.5	2
Total Approved Cascadia NERC CE Course Hours		**38.5**	**12.5**	**26.5**	**26**

PALCO NERC CE COURSES					
Course Code	**Course Title**	**OT**	**STD**	**SIM**	**EO**
100	Intro to Grid Management Systems	6	0	3	0
500	Voltage Control	12	6	5.5	12
Total Approved PALCO NERC CE Course Hours		**18**	**6**	**8.5**	**12**
Grand Total Approved IncSys Academy NERC CE Hours		**56.50**	**18.50**	**35.00**	**38.00**

Category: Frequency and Balancing

Students who complete this series of course modules will have covered every aspect of frequency control including load and energy balance, frequency control modes, frequency bias, frequency graphs, and system oscillations. Students will monitor frequency, predict the frequency response to different system conditions, respond to alarms, and keep their system within its NERC-mandated operating limits. They will apply the ACE equation, Automatic Generator Control, generator dispatch, Contingency Reserve, and how to identify and correct Time Error. A student who has completed all modules in the Frequency and Balancing Series should demonstrate exemplary competence in all frequency-related job tasks.

3010: Introduction to Frequency Control

OT	STD	SIM
2.0	0	1.5

Introduction to Frequency Control is a computer-based training module which consists of a video lecture and simulation exercises. The course covers some basic concepts in frequency behavior on interconnected electric systems, including island size and generator setpoints. The students apply those concepts on a hypothetical power system that behaves like actual transmission equipment. Student performs an exercise to assess an islanded system while recognizing islands and boundaries, as they calculate available generation capacity. They will also observe frequency response within different sized islands by manually adjusting generation and shedding load. The second exercise allows them to observe and control frequency changes within an island, while adjusting generator setpoints, observe frequency changes and how frequency affects the load.

3020: Governor Components & Operation

OT	STD	SIM
2.0	0	1.5

Governor Components and Operation is a computer-based training module which consists of a video lecture and simulation exercises. The course covers some basic concepts in generator governor behavior on interconnected electric systems, including droop and generation setpoints. The students apply those concepts on a hypothetical power system that behaves like actual transmission equipment. Student operates a simulation of a small islanded system. Students anticipate and observe frequency response on loss of generation and they will calculate and apply generator setpoints to restore island frequency to normal. In the second exercise the student operates a simulation of a small islanded system whre they apply different droop settings to generators and observe their behavior. They will also place generators in isochronous mode and observe system behavior during changes in generation and load.

3030: System Frequency Response

OT	STD	SIM
1.5	0	1

System Frequency Response is a computer-based training module which consists of a video lecture and a simulation exercise. Students view a video lecture covering system frequency response under various conditions on a network. Instructor describes the major interconnections in North America and how frequency response changes based on the size of network and how frequency responses are becoming lower over time. Instructor covers different generation plant control modes and how they affect system frequency. Students act as System Operators to simulate the loss of a generating unit. Using simulator displays, students observe and record frequency response, and differentiate measured frequency drop and steady state frequency drop. Students respond to the same loss of generation with LFC first disabled, then with LFC enabled.

3040: Automatic Generation Control

OT	STD	SIM
2	0	.5

Automatic Generation Control is a computer-based training module which consists of two video lectures and a simulation exercise. The video lectures cover the concept and application of Automatic Generation Control and their critical role in maintaining load balance, ACE, and to return frequency to 60HZ following a disturbance. Using diagrams, the instructor explains the function, characteristics, and responsibilities of Balancing Authorities. Using real examples from across North America, the instructor explains BA diversity and the computer systems a BA System Operator may use. Using diagrams, instructor provides examples of the actual, scheduled, and inadvertent interchanges. Students act as System Operators to simulate the loss of a generating unit. Students will trip a unit in a designated area, then use the data from various PowerSimulator® displays to calculate the frequency bias. The exercise is repeated using a different unit in the adjacent BA, and the bias is again calculated.

3060: DCS and Contingency Reserves Monitoring

OT	STD	SIM	EO
2	2	1.5	2

This is a computer-based training module which consists of a video lecture and a simulation exercise. The instructor describes and differentiates the categories of operating reserves, discussing the requirements for each class of reserve as required by NERC Standard BAL-002 and explains the difference in spinning and non-spinning reserves while providing examples of what sources can be used as Contingency Reserve. The Instructor defines the Most Severe Single Contingency and provides examples while states the DCS Performance Criteria for ACE from NERC Standard BAL-001, defines the term Percentage Recovery, and states the penalty of holding additional reserves if ACE is not recovered after reportable disturbances. Instructor describes the Contingency Event Recovery Period, Contingency Reserve Restoration Period and Reserve Sharing Groups. The students will operate the simulated power system as a Balancing Authority where they apply the requirements of NERC Standard BAL-002 and EOP-011 during an exercise of the loss of a major generating unit during peak load conditions. They will review Reserve Sharing Agreement for the simulated Balancing Authority and monitor the system and calculate reserves and prepare for the Most Severe Single Contingency. They will also use multiple methods to prepare and respond to the MSSC for the simulated Balancing Authority including scheduling interchange and bringing generating units online and changing MW setpoints, deploying contingency reserve, and making appropriate notifications based upon BAL-002 criteria while following the guidelines of EOP-011, apply an adjusted IROL in response to an Energy Emergency Alert Level 3

Category: Transmission Network Flows

Students who complete all modules in this series should be well-versed in transmission network flows on parallel paths, standing phase angles, and shaft torque. They will be capable of identifying potential outages and minimizing/restoring unscheduled outages when they occur. They will identify angle differences, calculate both Power Transfer and Line Outage Distribution Factors, identify path impedance, manage buses effectively during contingencies, and comply with all NERC System Operating Limits. They will identify key factors contributing to the Southern California Outage, the regulatory response to it, and what that means for operators manning desks today. They will be able to operate breakers without damaging generators or deviating from frequency limits. They will identify and plan for their Most Severe Single Contingency and respond to outages by shedding load, shifting generation and initiating a controlled shutdown to accommodate an outage. Students will also resynchronize islands and remove transmission lines from service without causing a cascading outage.

OT	STD	SIM	EO
3	0	2	3

4010: SOLs and IROLs

This is a computer-based training module which consists of a video lecture and two simulation exercises. The instructor describes on widespread interconnection outages and operating limits, using the Southern California Blackout and the Northeast Blackout as examples. The instructor describes the steps that led to the blackout, and recommendations made by NERC and FERC and also defines the various ratings and limits defined by NERC and reviews NERC standard TOP-001. In the first simulation exercise, students will operate a real-time scenrio on a hypothetical power system according the NERC Standard TOP-00 and respond to System Operating Limit violations, identify the location and return system to a stable state using contingency analysis. The second simulation scenrio the studdent will operate a real-time simulation of a hypothetical power system according the NERC Standards TOP-001 and IRO-009-2. They will respond to a Interconnection Reliability Operating Limit violation and use contingency analysis to identify and test different IROL violations. After experiencing a contingency that results in an IROL violation, students identify the condition and return the system to a stable state while adhering to NERC standards.

OT	STD	SIM	EO
5	1.5	4	5

4020: MW Flow Basics

This is a computer-based training module which consists of a video lecture and three simulation exercises. Students watch a video lecture covering a series of topics related to the basics of megawatt flows, the principles of megawatt flow in AC networks, Kirchhoff's voltage and current laws, and Ohm's law, the impedance in series and in parallel and how it can be used to calculate phase angles. They will also learn how to calculate bus angle differences. Students will perform a series of simulated exercises related to Kirchhoff's Node Law, Kirchhoff's Loop Law and DC Load Flow Analogy.

OT	STD	SIM	EO
2	0	1.5	2

4030: Power Transfer Distribution Factors

This is a computer-based training module which consists of a video lecture and a simulation exercise. Students watch a video lecture covering parallel path flows where they will learn about how megawatts flow along parallel paths. They will also learn how to calculate power transfer distribution factors (PTDF), and the elements that affect PTDFs. Students learn how changing MW flow can help mitigate overloaded transmissions. Students perform a simulated exercise on a hypothetical power system that teaches about PTDFs, LODFs, and controlling MW flows. Students use the hypothetical power system to build equivalent line 230kV line lengths along the major transmission lines, loops, transformers, and sets of multiple parallel lines. The equivalent line lengths are then used to calculate PTDFs for a generation shift to alleviate overloaded transmission lines following various line outage

OT	STD	SIM	EO
2	2	2	2

4040: Generator Re-Dispatch

This is a computer-based training module which consists of a video lecture and two simulation exercises. Students watch a video lecture explaining the concept of generation redispatch as a tool for transmission operators to reduced overloaded transmission line conditions as they define generation shift factors (GSF) and how it affects a network and how network topology changes GSFs. In the simulation exercises the student learns how to calculate GSF along with the applicable requirements from TOP-001 and apply the concept of generation redispatch to alleviate SOL violations following a system contingency and respond to a double circuit line outage and observe a SOL violation on remaining parallel lines and review generation resources and determine which candidates to use for the generation redispatch. In the second exercise students will apply generation redispatch and load shedding during an Interconnection Reliability Operating Limit violation and play the roles of TO, BA, and RC. Students review TOP-001 requirements presented in "concept diagram" format and the established operating limits for the hypothetical power system. They will run an event file that leads to a transmission line being overloaded beyond its long-term rating. Based on contingency analysis studies that predict system collapse for the next N-1 contingency, students react to being in an IROL violation condition and choose the best action to stabilize the system. Students calculate the generation shift using power transfer distribution factors, then dump generation and shed load based on their choice and they will also observe the results and compare them to their calculations.

OT	STD	SIM	EO
2	.5	1.5	2

4050: Line Outage Distribution Factors

This is a computer-based training module which consists of a video lecture and two simulation exercises. Students watch a video lecture explaining the concept of generation redispatch as a tool for transmission operators to reduced overloaded transmission line conditions and the applicable requirements from TOP-001. The instructor describes the conditions where generation redispatch is effective, including reducing MW flow, providing MVAR resources, and decreased bus angle differences and also provides guidelines for applying generation dispatch using diagrams. They also define generation shift factor (GSF) and how it affects a network and how network topology changes GSFs. The instructor provides several examples from a hypothetical power system on how to calculate GSF and students will apply the concepts of Line Outage Distribution Factors to a hypothetical power system while reacting to a brush fire event that leads to transmission line outages. An Electrical Distance Diagram is used by students to calculate the LODF on designated transmission lines and they will use the LODF and simulator data to predict the flow on parallel lines when other lines are removed from service. Students then remove the line and compare the simulator results to their calculations. This process is repeated for different configurations with multiple, non-identical, parallel paths. Students will perform a more complicated simulation exercise where they calculate Line Outage Distribution Factors and apply them to multiple paths as they prepare for the outage of a major transmission corridor. Students use the equivalent 230 kV line lengths to accurately estimate the amount of MW flow that will move to another two parallel paths as each transmission line is removed from service

OT	STD	SIM	EO
2.5	1.5	2	2.5

4060: Managing a Bus Outage

This is a computer-based training module which consists of a video lecture and two simulation exercises. Students watch a video lecture explaining bus configurations and bus outages. The instructor discusses the causes and conditions of both planned and forced bus outages. Using one-line station diagrams, the instructor provides explanations of Double Breaker, Main and Transfer, Breaker and Half, and Ring Bus schemes and the advantages of each scheme and how a bus outage in each could affect load and transmission elements. Students perform a simulated exercise where they respond to two types of outages at a main and transfer substation while reviewing the applicable NERC TOP-001 requirements, and operating limits, and definitions for System Operating Limit (SOL) or Interconnection Reliability Operating Limit (IROL). Students will set up the proper displays for running the system as a transmission operator and identify equipment transmission equipment and substations configurations on the simulator station one-line displays. They will also respond to the contingencies by making the correct reports to the Reliability Coordinator placing the system into a secure state. Students will use contingency analysis to help determine the severity of the fault and any SOL or IROL violations and whether their actions have resolved any SOL and IROL violations while developing switching plans to return equipment back into service. In the second exercise the students will experience contingencies that affect a breaker and half scheme and they will apply a fault to a transmission line and then apply a fault to a bus, observing the results and comparing the effects of each. While one bus in a breaker and half scheme is out of service, students apply faults on other transmission elements to observe the effect

OT	STD	SIM	EO
1	.5	.5	1

4070: Standing Phase Angles

This is a computer-based training module which consists of a video lecture and a simulation exercise. Students watch a video lecture and learn about Standing Phase Angles (SPA). The Instructor reviews findings of the 2011 Southwest Blackout, the definition of Standing Phase Angle, the conditions that lead to SPAs, and the relationship between SPA and impedance. Shock torque will be defined in the lecture and they will calculate an example using per unit values and descript the damage that can be caused to generator suffering shock torque. Synchro-check relays will be defined, along with how they function and provide solutions for lowering SPA by shifting generation, dropping load, and closing in a transmission line at an intermediate point. Students will explain the technique of using double bus arrangement to drop load from the lagging angle end then restore it using the bus with the leading angle. They will learn how to calculate the angle difference based on the estimated line lengths, typical reactance's of transmission lines, and the amount of MW flow on the line in per unit values. Students will perform a simulated exercise where they will play the role of Reliability Coordinator and Transmission Operator while responding to a tripped 500 kV transmission line that causes a large standing phase angle. Students will review the applicable NERC standards IRO-001 and IRO-009 to establish the responsibilities of the RC, TOP, and BA in regards to reliability and having processes to operate within IROLs. Students review applicable NERC standard TOP-001 to establish the TOPs responsibility in monitoring and controlling SOL and IROL violations. They will also review the actions that could be taken to reduce a SPA and the role the RC has in directing the TOPs and BAs to take operating action. Students will place a fault a on a 500-kV transmission line and attempt to reclose it and use a synchroscope display to observe a large SPA then choose the action to take to reduce it. Upon reducing the angle to a manageable level, they return the line to service.

OT	STD	SIM	EO
2	1	1.5	2

4080: Phase Shifter Operation

This is a computer-based training module which contains a blend of video lecture and simulation to instruct students on the design, operation, and functions of Phase Shifters. Students learn how phase shifters can control MW flow in AC networks. Then students operate a phase shifter in hypothetical power system to observe the effects of different tap settings. Students also use the phase shifter to remove an IROL violation during a simulated loss of transmission line contingency. The Instructor presents a lecture on phase shifters construction and use and the students review how power flows on transmission lines. The instructor will provide examples of network conditions with a phase shifting transformer as it controls the angle of the sending bus. The instructor also reviews the phase shifter tap settings and how they are operated. Students will perform a simulated exercise on a hypothetical power system where they record MW flows around a major loop in the network, operate a phase shifting transformer, and record the changes in the system as they review the simplified power flow equation in order to predict the changes in looped MW flow when setting the tap positions of the phase shifting transformer. Students will perform another simulated exercise on a hypothetical power system where they play the role as the Transmission Operator while responding to transmission line MVA System Operating Limit violations. They will review NERC standard TOP-001-4 and the system operating limits of the equipment on the hypothetical system and use the SCADA interface and contingency analysis program to monitor for System Operating Limits and Interconnection Operating Reliability Limits. They will also operate the phase shifting transformer to remove IROL violations.

Category: Voltage and Reactive Power Control

This course series introduces one of the most difficult subjects in power system, operations: Reactive power. They will articulate the relationship between real and reactive power, the effects of high and low voltages on equipment, the nature and application of MVAR resources and the NERC standards governing voltage scheduling. They will be able to calculate a power triangle, anticipate variations in bus voltage, explain the effect of Ferranti rise, operate tap changers in a simulated system, and restore a system to normal operation. They will apply the mental model for identifying weak and strong buses based on system conditions, and to identify bus voltage variations with inductors, capacitors, and MW loads. They will dispatch MVAR reserves, respond to severe over voltage conditions, and anticipate the isolating effects of generators. Students will describe Automatic Voltage Regulator operation and the role of generators in voltage control. They will monitor steam and hydro MVAr Capability Curves and coordinate Generator Regulated Voltage Schedules. They will comply with the NERC standards for Generator Operators in maintaining voltage schedules. They will use PowerSimulator® to adjust voltage setpoints and predict MVAr output and terminal voltages. Students will respond to overloaded transmission lines, tripped lines, Ferranti Rise on open-ended lines, and will take the appropriate post-contingency actions. Students will accurately describe the purpose, construction, and applications of shunt capacitors and reactors as well as Static VAR Systems. They will identify the failure modes of capacitors and the effects of shunt capacitors on weak buses and generators. Students will explain the construction and operation of various types of transformers, their winding configurations, tap changers, and applications in a transmission network. They will anticipate voltage collapse conditions and load pickup based on time of day and plan for increased load. They will use PowerSimulator® to respond to a triple contingency and operate tap changers following a contingency. They will also use it to maintain system stability by shedding load, decreasing the interchange schedule, and reducing overloads before restoring the system to normal operation.

OT	STD	SIM
2	0	.5

5010: Reactive Power and Voltage Operating Limits

This is a computer-based training module which consists of three video lectures and a simulation exercise. Students view a video lecture on the fundamentals of real and reactive power where the instructor discusses the role electric fields play in transmission system equipment and the production of reactive power, differentiating inductive reactive power and capacitive reactive power and the devices that provide those sources of MVars. To include explaining the components of power, power factor, and illustrating the real and reactive power triangles. The second video lecture explains the behavior of reactive power as applied to networks where the instructor discusses MVAR sources and MVAR loads within the power system, and describes how operators use those pieces of equipment to maintain voltage. Using diagrams, the instructor explains reactive power flow in relation to voltage, angle, and MW transferred and also discusses the condition of voltage collapse and provides examples of events that can cause low voltage. The final video lecture the instructor stresses the importance of voltage operating limits by illustrating the various causes, effects, and indicators of excessively high or low voltages and also provides real-world examples of voltage contingency limits, required actions and time limits. The simulation exercise engages the students to use various screens, tables, and controls to act as operators of a simulated power system. Working within a small islanded system, the student observes generator behavior as they add reactive load and then energize a line and they also use transformer data to illustrate the real and reactive power triangle under multiple reactive load conditions.

OT	STD	SIM
3	0	1.5

5030: Reactive Power in a Simple Power System

This is a computer-based training module which consists of two video lectures and a simulation exercise. Students view a video lecture on the fundamentals of real and reactive power where the instructor discusses the role electric fields play in transmission system equipment and the production of reactive power. Instructor differentiates inductive reactive power and capacitive reactive power and the devices that provide those sources of MVars. Using diagrams, the instructor explains the components of power, power factor, and illustrates the real and reactive power triangles. The second video is a lecture on the behavior of reactive power as applied to networks. Instructor discusses MVAR sources and MVAR loads within the power system, and describes how operators use those pieces of equipment to maintain voltage. Using diagrams, the instructor explains reactive power flow in relation to voltage, angle, and MW transferred. Instructor discusses the condition of voltage collapse and provides examples of events that can cause low voltage. Students observe a video demonstration of reactive power principles in the hypothetical network. Students then take the role of the Puget Transmission Operator within the simulation. Students predict and observe changes in a small, islanded network as generator setpoints are raised and lowered. Students observe the effect of limited MVAr reserves, and simulate a blackout when specific lines and capacitors are removed from service.

OT	STD	SIM	EO
2.5	2	2	2.5

5040: Pole & Beam Analogy

This is a computer-based training module which consists of a blend of a video lecture and simulations to instruct students on the Pole and Beam analogy to explain voltage control on networks. Students will view a video lecture explaining the fundamentals of MW and MVArs and what techniques are available to operators when controlling voltage on the system. Students apply what they have learned through two simulation exercises where they operate a hypothetical network. Students will view a video lecture on the fundamentals of voltage and MVArs in a power system and students are introduced to the pole and beam analogy that describes the interaction of line length, capacitors, reactors, and generators in a network to explain how voltage and MVARs behave. Students learn which transmission elements will cause the voltage profile to rise or sag. Using the analogy, students learn how to anticipate MVAR deficiencies and predict over and under voltages on a hypothetical network. Students perform an exercise using an online simulation of a hypothetical network while acting as a Transmission Operator, students perform operations according to NERC standards, and learn how to apply the standards from VAR-001, TOP-001 and IRO-009. During the exercise, students experience a bus outage on a radial part of the system causing low voltage. Students run the contingency analysis program to identify SOLs and IROLs, then identify corrective action to remove the violations. Students respond the contingency by bringing online more generation and returning equipment to service. Students calculate the correct amount of load shed and take that action. Students perform an exercise using an online simulation of a hypothetical network. Acting as a Transmission Operator, students perform operations according to NERC standards, and learn how to apply the standards from VAR-001 and TOP-001. During the exercise, students receive a circuit breaker SF6 low pressure alarm. Students respond by removing the breaker from service. A following wind storm event causes multiple faults on the system and students use displays and the alarm log to identify the effected lines and busses. Students run the contingency analysis program to identify SOLs and IROLs, then identify corrective action to remove the violations. Students record and monitor voltage as they remove capacitors and return transmission lines to service. Students review their actions and how the pole and beam analogy apply to the scenario.

OT	STD	SIM	EO
2	1.5	1.5	2

5060: Transmission Lines

This course is a computer based blended course of video lecture and simulation exercise to instruct students on the features of Transmission Lines in regards to voltage control on networks and surge impedance loading. They will also learn the characteristics of transmission lines in regards to voltage control on a network. The lecture will explain the behavior of transmission lines under various loaded conditions. Students will learn the definition and derivation of Surge Impedance Loading (SIL). Using the concept of SIL as a square function, students learn how severely MVArs are consumed or created based on the line loading and the SIL. Students will then apply what they have learned through a simulation exercise where they operate a hypothetical network and observe transmission lines characteristics at different loading levels. The students learn how MVAr gains and losses affect the voltage profile in order to predict the changes in voltage during the simulation exercise. Students will also learn the derivation of the Ferranti rise calculation, how the condition is caused, and the risks associate. They will also observe and record system conditions on different transmission lines in the network and record the MVAr reserves in the system and what are produced on a set of transmission lines. Students prepare to increase the load on those lines, and calculate the change in voltage and MVArs absorbed by transmission lines. They will also simulate contingencies by removed lines from service, loaded parallel lines 2x and 4x their SIL. During the contingencies, students monitor for IROL violations and record system conditions including voltage and MVAr reserves.

IncSys Academy Courses on PALCO

Power Systems Operation Courses - PALCO

The Power System Operations Courses (PSOC) are a series of course modules that are longer in length than the Cascadia courses mentioned earlier in the catalog and they use the Generic Simulator called - PALCO. These course modules introduce operators to training with theory and practical knowledge, coupled with power system simulation and each module can take from 4-10 hours to complete. Currently we only have two course modules in PALCO named PSOC 100 and PSOC 500. The course descriptions for each series are outlined below.

OT	STD	SIM
6	0	3

PSOC 100: Introduction to Grid Management Systems

This is a computer-based training module which consists of a number of video lectures and simulation exercises. The instructor presents a lecture on the evolution of Energy Managements system starting with Analog AGC systems in 1950's, through first Digital AGC/SCADA systems in 1960's first generation EMS in 70's to 90's and second-generation systems in 2000's. The lecture also covers the evolution of master station to substation communications including first generation discrete component Remote Terminal Units (RTUs), second generation computer based RTUs and third generation distributed Intelligent Electronic Devices (IEDs). Grid management applications that are recommended by NERC for maintaining network reliability are also explained where they cover new reliability applications that consider system dynamic response and use PMU data. Some challenges in sharing models and upgrading legacy Energy Management Systems are also covered. The instructor lectures from the EPRI report on Grid Operating Systems 3.0. and covers power system changes such as: distributed generation, electric vehicles, increased renewables and distributed controls and how these changes are necessitating a new generation of Grid Monitoring, Control and Analysis Systems. The characteristics and behaviors of people with different levels of expertise from novice to expert or master are explained as well as the recognition primed decision model originally developed by Dr. Gary Kline that has been adapted to describe how system operators develop situational awareness and make decisions. Students will learn the basic functionality of the power simulator features in this lecture as well as operate it with detailed step by step instructions and build a cranking path from a generator which has the capability to run back to house load after a system disturbance. After the secondary steam unit is synchronized, the student will add load in controlled steps to bring both units up to their minimum operating level while keep the frequency deviations within limits.

OT	STD	SIM	EO
12	6	5.5	12

PSOC 500: Voltage Control

This is a computer-based training module which consists of a numner of video lectures and simulation exercises. The Instructor presents lectures on the reactive power, the real and reactive power triangle and waveforms, static and dynamic MVAR resource, MVAR characteristics on line and voltage collapse in radial systems. Instructor presents lecture on high and low voltage limits and how a large Reliability Coordinator categorizes these limits along with appropriate corrective actions and timeframes. Pole and beam analogy for understanding voltage and MVAR characteristics in a network. Students learn to recognize when a network may be vulnerable to voltage collapse and they are also shown how to calculate MVAR reserves in vulnerable areas while learning about Automatic Voltage Regulator operation. Students will identify the limiting elements of the Steam and Hydro Generator MVAR Capability Curves. NERC standards VAR-001 and VAR-002 are covered for the role transmission operators and generator operators play in maintaining voltage schedules and students will observe the voltage and megavar characteristics of generators in the simulator by adjusting AVR voltage setpoints and monitoring MVAR output and terminal voltages. They will also observe the effects of switching AVRs from AUTO to MAN mode while applying the NERC standards VAR-001 and VAR-002. Instructor presents a lecture on transmission line Surge Impedance Loading, Ferranti rise and effects of heavy transmission line loads on bus voltages. Students will operating the simulator according to the NERC standards IRO-008 and TOP-001 and determine the maximum power transfer on a path when a line has voltage support at both ends while monitoring line MVAR flows and detect when it is operating at the SIL. The instructor presents a lecture on shunt capacitors, reactors and Static VAR Systems (SVS)and students will learn about the purpose, application, and construction of shunt capacitors, shunt reactors and SVS. Students learn the different failure modes of capacitors, back-to-back switching, and trapped charge as well as the concept of "Getting Ahead of the Voltage". Students learn about the purpose, application, and construction of static var compensators, including transmission, industrial, and wind farm applications and also learn about transformers and their role in transmission networks, the various types of transformers, their construction, and the principles of operatio. Instructor presents a lecture on construction and operation of tap changers and how to use tap changers to control voltagew where they will learn different methods of cooling transformers and the impact they have on transformer operation and how they tie into a SCADA system.

End of Course Instructions

After successful completion of all of our courses a certificate of completion is available for download and print from your training portal homepage.

If you are PJM Certified you can also submit your course certificate to TrainingSupport@pjm.com and also received the PJM Credits for our courses.

After succesful completion any course completed, your course credits will be reported via SOCCED manually on a **WEEKLY** basis (ever Monday). If you encounter any issues with your NERC CE Credits please contact our team at 425.732.2377 X 3 or email calvin.kaiser@incsys.com or 425.732.2377 X 2 or email david.miranda@incsys.com.

Quiz & Simulation Information
In order to receive your NERC CE credits all quizzes and simulation exercises must be passed with a **MINIMUM** grade of 75%.

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