



**Bismarck State College  
National Energy Center of Excellence  
System Protection Apprenticeship Program**

**APP 109 – Safety I**

This course covers the general safety practices and information employees need while working in any segment of the electrical industry, and the Federal Agencies responsible for insuring a safe working environment. Students will also gain an understanding of the Workers Right to Know regulations and awareness of Public Safety issues.

**TPC 280 – Safety Calibrations and Testing Procedures**

Covers the responsibilities of employer, employee, and regulatory agencies in maintaining safety. Discusses ways of identifying and handling chemical, electrical, biological, radiation, and mechanical hazards. Discusses importance of maintenance (including calibration) and proper record keeping. Describes use of common electrical and electronic test instruments. Offers guidelines for handling heavy equipment, decontaminating and servicing pneumatic and hydraulic equipment, and troubleshooting.

**APP 151 – Reading Electrical Diagrams II**

This course covers advanced electrical prints used to navigate complex electrical systems and feeder maps. Students also study schematics that are used when working with electronic systems and system instrumentation that is used to control and monitor the flow of electricity through the electrical system. Students also learn to use the diagrams to troubleshoot system problems and to safely isolate sections of the electrical system.

**APP 152 - Safety in Substations and Switchyards**

This course will cover the safe operating practices, system isolation procedures, and accident prevention procedures used in the transmission and distribution of power. Emphasis will be placed on electrical system lock out and safety procedures.

**APP 120 - Troubleshooting and Emergency Repair of DC Systems and Equipment**

The course provides a basic understanding of how to locate problems in DC systems and equipment and make temporary repairs. Particular emphasis is placed on industrial DC systems, subsystems, units, and components commonly in use.

**APP 153 – Transformer Maintenance**

This course begins with a review of basic transformer design and operation. Students will study 3-phase transformers, single phase loads for 3-phase transformers, and the different connections used in such transformers. The course introduces students to installation procedures and maintenance procedures.

**APP 160 - Introduction to Transmission and Distribution Systems**

This course will begin with a look at several types of power generation stations, such as large fossil fired power plants, hydroelectric power plants, gas turbine and combined cycle generating stations and finally a brief look at wind generation. After the introduction to power generation, students will study how the power is delivered from the power station to the consumer. This course will cover transmission lines and related components within a typical transmission system, such as step-up and step-down transformers, circuit breakers, disconnects and protective relaying.

**APP 161 – System Protection and Monitoring**

This course covers protection fundamentals, philosophies and principles used to protect the electrical system, beginning with the generator itself. Various types of relays, input sources and system grounding are also covered.

**APP 162 – Distribution**

This course covers the basic principles and applications of components that comprise an electric power distribution system. It includes customer requirements, design layout considerations, and apparatuses that work together to provide reliable service to a wide variety of end use customers. Tariffs and new construction permitting requirements for overhead and underground distribution systems will also be covered.

**APP 163 – High-Voltage AC Power 1 and 2**

In this course, students will study the control of power flow through interconnected systems and the operation of parallel power systems. The topics will include generator synchronization, phase angle, VAR control and voltage regulation.

**APP 119 - Troubleshooting and Emergency Repair of AC Systems and Equipment**

This course provides a basic understanding of how to locate problems in AC systems and equipment and make temporary repairs.

**APP 170 – Relays 1 and 2**

This course focuses on testing and calibrating substation equipment, including voltage testing on equipment feeder relays, and circuit breaker relays. Students also learn the various tests that need to be conducted on protective relays, such as overcurrent and voltage relays, directional and line relays, as well as ground and test device testing.

**APP 164 - Control Equipment, Substations and Switchyards**

This course will detail the specifics of power electronics as applied in substations for power transmission. It will describe typical functions provided in utility substation automation systems and some important considerations in the interface between substation equipment and the automation system components. Students will look at the availability of information, the analysis of this information, and the subsequent decision making to optimize system operation in a competitive environment. Oil containment, animal issues and security will also be discussed and the requirements necessary to qualify a substation to withstand seismic events. The operation of substation fire protection and substation communications systems such as the SCADA system and SCADA security will be examined.

**APP 110 – Safety I**

This course focuses on specific safety practices of the industry. Students begin by studying general practices, such as confined space entry, lock-out tag out procedures, fall protection, fire safety and working with hazardous materials. Students also learn some specific safety procedures used by linemen, such as proper bucket truck operation, and some techniques used when working with electrical conductors. Finally, students learn some of the specific considerations that must be adhered to as an electrical system dispatcher to ensure the safety of line crews and technicians working on the electrical system.

**APP 165 – Using Line Test Equipment**

This course will identify types of line test equipment commonly used in the field, demonstrate how to use ammeters, voltmeters, and voltage testers and describe the types of readings expected from ammeters, voltmeters, and voltage testers.

**TPC 262 – Examining Application I/O Devices**

Covers many of the input/output devices that make up a typical computer system. Explores communication-the successful transmission of information between computers-at length. Discusses both the user/machine interface and the machine/machine interface, as well as the various network configurations. Concludes with two "real-world" examples of how microprocessors are connected to I/O devices.

**TPC 267 - Examining System I/O Devices**

Covers more fully many of the input/output devices introduced in Course 262. Describes various magnetic and optical memory devices, including tapes, disks (hard and floppy), and CD-ROMs. Explains how signals are converted from analog form to digital form, and vice versa. Covers data acquisition systems and common digital transmission standards. Defines the error detection techniques used to ensure the accurate transmission of digital data. Describes various types of digital transmission equipment, such as modems and fiber optics. Concludes with a practical application that combines all of the principles presented in previous lessons.

**TPC 268 - Maintaining Troubleshooting Microprocessor Systems**

Covers the maintenance of microprocessor-based equipment, including preventive maintenance. Describes diagnostic procedures and takes a "hands-on" look at many types of test equipment, including oscilloscopes, logic analyzers, and in-circuit emulators. Emphasizes the importance of thorough documentation in all areas. Discusses general troubleshooting guidelines and covers troubleshooting aids and accessories.

**TPC 206 – DC Equipment and Control**

Covers DC power applications in industry, types of DC generators, operating characteristics of DC motors, DC armature principles, and armature maintenance and repair. Includes types of DC relays, DC controllers, overspeed and overload protection, drum and reversing controllers, dynamic braking, DC power supplies, diodes, semiconductors, SCR principles, and DC maintenance practices.

**TPC 208 – Operating and Maintaining Three Phase Systems**

Covers three-phase motor principles for induction, synchronous, and multi-speed dual-voltage motors. Gives recommended maintenance practices for large AC motors. Covers principles of three-phase motor starters, part winding, reversing, jogging, alternator principles and operation. Describes three-phase power distribution.

**TPC 210 - Developing Electrical Troubleshooting Skills**

Covers use of schematic diagrams, determining sequence of operation, and use of building diagrams and single-line diagrams. Includes troubleshooting procedures for control circuits and combination starters. Explains troubleshooting practices on DC and AC motors, identifying unmarked leads on three-phase delta and Y-connected motors, and troubleshooting lighting systems.

**TPC 251- Semiconductors**

Covers the theory behind semiconductor operation. Describes the characteristics and operation of various diodes and transistors. Stresses the importance of proper environmental conditions and explains how to minimize electrostatic discharge (ESD) and radio frequency interference (RFI). Discusses printed circuit board (PCB) and integrated circuit (IC) technology, including connection and replacement methods. Identifies kinds of semiconductor packages. Explains how to interpret manufacturers' spec sheets and how to analyze circuit performance by Q points and characteristics.

**TPC 252 – Power Supplies**

Covers the four basic kinds of power supply conversions. Explains how to work with nonchemical cells as well as primary and secondary cells of various materials. Describes in detail the functions and operation of several kinds of rectifiers, filters, and voltage regulators and explains how they work together as power conditioners. Discusses basic tools, test devices, and procedures for troubleshooting to solve the greatest number of problems in the least amount of time.

**TPC 291 – Digital Logic Systems**

Covers the comparison of analog and digital switching circuits. Explains Boolean logic functions. Describes TTL and CMOS logic, as well as IC logic devices. Explains how flip-flops, clock circuits, counters, multiplexers, and memory circuits work. Describes the sections and interfaces in functional logic systems, including microprocessors. Describes proper methods for detection and correction of common fault potentials.

**TPC 266 – How Computers Function**

Covers the function and basic operation of each major element of a microprocessor. Explains the structure and purpose of various computer buses. Examines characteristics of different types of main memory in detail. Includes in-depth discussion of both low- and high-level computer languages.

**TPC 298 – Programmable Logic Controllers**

Prepares technicians to take full advantage of vendor training on specific equipment. Covers the basic operating principles of all PLCs, their inputs and outputs, programming, maintenance, and networking.

**APP 103 – General Math Concepts**

This course will teach basic math skills and apply those to energy industry situations. Students will learn the metric system, basic volume and area calculations as well as algebra and trigonometry and how they apply to industry specific situations.

**APP 112 – Math II**

This course will cover algebra, geometry, and trigonometry needed for energy technicians working in the electrical system design and metering specialization areas. This course will cover the fundamental concepts of algebra, equations, functions and graphs. This course will also cover trigonometric functions, laws of sines and cosines and vectors. Lastly the course will discuss analytic geometry.

**APP 180 – Introduction to Metering**

This course introduces students to the fundamentals of metering, such as terminology and basic principles of meters. Students learn basic math needed in metering, and review basic electricity and magnetism principles. They are introduced to meter testing equipment, meter diagrams and standards, and learn technical data and how to read watt hour and demand meters.

**APP 181 – Instrument Transformers and Polyphase Metering**

This course will introduce students to various metering system designs and application options. The student will study the metering system components, associated wiring configurations and instrument transformer variations. Topics will include ratio, burden, and correction factor calculations; functional testing, and calibration procedures as well as safe installation procedures. Also included are cogeneration metering, and principles of load management and associated equipment.

**APP 182 – Watthour Meter Principles**

In this course students learn about single-phase metering and polyphase metering, including meter design, adjustments and compensations, and applications. They also learn about power factor analyzers, high amperage CT cabinets, meter demand theory, demand registers, and testing and maintenance of thermal demands.