Bismarck State College
National Energy Center of Excellence
Instrumentation Technician Apprenticeship Program

TPC 111 – How Power Plants Work
Covers the basic steam generation system, how thermal energy is converted into electrical energy, components of the system, and design features for gaining thermal efficiency. Includes handling of water, fuel, and wastes, and the operating features of a power plant

TPC 112 – Generating Steam in the Power Plant
Covers energy principles and boiler maintenance. Explains coal, oil, and natural gas combustion, and how to conserve energy through improved combustion control.

TPC 113 – Using Steam in the Power Plant
Covers how to conserve energy in turbines, auxiliaries, electric power generation, and air conditioning systems.

TPC 114 – Waste-to-Energy Fundamentals
Covers fundamentals of waste combustion-characteristics and handling of MSW fuel, furnace designs, waste combustion, and plant operations.

TPC 103 – Mathematics in the Plant
Begins by introducing mathematical basics-numbers and numerals, subtraction, addition, multiplication, and division. Examines common fractions and decimal fractions, ratios and proportions, powers and roots. Discusses the calculator: usage, basic and special functions, internal logic, and special purpose calculators. Moves on to cover geometry, algebra, and formulas for problem solving. Concludes by explaining properties of triangles and trig and inverse trig functions.

TPC 109 – Industrial Safety and Health
Explains government involvement in ensuring a safe workplace. Discusses safety in various situations. Discusses personal protective equipment and fire safety. Includes expanded coverage of many health hazards. Covers ergonomics, environmental responsibility and importance of maintaining a safe work environment.

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 253 – Amplifiers
Covers the effects of gain, bandwidth, and distortion on amplifier performance. Compares linear and nonlinear (switching) amplifiers. Explains how to use transistor curves to analyze amplifier operation in terms of operating regions, load lines, operating (Q) points, and biasing. Discusses impedance matching and compares capacitive, transformer, and direct-coupled amplifiers. Describes many ways op amps are used today, including integrators and comparators. Provides specific methods for troubleshooting common amplifier problems.

TPC 254 – Oscillators and Waveforms
Covers how oscillation is started and maintained. Compares LC (tuned), RC (phase-shift), and crystal oscillators. Compares sine-wave oscillators and square-wave switching circuits. Discusses monostable, astable, and bistable flip-flop operation in detail and shows expected waveforms. Explains how logic clocks are generated and conditioned. Discusses Schmitt trigger circuits, frequency dividers, and ripple counters, as well as propagation delays and glitches. Describes the operation of low-pass, high-pass, band-pass, and band-reject filters, including differentiators and integrators. Describes the equipment and procedures for troubleshooting oscillator components and circuits.

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 271 – Introduction to Process Control
Covers the function of basic devices for measuring and controlling different kinds of variables in process control. Introduces closed-loop control and PID functions. Introduces analog and digital devices and programmable logic controllers (PLCs). ISA and SAMA instrumentation symbols and interpretation and use of process diagrams are covered.

TPC 272 – Foundations of Measurement Instrumentation
Covers basic principles of measurement and defines process control terms. Describes several kinds of signals and displays and traces the path of a signal through the system. Explains the operation of transducers, transmitters, signal conditioners, converters, and recorders. Discusses specification details, conversion between English and SI units, calibration methods, and the maintenance of records.

TPC 273 – Pressure Measurement
Covers units of pressure and discusses Boyle's and Charles' laws to explain relationships among pressure, volume, and temperature. Describes sensor operation of manometers, bourdon tubes, diaphragms, and bellows. Explains the operation of potentiometric, capacitive, reluctive, servo, strain-gauge, and piezoelectric transducers. Describes devices used in low-pressure control. Discusses proper and safe methods for installing and servicing pressure instruments.

TPC 274 – Force, Weight, and Motion Measurement
Covers force, stress, and strain and explains the operation of strain-gauge systems. Relates weight to mass and scales to balances. Explains the operation of load-cell scales. Describes belt-scale, nuclear-scale, and weigh feeder operation. Covers position measurements by means of proximity detection, air gauging, LVDT gauges, synchros, code disks, and other devices. Explains machine tool control and accelerometer operation. Describes the measurement of angular velocity and acceleration, vibration detection, and machinery balancing.

TPC 275 – Flow Measurement
Covers principles of fluid flow and how primary devices affect fluid flow. Describes flow measurement using several kinds of secondary devices. Discusses rotameters and other variable-area instruments. Explains how weirs, flumes, and other arrangements measure open-channel flow. Compares many kinds of positive-displacement meters and explains the operation of several kinds of turbine and magnetic flowmeters. Describes less-common flowmeters (including vortex-precession, mass flow, and ultrasonic devices) and instruments that meter the flow of solids. Provides guidelines for safe installation and maintenance of flow devices.

TPC 276 – Level Measurement
Covers principles governing various methods of measuring level. Explains operation of conductive, capacitive, resistive, ultrasonic, and photoelectric devices. Compares the operation of several kinds of pressure-head instruments. Explains the measurement of solids by ultrasonic, microwave, radiation, and other methods. Discusses several special-application devices for both continuous and point level measurement.

TPC 277 – Temperature Measurement
Covers units in thermal measurement and operation of RTDs (and wheatstone bridges), thermistors, and thermocouples and thermometers. Includes principles of pyrometry and operation of narrowband, broadband, and bandpass pyrometers. Discusses calibration standards, typical calibrating methods, and instrument testing.

TPC 278 – Analytical Instrumentation
Covers principles, installation, calibration, and maintenance of conductivity probes, and methods of stack gas monitoring. Includes how to install, calibrate, and maintain pH and ORP measurement instruments and operation, installation, calibration, and maintenance of several optical analyzers. Discusses principles and safe practices governing sensors used in measuring oxygen, carbon monoxide, carbon dioxide, and other products of combustion. Concludes with operation, calibration, and system components in liquid and gas chromatography.

TPC 279 – Final Control Elements
Covers how elements in a closed-loop system affect final control element. Describes components in final control subsystems. Discusses operations of solenoids, motors, relay systems, and PLCs. Explains pneumatic actuators and positioners. Describes mechanical advantage in several hydraulic control systems. Compares construction, characteristics, and applications of eight control valves. Traces operation of each element in typical feedwater, turbine, and robotic control systems.

TPC 280 – Safety, Calibration, 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.

TPC 261 – Introduction to Computers-User Level
Covers a brief history of the computer and defines fundamental computer terms. Introduces the binary and hexadecimal number systems. Explains the different levels of programming languages. Describes microprocessor characteristics and architecture in general terms. Concludes with examples of practical applications.

TPC 262 – Input/Output Devices I-User Level
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 266 – How Computers Function-Technician Level
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 267 – Input/Output Devices II-Technician Level
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 Computer 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 281 – Working with Controllers
Covers the purposes and kinds of controllers and their relationship to other components in process control systems. Explains the concepts of current-, position-, and time-proportioning control. Compares the operation of several kinds of controllers. Describes the operation of proportional, integral, and derivative modes, and discusses tuning procedures for each. Discusses cascade, feedforward, ratio, and auctioneering control systems as well as other operations. Describes ways to eliminate or reduce controller problems.

TPC 282 – How Control Loops Operate
Covers definition of control loop terms and characteristics. Includes specific examples of operation of control loops of many kinds. Discusses proportional, integral, and derivative modes in detail. Describes advanced control methods by means of four strategies with specific examples. Examines the effects of loop dynamics on system stability.

TPC 283 – Data Transmission
Covers mechanical, hydraulic, pneumatic, and telemetric data transmission methods. Discusses indicators, other devices, and methods used for electrical/electronic data transmission in detail. Compares methods and standards for parallel and serial digital data transmission. Describes optical isolation and the operation of optical data transmission systems in detail. Provides specific methods for preventing common kinds of data transmission interference.

TPC 284 – Computers in Process Control
Covers the evolution of today's process control computer systems. Compares smart components to older conventional system devices. Covers the architecture (hardware and software), configuration, and operation of distributed control systems in depth (two entire lessons) by using as an example a typical DCS controlling an ice cream plant. Defines common terms used in today's integrated plant and discusses the integration of discrete and continuous processes with plant business functions.

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.