

**CONTENT STANDARD 1.0: GENERAL ELECTRICAL SAFETY**

**Performance Standard 1.1: Safety and NFPA 70E**

- 1.1.1. Achieve an electrically safe work condition.
- 1.1.2. Interpret arc flash labeling.
- 1.1.3. Choose appropriate levels of PPE for the hazard.
- 1.1.4. Describe the steps to verify your testing equipment.
- 1.1.5. Explain lockout and tagout procedures.
- 1.1.6. Identify the use of Category I through Category IV meters.
- 1.1.7. Identify proper meter maintenance.
- 1.1.8. Explain the use of a safety harness.
- 1.1.9. Explain safety for ladders and scaffolds.
- 1.1.10. Explain what a material safety data sheet (MSDS/SDS) is and its requirements.
- 1.1.11. Explain safety procedures for trenches.
- 1.1.12. Explain safety for confined space.
- 1.1.13. Explain protective clothing to include eye and hearing protection.
- 1.1.14. State the purpose of arc-fault and ground-fault circuit interrupters.
- 1.1.15. Identify safety handling and use of hand and power tools.

**CONTENT STANDARD 2.0: BLUEPRINTS**

**Performance Standard 2.1: Print Reading Fundamentals**

- 2.1.1. Recognize site plan, floor plans, elevations, sectional views, wiring diagrams, details, and schedules.
- 2.1.2. Recognize types of electrical schedules to include fixtures, feeders, main switchboard, branch circuit panels, and transformers.
- 2.1.3. Demonstrate the application of building plans and specifications.
- 2.1.4. Locate specific information on building plans.
- 2.1.5. Research additional information from industry-related resources.

**Performance Standard 2.2: Residential and Commercial Electrical Symbols**

- 2.2.1. Read and interpret electrical symbols used in construction drawings.
- 2.2.2. Identify the electrical installation requirements for a building from symbols.
- 2.2.3. Determine aboveground and underground electrical distribution.
- 2.2.4. Determine electrical materials, measurements, and specifications.

**Performance Standard 2.3: Electrical Drawings and Plans**

- 2.3.1. Differentiate between the purposes and characteristics of drawings, plans and diagrams. Describe the purpose of and list the primary features included on each type of drawing and plan to include floor plans, pictorial drawings, orthographic elevations, orthographic views, application drawings, location drawings, detail drawings, assembly drawings, site plans, foundation plans, structural plans, and utility plans.
- 2.3.2. Identify the proper drawing or plan for the application.
- 2.3.3. Identify the proper drawing or plan for the application.

**Performance Standard 2.4: Construction and Maintenance**

- 2.4.1. Describe the different responsibilities of various construction personnel.

- 2.4.2. Identify the major steps on the construction process.
- 2.4.3. Describe the different responsibilities of various maintenance personnel.
- 2.4.4. Compare preventive and predictive maintenance.

**Performance Standard 2.5: Residential and Commercial Power and Lighting Systems**

- 2.5.1. Compare how power and lighting information is included on residential and commercial plans.
- 2.5.2. Describe the types of electrical equipment included on single-line diagrams
- 2.5.3. Describe the typical information included on light fixture schedules and how this information is linked to floor plans.
- 2.5.4. Describe the common types of electrical detail drawings.

**CONTENT STANDARD 3.0: LOAD CALCULATIONS**

**Performance Standard 3.1: Single Family Dwelling Unit Calculations**

- 3.1.1. Properly define a one-family dwelling.  
Calculate the general lighting, general use receptacle, small appliance, and laundry demand load for a dwelling.
- 3.1.2. Calculate the appliance demand load for a dwelling.
- 3.1.3. Determine the dryer demand load for a dwelling.
- 3.1.4. Determine the cooking appliance demand load for a dwelling.
- 3.1.5. Determine the heating and air conditioning demand load for a dwelling.
- 3.1.6. Properly size the service equipment and service conductors for a dwelling using the standard calculation as per Article 220.
- 3.1.7. Properly size feeder conductors (main to sub-panel) for a dwelling.
- 3.1.8. Use the optional calculation for a dwelling as per Article 220.
- 3.1.9. Calculate and size the service neutral conductor in a dwelling (neutral load).

**Performance Standard 3.2: Multifamily Dwelling Calculations**

- 3.2.1. Properly define a multifamily dwelling.  
Calculate the general lighting, general use receptacle, small appliance, and laundry demand load for a multifamily dwelling.
- 3.2.2. Calculate the appliance demand load for a multifamily dwelling.
- 3.2.3. Determine the dryer demand load for a multifamily dwelling.
- 3.2.4. Determine the cooking appliance demand load for a multifamily dwelling.
- 3.2.5. Determine the heating and air conditioning demand load for a multifamily dwelling.
- 3.2.6. Properly size the service equipment and service conductors for a multifamily dwelling using the standard calculation as per Article 220.
- 3.2.7. Properly size feeder conductors (main to sub-panel) for a multifamily dwelling
- 3.2.8. Use the optional calculation for a multifamily dwelling as per Article 220.
- 3.2.9. Calculate and size the service neutral conductor in a multifamily dwelling (neutral load).

**Performance Standard 3.3: Commercial Calculations**

- 3.3.1. Determine the lighting demand factor for any commercial building to include stores, hotels and motels, warehouses, hospitals, office buildings, schools, restaurants, etc.
- 3.3.2. Determine sign and show-window demand loads.

- 3.3.3 Determine the demand loads for multi-outlet assemblies.
- 3.3.4 Determine the receptacle demand loads for offices and banks.
- 3.3.5 Determine the receptacle demand load for general commercial applications.
- 3.3.6 Determine the demand loads for commercial kitchens.
- 3.3.7 Use the optional method for commercial demand load calculations.
- 3.3.8 Determine the demand load for manufactured home parks, recreational vehicle parks, and marinas.
- 3.3.9 Determine the ampacity of conductors based on the type of special equipment (e.g., welders, electrical vehicles, HVAC, signs, etc.).
- 3.3.10 Determine the service size for any commercial installation.

#### **CONTENT STANDARD 4.0: CONDUCTOR CALCULATIONS**

##### **Performance Standard 4.1: Raceway and Box Calculations**

- 4.1.1 Determine the cross-sectional area of any conductor using NEC Chapter 9, table 5.
- 4.1.2 Determine the cross-sectional area of compact conductors using NEC Chapter 9, Table 5(A).
- 4.1.3 Understand and apply raceway fill limitations.
- 4.1.4 Size any raceway for the required wire fill.
- 4.1.5 Define and size raceway nipples for required wire fill.
- 4.1.6 Calculate conductor fill when using various sizes and/or types of conductors.
- 4.1.7 Calculate raceway size for multi-conductor and optical fiber cables.
- 4.1.8 Determine raceway fill using Annex C of the NEC.
- 4.1.9 Size a wireway for conductor fill.
- 4.1.10 Properly size an outlet or junction box based on wire fill.
- 4.1.11 Properly calculate the box fill of conductors, clamps, support fittings, devices or equipment, and grounding conductors.
- 4.1.12 Size pull and junction boxes for 4 AWG and larger wire.
- 4.1.13 Install conduits containing the same conductors the correct distance apart (4 AWG and larger).
- 4.1.14 Properly size the depth of pull boxes and conduit bodies when conductors enter opposite a removable cover.

##### **Performance Standard 4.2: Conductor Sizing and Protection Calculations**

- 4.2.1 Determine conductor properties.
- 4.2.2 Determine applications of insulation types based on NEC.
- 4.2.3 Determine conductor size for loads.
- 4.2.4 Determine conductor sizing based on the termination temperature rating.
- 4.2.5 Properly size the overcurrent device for loads.
- 4.2.6 Properly apply NEC Article 240 rules for small conductors.
- 4.2.7 Apply ampacity adjustment factors for temperature, wire fill, etc.
- 4.2.8 Identify when the neutral conductor is counted as current carrying when applying ampacity adjustment factors.
- 4.2.9 Apply ampacity adjustment to wireways.

- 4.2.10. Size conductors for continuous loads after ampacity adjustment.
- 4.2.11. Properly size feeders based on loads and adjustment factors.
- 4.2.12. Properly size tap conductors using the 10- and 25-foot rules (NEC Article 240).

**Performance Standard 4.3: Voltage Drop Calculations**

- 4.3.1. State the recommended voltage drop according the NEC.  
Use the information in Chapter 9, Table 8 to calculate the resistance of any conductor based on size and length.
- 4.3.2. based on size and length.
- 4.3.3. Use the voltage drop formulas for single-phase and three-phase systems.
- 4.3.4. Size conductors to account for voltage drop.

**Performance Standard 4.4: Motors: Article 430 of the NEC**

- 4.4.1. Determine the full load current of any motor according to the NEC.
- 4.4.2. Size the branch circuit wire size for any motor.
- 4.4.3. Determine the appropriate circuit protection for any motor.
- 4.4.4. Use the motor name plate to size overloads.  
Explain the difference between overload protection and short-circuit/ground-fault protection.
- 4.4.5. protection.
- 4.4.6. Size a feeder for any set of motors.
- 4.4.7. Size the feeder short-circuit/ground-fault overcurrent device.

**Performance Standard 4.5: Transformers: Article 450 of the NEC**

- 4.5.1. Calculate the high leg voltage of a delta-connected transformer.  
Calculate the primary and secondary line current of single- and three-phase transformers.
- 4.5.2. transformers.
- 4.5.3. Calculate the primary and secondary overcurrent protection for a transformer.  
Calculate and select the proper conductor size for the primary and secondary of a transformer.
- 4.5.4. transformer.
- 4.5.5. Properly size the grounding electrode conductor and bonding jumpers.

**CONTENT STANDARD 5.0: MOTOR CONTROLS**

**Performance Standard 5.1: Basic Principles of Motor Controls**

- 5.1.1. Recognize ladder diagrams.
- 5.1.2. Recognize wiring/connection diagrams.
- 5.1.3. Recognize pictorial diagrams.  
Use and interpret definitions, abbreviations, and graphic symbols used on motor control diagrams.
- 5.1.4. diagrams.  
Describe the function of pushbutton stations, solenoids, flow switches, pressure switches, limit switches, and timing relays.
- 5.1.5. switches, limit switches, and timing relays.
- 5.1.6. Define the basic operation of variable frequency drives.

**Performance Standard 5.2: Components of Magnetic Control Circuits**

- 5.2.1. Use a ladder diagram to illustrate a simple two-wire control circuit for a single-phase motor operated by a float switch or similar device.
- 5.2.2. Use a ladder diagram to identify a simple start/stop station operating a motor starter.

- 5.2.3. Identify circuit types classified by power source (e.g., common control circuits, transformer control wiring, and separate control wiring).
- 5.2.4. Identify control devices and their function.
- 5.2.5. Identify remote-control circuits and their function.
- 5.2.6. Identify the components of a magnetic motor starter.
- 5.2.7. Design both two-wire and three-wire controls using start/stop stations and other devices such as float switches.
- 5.2.8. Design a circuit operating a motor starter using two or more start/stop stations.

**Performance Standard 5.3: Overcurrent Protection for Control Circuits**

- 5.3.1. Use the NEC to properly protect control circuits to include conductor sizes, overcurrent protection, and control transformers.

**Performance Standard 5.4: Indicator Lights, Illuminated Pushbuttons, and Selector Switch Truth Tables**

- 5.4.1. Understand the use of illumination in motor controls.
- 5.4.2. Interpret symbols used on diagrams.
- 5.4.3. Read truth tables.
- 5.4.4. Diagram the use of a selector switch on a three-wire control for a jogging application.

**Performance Standard 5.5: Reversing Motor Controls**

- 5.5.1. Understand the operation of a reversing starter with interlocks.
- 5.5.2. Understand the operation of a reversing control station.
- 5.5.3. Understand the operation of a reversing control selector switch.
- 5.5.4. Apply functional indicator lights to reversing controls.
- 5.5.5. Understand reversing operations using limit switches.
- 5.5.6. Understand the operation of reversing a single-phase motor.

**Performance Standard 5.6: Sequencing Control and Master Stop Function**

- 5.6.1. Interpret a diagram showing the sequencing of several motors.
- 5.6.2. Apply the master stop function to a process using motor controls.

**Performance Standard 5.7: Sequencing Control and Master Stop Function**

- 5.7.1. Describe the major characteristics of each type of electrical and electronic diagrams. Compare the special functions included on ladder diagrams and PLC programming diagrams.
- 5.7.2. Compare the applications and component arrangements of wiring diagrams and schematic diagrams.
- 5.7.3.

**Performance Standard 5.7: Industrial Control System**

- 5.8.1. Compare the common component types and voltage levels of power and control circuits.
- 5.8.2. Identify the common numbering systems that are used in control circuit diagrams. Describe the purpose of each logic function and the device arrangements used to form each one.
- 5.8.3.