

# JOURNEYMAN SUBSTATION TECHNICIAN CERTIFICATION PROGRAM

## MINIMUM REQUIREMENTS

Each candidate must meet the following requirements:

- Must be an **IBEW recognized Journey level worker** in the electrical field.
- Be a member of one of the four locals OR working within the four local Agreement area

***\*\*Candidates who can provide proof of completion of a registered substation program may submit documentation to the JATC for consideration, in lieu of placement testing, and may be awarded a completion certificate.***

Individuals and/or Contractors on their behalf, may request placement testing for the program. All applicants must provide documentation of a completed apprenticeship program and a letter from the Local Union verifying the individual is a member in good standing.

Documentation should be submitted to [nwline@nwlinejatc.com](mailto:nwline@nwlinejatc.com) for approval and confirmation of acceptance.

Upon acceptance, the NW Line JATC will notify the candidates of the date, time, and location for placement testing.

## PLACEMENT TESTING

After completion of necessary documentation, each candidate will be tested for placement as follows:

1. All candidates will be given a first-year qualifying test. If the test is not passed with a minimum score of 70%, the candidate will be placed in the first year and be provided with the necessary text and workbooks. If the candidate scores 70% or above on the first-year qualifying test, they will be given a second-year qualifying test.
2. If the candidate does not pass the second-year qualifying test with a minimum score of 70%, the candidate will be placed in the second year and provided the necessary text and workbooks. If the candidate scores 70% of above on the second-year qualifying test, they will be given a third-year qualifying test.
3. If the candidate does not pass the third-year qualifying test with a minimum score of 70% or higher, the candidate will be placed in the 3<sup>rd</sup> year and be provided with the necessary text and workbooks.
4. If a candidate passes all three-qualifying test, the NW Line JATC will issue a Journeyman Substation Technician Certification and will notify the four Local Unions of the status.

## COURSE CURRICULUM

The Journeyman Substation Technician course is intended for three years of study; however, it is self-paced and completion may be achieved in less time.

- Workbooks will be completed via the online LMS.

- a. If a passing score of 70% is achieved, the candidate will be scheduled for a proctored exam.
- b. Trainee is responsible for all costs associated with workbooks and tests.

### **WITHDRAWAL OR CANCELLATION FROM THE PROGRAM**

- A candidate may withdraw from the course at any time by submitting a written request. Returning to the program will require the candidate to retake the qualifying test.
- A candidate that does not complete in a workbook within a period of one year will be canceled from the program.
- Candidates must complete the course within a period of three years, or they will be canceled from the program, unless the NW Line JATC, through committee action, agrees to extend the time period required.

### **Program Costs**

- The program costs will range from \$600.00 to \$1,800.00 depending on amount of training materials you will be required to purchase. A more accurate cost estimate will be made after you have completed the placement testing.

***To schedule placement testing, please submit your request with documentation to [nwline@nwlinejafc.com](mailto:nwline@nwlinejafc.com), or by calling the NW Line JATC office at 360.816.7100.***

## **Substation 1st Year, Level I**

This course begins with a lesson that instructs the student on how to study the course and gives helpful pointers on negotiating the course materials. The next three lessons present the advantages of an IBEW/NECA apprenticeship and the responsibilities of an apprentice. Other lessons give the student a thorough understanding of the history of the IBEW and NECA. This course also covers subjects that every apprentice should be familiar with, such as avoiding the hazards of drug use, sexual harassment, absenteeism, and how to achieve a sense of professional personal conduct.

- **How to Study This Course and Achieve Your Personal Goals**
  - **Knowing Your Apprenticeship and Your Responsibilities**
  - **The Attributes of an IBEW/NECA Apprenticeship**
  - **Your Job and the Future It Holds for You**
  - **Sexual Harassment**
  - **The IBEW and Its History**
  - **NECA's Structure and Heritage**
  - **Avoiding the Hazards of Drug Abuse**
  - **This is a National Program**
  - **Becoming Familiar with the IBEW Constitution**
  - **Professional Personal Conduct**
  - **Absenteeism**
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## **Substation 1st Year, Level II**

The first seven lessons in this course expose the student to everyday mathematical equations, with each lesson building upon the last. They take the student from basic math with whole numbers to working with powers of 10 and metric prefixes. The next lesson picks up on some of the metric concepts that have been introduced and expands on them to include the metric system of measurement. The next two lessons use the concepts learned in the previous eight lessons and present how to calculate the area and volume of a circle. The remaining four lessons introduce basic electrical concepts every substation technician must know. The lessons introduce current, voltage, and resistance in a circuit, and Ohm's Law. The course ends with a lesson that answers the question: What is electricity?

- **Math Basics with Whole Numbers**
  - **Fractions**
  - **Decimals**
  - **Percentages**
  - **How to Solve Basic Algebraic Equations**
  - **Working with Ratios and Proportion**
  - **Working with Prefixes and Powers of 10**
  - **The Customary and Metric Systems of Measurement**
  - **The Circle**
  - **Area and Volume**
  - **Current, Voltage, and Resistance in a Circuit**
  - **The Electrical Circuit and Ohm's Law**
  - **Power in a Circuit**
  - **What is Electricity?**
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### **Substation 1st Year, Level III**

The fundamentals of electricity and DC circuits are presented in this course and built upon with in-depth coverage of Ohm's Law and its relation to voltage, current, resistance, and power. Lessons also introduce electrical devices and cover the principles of magnetism.

- **Electrical Energy Sources**
  - **Electrical Switches**
  - **Conductors, Conductor Resistance, and Wattage Loss**
  - **Introduction to Electrical Devices**
  - **The Series Circuit**
  - **Understanding and Calculating Resistance in DC Series Circuits**
  - **How Current Reacts in DC Series Circuits**
  - **Voltage in Series Circuits**
  - **How to Calculate Power in DC Series Circuits**
  - **How Current Reacts in a DC Parallel Circuit**
  - **Understanding Resistance in DC Parallel Circuits**
  - **How Voltage Functions in a DC Parallel Circuit**
  - **How to Calculate Power in a DC Parallel Circuit**
  - **The Principles of Magnetism**
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### **Substation 1st Year, Level IV**

To be successful in this industry, a substation technician must be knowledgeable about the trade, highly skilled in the mechanics, and aware of the importance of safety on the job. This course introduces OSHA, the reasons for its formation and its regulations. Several lessons deal specifically with situations substation technicians face, such as structure rescue and fall protection. The course also includes lessons on grounding in substations and how to establish a protective grounding scheme in a substation and concludes with a lesson on the hazards of working outdoors.

- **Introduction to OSHA**
  - **Responsibility for Safety**
  - **Personal Protective Equipment**
  - **Electrical Awareness**
  - **Energized and Non-Energized Parts**
  - **Substation Construction—Safety and First Aid**
  - **Live-Line Tools—Introduction, Identification, and Care**
  - **Fall Protection**
  - **Baskets, Aerial Lifts, and Platforms**
  - **Substation Structure and Rescue**
  - **Bucket Rescue**
  - **Personal Protective Grounding—Grounding in Substations**
  - **Grounding and Protective Grounds**
  - **Working Outdoors**
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## **Substation 1st Year, Level V**

Because every Electrical Worker needs a basic knowledge of the tools of the trade, this course presents lessons on a wide variety of subjects. It begins with two lessons on identifying basic tools and the use and care of hand tools. This course explores the use and operation of blocks, slings, and chokers, as well as various rigging tools and equipment. It also explains the properties of ropes and how to use and care for them. This course discusses ladder safety topics including proper use, selection, and care. Lesson also introduces rigging tools and hardware, digger derricks, and the use of load charts associated with digger derricks. It concludes with a lesson on hand signals that are common to the electrical industry.

- **Identify Some Basic Tools of the Trade**
  - **Use and Care of Hand Tools**
  - **Protective Line Devices, Care and Use**
  - **Good Housekeeping**
  - **Powered Equipment Safety—Compressors and Portable Generators**
  - **Powered Equipment Safety—Underground**
  - **Digging Holes and Trenches**
  - **Ladders/Step Bolts**
  - **Ropes, Knots, Hitches, and Splices**
  - **Use and Operation of Blocks**
  - **Slings and Chokers**
  - **Rigging Tools and Rigging Equipment**
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## **Substation 1st Year, Level VI**

This course begins with an overview of the electric system in general and offers an introduction to the various types of substations a technician might encounter. The next five lessons present the groundwork that goes into building a substation. They cover building substation foundations, excavating trenches, building duct banks, and proper methods of backfilling and compacting a trench. Three lessons discuss the various cable types used in substations, how to safely pull cable, and how to install cable in vaults and manholes. This course concludes with two lessons on the substation ground grid. One lesson deals with ground grid construction and the last deals with the exothermic welding process used to join ground grid conductors together.

- **The Electric System**
  - **Introduction to Substations**
  - **Substation Construction – Foundations**
  - **Working in Excavations and Trenches**
  - **Excavating the Trench**
  - **Laying Conduit/Building Duct Banks**
  - **Manholes and Handholes**
  - **Trench Encasements, Backfill, and Compaction**
  - **Cable Types**
  - **Substation Construction – Underground Power Cables**
  - **Pulling Cables**
  - **Installing Cable in an Underground Vault/Manhole**
  - **Substation Construction – Ground Grids**
  - **Exothermic Welding**
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## **Substation 2nd Year, Level I**

Level I opens with lessons that introduce the student to blueprints and specifications. Electrical drawings and diagrams, along with civil drawings, also are reviewed. Other lessons discuss what blueprint symbols mean and how drawings are scaled and dimensioned. This course also contains a lesson dealing with substation steel erection and a lesson that introduces measuring and leveling devices. The course concludes with a lesson on measuring and drawing angles and another on right triangles.

- **Symbols, Conventions, and Abbreviations**
  - **Scaling and Dimensioning Drawings**
  - **Single-Line Drawings**
  - **Schematic Diagrams**
  - **Electrical Drawings and Diagrams**
  - **Introduction to Blueprints and Specifications**
  - **Civil Drawings**
  - **Steel Erection Drawings**
  - **Introduction to Measuring and Leveling Devices**
  - **Measuring and Drawing Angles**
  - **Right Triangles**
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## **Substation 2nd Year, Level II**

Level II deals with the groundwork needed when constructing a substation, from site layout and preparation to building an oil spill prevention containment system as required by the EPA. Lessons expand on previous lessons dealing with ground grids, equipment grounding, and the types of ground connectors available to the substation technician. The student will also learn about boom capacities, load charts, steel superstructure assembly, and erection. The last four lessons deal with installing insulators, bus/jumper types, and wire bus types.

- **Site Layout and Preparation**
  - **Equipment Foundations**
  - **Substation Construction—Spill Prevention, Containment, and Countermeasure Plans**
  - **Substation Construction—Grounding/Ground Grids**
  - **Type of Ground Connectors**
  - **Boom Capacities and Load Charts**
  - **Insulated Platforms and the Second Point of Contact**
  - **Superstructure Assembly and Erection Part 1**
  - **Superstructure Assembly and Erection Part 2**
  - **Insulators**
  - **Bus/Jumpers – Types**
  - **Bus/Jumpers-Proper Handling, Installations**
  - **Wire Bus Type**
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### **Substation 2nd Year, Level III**

Level III covers equipment specific to substations. The first two lessons are an overview of substation equipment and each of the remaining lessons concentrates on specific pieces of substation equipment beginning with the power transformer and ending with lightning arrestors. The lessons explain the function of each piece of equipment and point out the hazards associated with them. Besides the equipment mentioned, this course covers capacitors, reactors, rectifiers, voltage regulators, and switches.

- **Substation Equipment Overview**
  - **Substations—Equipment Identification**
  - **Power Transformers**
  - **Substation—Air Switches**
  - **Voltage Regulators**
  - **Capacitors**
  - **Reactors**
  - **Rectifiers**
  - **Protective Equipment**
  - **Lightning Protection**
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### **Substation 2nd Year, Level IV**

Level IV starts with a review of the applications of DC theory and is followed by lessons dealing with resistance, current, voltage, and power in combination circuits. The student will then compare DC to AC and be introduced to generators and the fundamentals of AC. The course concludes with a lesson on inductance and another on the causes and effects of voltage drop.

- **Reviewing the Applications of DC Theory**
  - **Understanding Resistance in DC Combination Circuits**
  - **How Current Reacts in Combination Circuits**
  - **How Voltage Functions in DC Combination Circuits**
  - **How to Calculate Power in DC Combination Circuits**
  - **Comparing Direct Current to Alternating Current**
  - **Fundamentals of Alternating Current**
  - **An Introduction to 3-Phase Systems**
  - **Understanding How the DC Generator Works**
  - **Understanding the Design and Function of AC Generators**
  - **Introduction to Inductance**
  - **Voltage Drop**
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## **Substation 2nd Year, Level V**

Level V begins with a general safety awareness lesson, which is followed by a lesson on substation applications of lock-out/tag-out. The next lessons are on single-phase transformers and cover an introduction to transformers, their construction and characteristics, and how they operate. Single-phase connections are also reviewed. The lessons dealing with the installation of transformers help the students understand some of the pit-falls they may face when working with single-phase transformers. This course concludes with two lessons on the use of test instruments.

- **Safety Awareness – On the Job**
  - **Lockout/Tagout – Substation Applications**
  - **Introduction to Transformers**
  - **Transformer Construction**
  - **Transformer Information Characteristics**
  - **Vectors**
  - **Transformer Operation**
  - **Transformer Polarity/Connections**
  - **Tap Changers and Tap Changer Operation**
  - **Installing Transformers**
  - **Single-Phase Transformer Connections**
  - **Transformer Protection**
  - **Introduction to Test Instruments**
  - **General Use Test Instruments**
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## **Substation 2nd Year, Level VI**

Level VI starts with a review on how to conduct transformer load checks. Three-phase connections and voltages are covered and the lessons on single-phase transformers wrap up with information on ferroresonance and the specific hazards a substation technician may encounter when working with transformers. The next lessons include topics on step and touch potentials, equipotential zone grounding, and how to test ground (earth) resistance. This course concludes with two lessons that discuss subjects that substation technicians will be dealing with on a regular basis: power factor and power harmonics.

- **Conducting Transformer Load Checks**
  - **Transformers—3-Phase Connections**
  - **Transformers—3-Phase Voltages**
  - **Specific Hazards Working with Transformers**
  - **Ferroresonance**
  - **Grounding in Substations**
  - **Step and Touch Potential**
  - **Equipotential Zone Grounding**
  - **Testing Ground (Earth) Resistance**
  - **Substation Inspection**
  - **Substation CTs, VTs, and PTs**
  - **Power Factor**
  - **Power Harmonics**
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### **Substation 3rd Year, Level I**

Power transmission construction is one of the fastest growing electrical industries. Substations and switchyards are key components of power transmission. The substation technician has to be highly trained in electrical construction and also be a productive leader. Level I opens with lessons on taking pride in the industry and understanding union by-laws and parliamentary procedures. Students then will have an introduction to the COMET program and learn about the National Electrical Benefit Fund and labor management relations. They then will learn about the hazards of cell phone use in the workplace and the economics of unemployment. The remaining lessons cover motivation and leadership, foremanship, and Journeyman responsibilities.

- **Almost a Journeyman**
  - **Pride in Your Industry**
  - **Understanding Local Union Bylaws**
  - **Parliamentary Procedure and How It Works**
  - **An Introduction to the COMET Program**
  - **The National Electrical Benefit Fund**
  - **Productivity**
  - **Hazards of Cell Phone Use in the Workplace**
  - **Labor-Management Relations/LMCCs**
  - **The Economics of Unemployment**
  - **Keys to Success—Motivation and Leadership**
  - **After Apprenticeship**
  - **Foremanship**
  - **Soon to Be an Instructor**
  - **Your Career—Journeyman Responsibilities**
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### **Substation 3rd Year, Level II**

There are many facets to substation construction that must be mastered. Safety is primary in both deenergized and energized situations. One of the significant dangers is arc flash. Level II discusses guidelines to prevent arc flashes, utilization of rubber protective devices, and general safety in substations and switchyards. Grounding of all components, including vehicles, is also covered. In addition, power quality and distribution circuits are explained.

- **OSHA 1910.269(u)**
  - **Arc Flash Compliance**
  - **Temporary Grounding for Substations**
  - **PPG—Induced Voltage and Multiple Grounds**
  - **Selection of Equipment and Installation of Grounds**
  - **Vehicle Grounding**
  - **Applying Rubber Protective Devices**
  - **PPG—Body Currents**
  - **Live-Line Tools—Using Hot Sticks**
  - **Power Quality**
  - **Substation Voltages**
  - **Distribution Circuits Overview**
  - **Substations—Operation and Maintenance**
  - **Safety in Substations and Switchyards**
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### **Substation 3rd Year, Level III**

The lessons in Level III cover cable splicing and the components of safety, materials and tools, cable preparation, terminations, elbows, grounding, and all phases of testing. The final three lessons provide an introduction to fiber optics, optical fiber, and connectors and splices. Fiber optic cables are quickly becoming the primary communication path of control and data throughout the entire transmission network

- **Cable Splicing — Safety**
  - **Cable Splicing — Material and Tools**
  - **Cable Splicing — Cable Preparation**
  - **Cable Splicing — Terminations**
  - **Cable Splicing — Splicing**
  - **Cable Splicing — Elbows (Separable Connectors)**
  - **Cable Splicing — Grounding Cables**
  - **Cable Splicing — Insulation Testing**
  - **Cable Splicing — Introduction to Cable Fault Locating**
  - **Cable Splicing — Underground Troubleshooting**
  - **Cable Splicing — Manufacturers' Kits**
  - **Introduction to Fiber Optics**
  - **Optical Fiber**
  - **Connectors and Splices**
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### **Substation 3rd Year, Level IV**

There is much to understand about power transformer operations in substations. In these Level IV lessons, transformer principles, inspection and testing, tap changers, and oil quality are discussed in great detail. Along with these components, there are many tests to understand, such as insulation power factor testing, resistance testing, temperature indicator testing, and pressure relay testing. Various methods of insulation, including SF<sub>6</sub> gas and its proper handling, are also covered.

- **Power Transformer Principles**
  - **Power Transformers—Inspection and Tests**
  - **Power Transformers—Tap Changers and Turns Ratio Testing**
  - **Transformer Oil Quality/Oil Filtration**
  - **DC High Potential Testing (Hi-Pot)**
  - **Insulation Power Factor Test**
  - **Insulation Resistance Test**
  - **Power Transformer Temperature Indicator Testing**
  - **Power Transformer Pressure Relay Testing**
  - **SF<sub>6</sub> Gas—Properties**
  - **SF<sub>6</sub> Gas—Handling**
  - **Vacuum Bottle Hi-Pot Testing**
  - **Oil Containment**
  - **Temporary Substations—Mobile Units**
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## **Substation 3rd Year, Level V**

Circuit breakers perform an important role by preventing the enormous available power from destroying equipment, along with protecting human life. In Level V, the various operational, maintenance, and inspection and testing requirements of circuit breakers are covered. Time-travel characteristics of circuit breakers are also explored in respect to proper selective coordination. The lessons also discuss the roles of capacitors, reactors, voltage regulators, and simple components such as raptor protection and animal control. Bus configuration, connections, welding, and infrared thermography lessons are included.

- **Circuit Breaker Operation**
- **Circuit Breaker Maintenance**
- **New Circuit Breaker Inspections and Tests**
- **Circuit Breaker Time-Travel Characteristics**
- **Circuit Breaker Time-Travel Testing and Analysis**
- **Contact Resistance Testing**
- **Lesson 7: Capacitors and Reactors**
- **Lesson 8: Capacitor Bank Maintenance and Testing**
- **Voltage Regulators**
- **Bus Configurations**
- **Bus Connections**
- **Bus Welding**
- **Infrared Thermography**
- **Raptor Protection and Animal Guards**
- **Alternative Energy Sources**

## **Substation 3rd Year, Level VI**

Level VI focuses on substation controls and the monitoring of all systems and components. Control devices include protective relays and transmission system controllers. These systems communicate through power line carriers utilizing system control and data acquisition (SCADA) equipment. The monitoring of substation components are not only for observing healthy conditions, but for analyzing short circuits and identifying distribution line faults. These systems must have constant power to operate at all times; therefore, lessons on substation batteries and uninterruptible power supplies – and their maintenance and testing requirements – are included. The final lessons discuss the procedures of commissioning and energizing a substation.

- **Substation Control Rooms**
  - **Protective Relays**
  - **Protective Relays and Transmission Systems**
  - **Control Equipment**
  - **Power Line Carrier**
  - **Supervisory Control and Data Acquisition**
  - **Short Circuit Analysis—Testing for Distribution Line Faults**
  - **Metering**
  - **AC/DC Generators**
  - **UPS—Uninterruptible Power Supplies**
  - **Substations—Batteries**
  - **Substation Battery Testing**
  - **Substation Battery Chargers**
  - **Substation, Cell and Charger Replacement**
  - **Commissioning a Substation**
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