



**Bismarck State College**  
**National Energy Center of Excellence**  
**Relay Apparatus 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.

**APP 150 – Reading Electrical Diagrams I**

This course gives students an introduction to the different schematics used in power plant operations and electrical transmission and distribution systems. Students will gain an understanding of the standard symbols used in the various systems schematics and how to read them. Students learn how to read basic piping and instrumentation diagrams, and how to interpret single line electrical diagrams. Students finish the course by studying electrical system diagrams beginning at the generator and following through to the distribution system.

**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 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.

**TPC 202 – Storage Batteries and Chargers**

Covers how electrochemical action is used. Covers batteries, electrolytic action, electroplating, Characteristics of storage batteries, application and maintenance of lead-acid, nickel-alkaline, and nickel-cadmium batteries, putting batteries into service, charging batteries, maintaining records, fundamentals of DC circuits, and using Ohm's Law to solve problems in DC series, parallel, and series-parallel circuits.

**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 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 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.

**TPC 207 – Operating and Maintaining One Phase Motors**

Covers the types and operating principles of common single-phase motors. Explains NEMA motor standards. Explains how to identify motor leads on split-phase, capacitor-start, capacitor-run, permanent split capacitor, and repulsion motors. Also covers universal motors, shaded-pole motors, and other special types, including synchro and servo systems. Gives general maintenance procedures on all single-phase motors.

**TPC 205 – Electrical Safety and Protection**

Examines electrical hazards and stresses the importance of electrical safety. Covers the equipment and procedures necessary to work safely with electricity, including PPE, lockout/tagout, and first aid. Explains the importance of grounding. Describes many kinds of fuses, circuit breakers, and motor protection devices and their uses.

**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 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 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 172 – Current Transformer Testing 1**

This course will cover the functions of a current transformer; describe common current transformer applications in a substation and describe the construction of common substation current transformers. Students will explain the meanings of CT accuracy class ratings; describe the basic operation of a current transformer; explain saturation in a CT core and describe a CT's turns ratio and current ratio as they relate to the CT's current and voltage output. Polarity Testing will also be discussed.

**APP 173 – Current Transformer Testing 2**

This course will explain why it may be necessary to demagnetize a current transformer. Students will describe the basic steps for demagnetizing a current transformer, complete ratio testing and describe the voltage method of checking the full winding ratio and tapped winding ratios of a CT. Insulation Resistance Testing will also be discussed.

**APP 171 – Capacitors and Reactors**

This course will describe the basic principles involved in operating and maintaining capacitors and reactors. The course explains the effect that capacitors and reactors have on power factor and explains how and why capacitors and reactors are used. Demonstrations of inspection and maintenance of both capacitors and reactors are shown.

**TPC 206 – DC Equipment and Controls**

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 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 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 307 – Basic Hydraulics**

Covers hydraulic principles, types of hydraulic fluids and their characteristics. Describes components of the hydraulic system and their functions, including filters and strainers, reservoirs and accumulators, pumps, piping, tubing and hoses, control valves, relief valves, and actuating devices. Covers a variety of cylinders and hydraulic motors.

**TPC 308 – Hydraulic Troubleshooting**

Covers understanding the systems, using schematic diagrams, installation procedures, cleanliness and safety. Includes tubing cutting, bending, and flaring, identification and selection of proper fluid, and charging the system. Discusses planned maintenance, specific repair/replacement recommendations, system diagnosis, and troubleshooting.

**TPC 309 – Basic Pneumatics**

Covers how work, force, and energy are applied to principles of pneumatics. Shows operating principles of reciprocating, positive displacement, rotary, and dynamic air compressors. Covers primary and secondary air treatment. Includes valves, logic devices, cylinders, and air motors.

**TPC 310 – Developing Pneumatic Troubleshooting Skills**

Covers pneumatic systems, schematic symbols and diagrams, installing system components, planned maintenance, system diagnosis, and troubleshooting. Includes maintenance of air compressors, control valves, air motors, electrical components, and hybrid systems.

**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.