Registered Apprenticeship Program for

Substation Electrician

SAGE
Wisconsin's Sector Alliance *for the* Green Economy

Occupation Summary

Substation electricians inspect, test, repair, and maintain both high and medium voltage electrical equipment related to power transmission and distribution, with a specialization of substations. Tasks include:

- Oversight of construction and commissioning new equipment
- Routine maintenance and testing and analyzing test results
- Troubleshooting faulty equipment and monitoring the operation of substations

Summary of Apprenticeship Program

- On-the-job learning is the heart of apprenticeship, constituting approximately 90% of the program. Apprentices learn key duties and tasks in a hands-on manner directly from a skilled worker.
- Paid related instruction teaches apprentices the theory behind their daily duties, and constitutes approximately 10% of the program.
- The Substation Electrician apprenticeship is approximately four years, including approximately 7,360 hours of on-the-job learning and 640 hours of paid related instruction.
- The program uses a new "hybrid" model. In on-the-job training, apprentices must successfully complete learning hours and competencies, as described in the program provisions of the apprentice contract.

On-the-Job Training

Key duties and tasks, referred to as "work processes," include:

- Substation Safety, Substation Operations, Substation Repairs
- Substation Testing and Maintenance, Relays and Controls, Substation Equipment Installation
- Substation Grounding Systems, Cabling and Bus Systems, Environmental Protection & Oil Handling

Paid Related Instruction

- Related instruction is provided by Northeast Wisconsin Technical College
- The employer is responsible for paying the apprentice to attend 640 hours of required classes

Additional Requirements

- An employer may require an apprentice to obtain a heavy equipment operator license and/or Commercial Driver License (CDL)
- An apprentice must pay for and complete First Aid, CPR and applicable OSHA requirements, as indicated in the Special Provisions portion of the apprentice contract

Participant Support Services

Once registered, apprentices are notified by the Bureau via letter that they might be eligible for supportive services through the SAGE project until December 31, 2012. Services includes:

- Training Funds up to $1,800 per participant (tuition, book fees, job related tools/clothing/ equipment)
- Supportive Funds up to $1,800 per participant (transportation, childcare, auto repairs, etc.)

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Qualifications of a Substation Electrician Apprentice Applicant

- Must be High School graduate or equivalent
- Must be physically able to perform the work of the trade with reasonable accommodations, including lifting, climbing, ability to work outside in all types of weather, without hazard to themselves or others
- May be required to undergo drug or alcohol testing at time of selection as an apprentice
- Must have a valid driver's license

Responsibilities of a Substation Electrician Apprentice

- Work safely and follow employer's written work rules and policies
- Maintain a record of training required by the occupation information
- Pay the tuition and book costs for related instruction
- Advance competency on- the-job under the supervision of a skilled worker
- Notify the Apprenticeship Training Representative (ATR) of address changes, new phone numbers, or any other status changes and upon completion of related instruction and work-based competencies

Qualifications of a Sponsoring Employer

- Provide training environment conducive to delivering well-rounded, work-based training for apprentices, including well maintained and current equipment
- Ensure that apprentices are trained in the core work processes identified for this trade and employ a full time journey worker to supervise the apprentice and ensure safe training at all times
- Licensed and in good standing with appropriate regulatory agencies

Responsibilities of a Sponsoring Employer

- Train apprentice(s) on-the-job and provide learning experiences as outlined in the occupation information
- Provide proper supervision and mentoring of apprentices from an experienced journey level workers
- Monitor the apprentice's on the job progress and provide feedback
- Ensure apprentice is released from work to attend related instruction (school) and pay apprentices while attending classroom instruction at the same rate as for services performed

Getting Started

- Contact the Bureau of Apprenticeship Standards at (608) 266-3332 or www.wisconsinapprenticeship.org
- The Bureau will put you in contact with the Apprenticeship Training Representative in your area

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TERM OF APPRENTICESHIP: The term of apprenticeship shall be Hybrid, which has been established to be 8,000 hours. In addition to the specified hours, the apprentice must successfully attain the competencies described in these program provisions. Hours of labor shall be the same as established for other skilled employees in the trade.

PROBATIONARY PERIOD: The probationary period shall be the first 12 months of employment, but in no case shall it exceed twelve calendar months. During the probationary period, this contract may be cancelled by the apprentice or the sponsor upon written notice to the Department, without adverse impact on the sponsor.

SCHOOL ATTENDANCE: The apprentice shall attend the Wisconsin Technical College System or other approved training provider, as assigned, for paid related instruction four hours per week or the equivalent and satisfactorily complete the prescribed course material for a minimum of 640 hours, unless otherwise approved by the Department. The employer must pay the apprentice for attended related instruction hours at the same rate per hour as for services performed.

WORK PROCESS SCHEDULE: In order to obtain well-rounded training and thereby qualify as a skilled worker in the trade, the apprentice shall have experience and training in the following areas and shall demonstrate competency, as specified herein. This instruction and experience shall include the following operations but not necessarily in the sequence given. Time spent on specific operations need not be continuous.

Work Process Description	**Approximate Hours (Min - Max)**
Substation Safety •Adhere to applicable codes, standards and regulations, and employer operating procedures (National Electrical Safety Code, Public Service Commission, National Electric Code, Occupational Safety & Health Administration 1910.269) •Adhere to lockout and tagout procedures •Apply construction safety competencies •Inspect, use and maintain proper personal protective equipment •Operate trucks and moving equipment safely •Follow testing and grounding procedures •Protect people and equipment from arc flash •Follow confined space entry procedures •Use safe lifting, moving, and rigging techniques •Protect self and others from falls and overhead dangers •Adhere to hazard communication procedures •Follow machine and power tool safety guidelines •Follow trenching, shoring, and excavating procedures	400
Substation Operations •Verify the operational status of the substation •Inspect the condition of a substation (fence, security, damage, washouts, gravel, signage, grounding) •Perform required lockout and tagout procedures •Perform required grounding procedures •Operate single phase or gang operated switches •Operate automatic switch or breaker controls •Operate load tap changers and voltage regulators	1000

- Take action to resolve power and annunciator alarms
- Extract or record event information from relays or substation equipment
- Read, interpret and record nameplate information

Substation Repairs 1000

- Identify damaged foundations and plan for required repairs
- Clean insulators and bushings
- Replace damaged arrestors, insulators, bushings and conductors
- Troubleshoot and repair breakers, regulators, LTCs, and switches
- Troubleshoot SCADA and communication systems
- Repair or replace security equipment and devices
- Produce written reports, field logs, service/repair orders, and technical information
- Troubleshoot power transformers and plan for required repairs

Substation Testing & Maintenance 1000

- Perform inspection of substation equipment and components according to schedules
- Perform ground grid resistivity and resistance checks
- Perform infrared testing
- Perform insulation integrity test
- Perform transformer turns ratio testing
- Collect insulation oil samples from transformers, breakers, bushings, and regulators
- Test integrity of batteries, breakers and relays
- Test integrity of power cables
- Commission new substation construction and equipment

Relays & Controls 1000

- Mount prefabricated status and control panels
- Install and assemble AC panel and transfer switches
- Install building service lights, outlets, and service switches
- Install building service heating, ventilation, and air conditioning equipment
- Assemble battery bank systems following safety training
- Assemble DC panel boards
- Install relays, test switches, selector switches, light transducers, and other devices into existing control panels
- Install SCADA & other communication systems
- Install and maintain security equipment for substations and equipment
- Acquaint self with pre-fabricated control buildings
- Identify and evaluate zones of protection & interpret relay targets
- Apply knowledge of over/under frequency (NERC)
- Interrogate relays for fault locating, metering, current flows for switching operations
- Apply knowledge of reverse power flow during testing, service, and

repair

Substation Equipment Installation 600
•Install current transformers, potential transformers, and power transformers
•Install and assemble: single and gang pole switches; circuit breakers; gang operated switches; motor operated switch devices; capacitor banks; arrestors; and voltage regulators
•Operate processing rig for circuit breakers and transformers
•Operate gas cart for surface insertion and reclamation
•Demonstrate awareness of prefabricated control buildings

Environmental Protection & Oil Handling 500
•Control erosion and ground water runoff
•Handle environmentally friendly and mineral oils properly
•Handle SF6 gas reporting and control procedures
•Recycle used oil and equipment appropriately
•Respond to spill related incidents properly
•Manage evasive plant species
•Comply with DNR, EPA and other agency requirements including spill prevention control and countermeasures (SPCC)
•Apply knowledge of absorption and containments methods and techniques
•Reports spills following company or State rules promptly

Substation Grounding Systems 400
•Apply theories of ground grid, switching grates, equipment grounds, step potential, and subgrade soil/rock to jobsites
•Demonstrate exothermic welding & electrical theory to grounding systems
•Connect above grade ground connections (steel, equipment, fence, enclosures, control house, etc.)
•Interpret construction prints, electrical schematics and grounding plans
•Perform assurance testing for grounding systems
•Produce written records, as-built drawings, field installation notes, and technical reports

Cabling 400
•Interpret electrical schematics, drawings, and substation plans related to electrical cabling
•Measure, cut, label, install and terminate communication and control cables per installation drawing or schematic
• Measure, cut, label, install and terminate high and low voltage cables per installation drawing or schematic
•Perform tasks in accordance with cable classes and specifications
•Test cable installations

Bus Systems	300
•Measure and cut bus to length according to prints or plans	
•Clean and polish bus for proper connections	
•Erect rigid bus on equipment or structures	
•String bus between structures and equipment	
•Install compression, welded, and mechanical terminals on bus compression	
•Install and inspect bus, insulators, support fittings, and related devices	
OPTIONAL	760
•Substation Construction, including working effectively with substation owners, civil engineering personnel, or subcontractors to complete all aspects of constructing a substation	
•Raceways, including bending, threading, mounting, connecting and assembling raceway equipment and/or components.	
•Steel Construction, including rigging, bolting, cutting, drilling, spot galvanizing and welding	
•Supervisory Control And Data Acquisition (SCADA), including working with interfaces, protective devices and communication systems	
Paid Related Instruction	640
TOTAL	8000

The above schedule is to include all operations and such other work as is customary in the trade.

MINIMUM COMPENSATION TO BE PAID:

N/A

Base skilled wage rate N/A per hour.

If at any time the base skilled wage rate rises or falls, the apprentice's wage shall be adjusted proportionately. The wage rate of apprentices employed in this trade and this firm shall be based on the base skilled wage rate stated above.
All apprentices are covered by State and Federal Wage and Hour Standard requirements. All apprentices shall be paid no less than the minimum wage established under regulations.

CREDIT PROVISIONS: The apprentice, granted credit at the start or during the term of the apprenticeship, shall be paid the wage rate of the pay period to which such credit advanced the apprentice.

Work credit hours approved: N/A

School credit hours approved:
Paid related instruction: N/A

Unpaid related instruction: N/A

Total credit hours to be applied to the term of the apprenticeship: N/A

SPECIAL PROVISIONS:

The apprentice must take First AID & CPR during the first year of the program and maintain certification throughout the program.

An apprentice in his or her final year must participate in the Transition to Trainer Course. The course is currently included in Paid Related Instruction.

Statewide Apprenticeship Program for Substation Electrician
Courses for Related Instruction
Provided by Northeast Wisconsin Technical College

Overview

Related instruction teaches apprentices the science and theory behind their daily duties. It comprises 640 of the 8000 hours of the apprenticeship program, the equivalent of four hours per week when school is in session. The apprentice is paid by the employer to attend.

Course Descriptions

First Year

Trade Math, Safety & Orientation to the Trade reviews math commonly experienced by electricians, including arithmetic, geometry, simple trigonometry, US and metric units, and more. It also introduces safety and apprenticeship core abilities, and provides an orientation to the trade.

DC Theory, Safety, Print Reading & Circuits teaches apprentices to compare sources of electricity; perform math skills related to DC circuits; apply units of measure for electrical quantities, and calculate voltage, current, resistance, power and conductance. Apprentices also learn to analyze DC circuits; compare conductors and insulators, and examine electromagnetism and motor actions related to electrical devices. Safety and reading electrical schematics are also covered.

AC Theory, Safety, Print Reading & Circuits examines the characteristics of alternating current, AC measuring instruments, safety concepts surrounding AC electricity, and electrical prints and symbols related to AC circuits. The course will also examine capacitors, AC circuits, and 3-phase power. This course will be offered in the second half of the second semester follow DC Theory.

Second Year

NEC and NESC Codes, Electrical Safety investigates various electrical codes that pertain to substations. Apprentices will explore overcurrent protection plans and devices and learn to select proper conductor and raceways for substation applications. Competencies include sizing cords and cables according to electrical codes; comparing proper boxes, cabinets, gutters, and conduits; and discussing grounding to substation installations. NEC, NESC, PSC, NFPA, and related rules and regulations will be covered.

Motor Controls & Variable Speed Drives addresses principles of DC generators, motors, and alternators, and includes work with 3-phase and single phase motors. Apprentices will learn to apply safety procedures; use common tools and instruments involved with motor controls and VSD's; and sketch simple ladder diagrams and control circuits for 3-phase DC motors. Competencies will include the ability to explain both speed control and voltage control, apply motor control principles to VSDs, and analyze the operational characteristics of drive equipment and components.

Hydraulics, Pneumatics & Fluid Power Systems teaches apprentices the principles of hydraulics and pneumatics and how to interpret schematic diagrams for each commonly found on substations. Competencies will include the ability to analyze the function of fluid power components such as valves, directional controls, pressure relief, and flow control; and how to troubleshoot common fluid power systems.

Basic Mechanics & Mechanical Linkages teaches fundamental mechanical knowledge and skills apprentices commonly need when working on substations. The course also continues developing apprentices' print reading skills with a focus

on mechanical linkages. Apprentices will interpret print information, such as section views, assembly drawings, US and metric print information, and more.

Power Systems applies electrical theories learned in previous coursework to power systems commonly associated with substation equipment and components. The course covers single phase and 3-phase electricity, and the application of concepts such as Watts, Volts, Amps and Ohms.

Third Year

Substation Equipment teaches apprentices about equipment and components commonly found in substations, including inverters, battery systems, rotating machinery, oil pumps, and basic HVACR. Controls are introduced, too. Apprentices will become familiar with the roles related to monitoring substation operations, and the inspection, testing, and maintenance of equipment and components.

Relays and Protective Relaying explores the operations and principles of substation relays, and the types of relays used by utilities. Apprentices will discuss the roles for overcurrent relays, induction disc overcurrent relays, distance relays, current differential protection, static relays, digital protective relays; and interpreting protective relaying resources commonly used in the trade and industry. The course will also emphasize the inspection, testing, and maintenance of equipment.

Fourth Year

Substation Instrumentation & Controls introduces SCADA systems theory, and how to plan for installing and troubleshooting control systems. Apprentices will learn how to collect, verify, and interpret data, and will explore the applications for PLCs, RTUs, HMIs and relay information systems. Procedures for installing, operating, repairing, and maintaining equipment will be covered.

Substation Capstone: Construction, Inspection, Testing, & Maintenance is a course and a semester-long project that tie together concepts taught throughout the program. As apprentices work on a model substation, they will review the four phases of a substation: construction, commissioning, testing, and maintenance. Important trade knowledge, skills, and abilities will be demonstrated.

Transition to Trainer teaches soon-to-be journey workers how to serve as a mentor and job coach, how to provide hands-on skill training, and how to give positive and effective performance feedback.