
Appendix A

**TRAINING APPROACH, TERM OF APPRENTICESHIP,
RATIO OF APPRENTICES, WAGE SCHEDULE,
PROBATIONARY PERIOD, SELECTION PROCEDURES**

AND

**WORK PROCESS SCHEDULE
RELATED INSTRUCTION OUTLINE**

ALL INSTRUCTION PROVIDED BY:



North Idaho College

North Idaho College
Workforce Training Center
Industry & Trades Department
525 Clearwater Loop, Post Falls, ID 83854



Appendix A

WORK PROCESS SCHEDULE Electrician

O*NET-SOC CODE: 47-2111.00 RAPIDS CODE: 0159

This schedule is attached to and a part of these Standards for the above identified occupation.

1. APPRENTICESHIP APPROACH

Time-based Competency-based Hybrid

2. TERM OF APPRENTICESHIP

The term of the apprenticeship is approximately 4 years with an OJL attainment of 8000 hours, supplemented by the minimum required 576 hours of related instruction. (Note: The competency-based training approach does not require hours.)

3. RATIO OF APPRENTICE TO JOURNEYWORKER (Trainer/Mentor/Professional)

The apprentice to journey worker (trainer/mentor/professional) ratio is: 2 Apprentice(s) to 1 Journeyworker(s) when the apprentice license is with the State of Idaho and 1 apprentice to 1 Journey worker when the apprentice license is with the State of Washington as per 29 CFR § 29.5 (b)(7).

4. APPRENTICE WAGE SCHEDULE

Apprentices shall be paid a progressively increasing schedule of wages based on either a percentage or a dollar amount of the current hourly trainer (journeyworker / mentor / professional) wage rate, which is \$25.00.

Progressive Wage Schedule is as follows:

Term	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8
Hours	1000 Hours	1000 Hours	1000 Hours	1000 Hours	1000 Hours	1000 Hours	1000 Hours	1000 Hours
Percent/Dollar Amount	50%	55%	60%	65%	70%	75%	80%	85%

5. PROBATIONARY PERIOD

Every applicant selected for apprenticeship will serve a probationary period of 1000 hours.



6. SELECTION PROCEDURES

The process for finding and selecting the best talent possible for an apprenticeship opening position includes the following:

The sponsor may post open positions on career sites or the company's internal career board to solicit applications.

Applications will be pre-screened to eliminate candidates who do not meet the basic qualifications requirements of the position.

Those applicants that meet basic qualifications will be processed through an assessment to screen out those who lack the desire and interest for the apprenticeship. Screening applicants will be performed through interviews and job simulations to select candidates with the highest potential for apprenticeship success.

The Apprentice(s) will be selected based on the most qualified candidate.

Applicants that have accepted the position will be registered within 45 days.

The apprenticeship selection process and procedures will be uniformly and consistently applied to all applicants.

Any applicant who feels that they were wrongfully denied entry into the apprenticeship program may appeal the decision using the applicant appeals procedure described in Section J of the Standards.

Maintenance of Applications and Selection Records

The sponsor and participating employer will keep adequate records according to their own internal systems, policies, and procedures. There will be no undue burden placed on the company in regarding to hiring the applicant as their apprentice. The items and records maintained, including qualifications of each applicant; the basis for evaluation for selection or rejection of each applicant; the records pertaining to interviews of applicants; the original application for each applicant; information relative to the operation of the apprenticeship program, including, but not limited to, job assignment, promotion, demotion, layoff, or termination; rates of pay or other forms of compensation or conditions of work; hours including hours of work and, separately, hours of training provided; and any other records pertinent to a determination of compliance with 29 CFR § 30, as may be required by the U.S. Department of Labor.

The records pertaining to individual applicants selected will be maintained in such manner as to permit the identification of race, gender, or ethnicity.

Records will be maintained for 5 years from the date of last action and made available upon request to the U.S. Department of Labor or other authorized representative.



WORK PROCESS SCHEDULE Electrician

O*NET-SOC CODE: 47-2111.00 RAPIDS CODE: 0159

Work Process Schedule:

Total Minimum Hours Required: 8000

Tasks/Competencies	Hours/Testing
Preliminary work	600 Hours
<i>a. Learning the names and uses of the equipment used in the trade, such as kind, size, and use of cable, wire, boxes, conduits and fitting, switches, receptacles, service switches, cutouts, etc.</i>	
<i>b. Learning names and uses of the various tools use in assembling this material, care of these tools, and other instructions necessary to familiarize the apprentice with the material and tools of the trade</i>	
<i>c. Safety</i>	
Residential and commercial rough wiring	2500 Hours
<i>a. Assisting in getting the material from stockroom</i>	
<i>b. Loading truck and unloading material and equipment on the job</i>	
<i>c. Laying out the various outlets, switches, receptacles, and other details of the job from blueprints or by direction of the superintendent of construction</i>	
<i>d. Laying out the system with materials to be used, where they are to be placed, and other details as to how they shall be run</i>	
<i>e. Cutting wires, cables, conduit and raceway; threading and reaming conduit, boring and cutting chases under the direction of the journeyman</i>	
<i>f. Installing various kinds of wires, cables, and conduits in accordance with requirements</i>	
<i>g. Assisting journeyman in pulling wires, attaching wires to fishtape, and keeping wires from kinks or abrasions</i>	
<i>h. Connecting conductors to switches, receptacles, or appliances with proper methods of splicing, or soldering, and taping</i>	
<i>i. Installing service switches or load center and subfeeders and fastening up these parts, running raceways and pulling in conductors under the direction of journeyman electricians</i>	
<i>j. Assisting in preparing lists of materials used, including names, number of pieces, or number of feet, etc. for office records</i>	
<i>k. Loading unused material and cleaning UP job area</i>	
Residential and commercial finish work	1500 Hours
<i>a. Connecting and setting switches, receptacles, plates, etc.</i>	
<i>b. Installing proper size and types of fuses for each circuit</i>	
<i>c. Installing and connecting various kinds of fixtures</i>	
<i>d. Tracing the polarity of conductors and devices</i>	
<i>e. Testing the circuit for grounds and shorts and locating and correcting job defects</i>	



f. Assisting journey person in installing and completion of work in accordance with the rules and regulations of the National Board of Fire Underwriters and special local regulations-proper sizes of wires, service, conduits, etc.

Industrial lighting and service installation

2000 Hours

- a. Installing rigid conduit, electric metallic tubing, BX armored cable wire molds on all types of heavy electrical equipment and major size service entrance*
- b. Wiring all types (gas, oil, stoker, etc.) of heating equipment*
- c. Installing wiring and controls for air conditioning*
- d. Wiring of specialized systems to include: sound systems, CRT and data systems, telephones, fire alarm systems, fiber optics, energy management systems, nurse call systems, closed circuit TV, street and highway lighting, and signal systems*

Troubleshooting

1000 Hours

- a. Repairing all kinds of electrical work*
- b. Checking out trouble and making repairs under supervision of electrician*
- c. Checking out trouble and making repairs without supervision*

Motor installation and control

400 Hours

- a. Installing overcurrent devices.*
- b. Checking for installation and rotation.*
- c. Installing replacement motors.*
- d. Analyzing motor circuits and troubleshooting.*
- e. Installing emergency generators and controls.*
- f. Installing pushbuttons, pilot lights, relays, timing devices, and interlocking controls.*

TOTAL MINIMUM HOURS 8000

RELATED INSTRUCTION OUTLINE



Electrician

O*NET-SOC CODE: 47-2111.00 RAPIDS CODE: 0159

INSTRUCTION PROVIDED BY:



North Idaho College

North Idaho College
Workforce Training Center
Industry & Trades Department
525 Clearwater Loop, Post Falls, ID 83854

Related Instruction Descriptions:

Total Minimum Hours Required: 576

Period	Tasks/Competencies	Hours/Testing
1	Electrical Program Standards - Year 1	144

CONTENT STANDARD 1.0: INTRODUCTION TO ELECTRICAL WORK SAFETY

Performance Standard 1.1: General Safety

- 1.1.1 Explain what a material safety data sheet (MSDS/SDS) is and its requirements.
- 1.1.2 Explain safety procedures for trenches.
- 1.1.3 Explain safety for confined space.
- 1.1.4 Explain lockout and tagout.
- 1.1.5 Explain protective clothing to include eye and hearing protection.
- 1.1.6 Explain the use of a safety harness.
- 1.1.7 Explain safety for ladders and scaffolds.
- 1.1.8 State the purpose of arc-fault and ground-fault circuit interrupters.
- 1.1.9 Identify safety handling and use of hand and power tools.

CONTENT STANDARD 2: ELECTRICAL THEORY

Performance Standard 2.1: Electrical Qualities and Ohm's Law

- 2.1.1 Explain the structure of the atom.
- 2.1.2 Explain electron flow.
- 2.1.3 State the difference between insulators and conductors.
- 2.1.4 Explain the basic methods of producing electricity.
- 2.1.5 Describe electrical effects such as magnetism, light, and heat.
- 2.1.6 Define a coulomb.
- 2.1.7 Define an ampere.
- 2.1.8 Define an ohm.
- 2.1.9 Define a watt.
- 2.1.10 Determine the resistance of a resistor using the color code or an ohmmeter.
- 2.1.11 Determine whether a resistor is operating within its power rating.
- 2.1.12 Calculate different electrical values using Ohm's law.
- 2.1.13 Select the proper Ohm's law formula from a chart.

Performance Standard 2.2: Static Electricity and Magnetism

- 2.2.1 Discuss the nature of static electricity.



- 2.2.2. Discuss lightning protection.
- 2.2.3. Give examples of both nuisance and useful static charges.
- 2.2.4. Discuss the properties of permanent magnets.
- 2.2.5. Discuss the operation of electro magnets.
- 2.2.6. Determine the polarity of an electromagnet when the direction of the current is known.

CONTENT STANDARD 3: ELECTRICAL CIRCUITS

Performance Standard 3.1: Series

- 3.1.1. Discuss the properties of series circuits.
- 3.1.2. List three rules for solving electrical values of series circuits.
- 3.1.3. Calculate values of voltage, current, resistance, and power for series circuits.

Performance Standard 3.2: Parallel

- 3.2.1. Discuss the characteristics of parallel circuits.
- 3.2.2. State three rules for solving electrical values of parallel circuits.
- 3.2.3. Solve the missing values in a parallel circuit using the three rules and Ohm's law.
- 3.2.4. Calculate current values using the current divider formula.

Performance Standard 3.3: Combination

- 3.3.1. Define a combination circuit.
- 3.3.2. List the rules for parallel circuits.
- 3.3.3. List the rules for series circuits.
- 3.3.4. Solve combination circuits using the rules for parallel circuits, rules for series circuits, and Ohm's law.

CONTENT STANDARD 4: TOOLS

Performance Standard 4.1: Electrical Testing Equipment

- 4.1.1. Identify the use of Category I through Category IV meters.
- 4.1.2. Use an ohmmeter and measure any resistance in electrical equipment or conductor.
- 4.1.3. Measure voltage between phases and phase to ground.
- 4.1.4. Take an ampere reading of any load.
- 4.1.5. Diagram the proper connection of a wattmeter.
- 4.1.6. State the operation characteristics of analog and digital meters.
- 4.1.7. Recognize the waveform on an oscilloscope.

Performance Standard 4.2: Bending Conduit

- 4.2.1. Identify the parts of tools used for bending.
- 4.2.2. Identify the methods and tools used in bending raceways.
- 4.2.3. Define and identify saddle, offset, concentric, and 90-degree bends.

CONTENT STANDARD 5: INTRODUCTION TO THE NATIONAL ELECTRICAL CODE (NEC)

Performance Standard 5.1: NEC Articles 90, 100, and 110

- 5.1.1. Understand how the NEC began and its purpose.
- 5.1.2. Understand how changes to the code evolve.
- 5.1.3. Understand the terminology, and format of the NEC.
- 5.1.4. State the roles of nationally recognized testing laboratories, the National Electrical Manufacturers Association, and the National Fire Protection Association.
- 5.1.5. Accurately evaluate a location as accessible, readily accessible, or not readily accessible.
- 5.1.6. Identify equipment classified as appliances.
- 5.1.7. State the four categories of branch circuits.
- 5.1.8. State the difference between a continuous load and a non-continuous load.
- 5.1.9. Determine minimum vertical clearances for each installation using the NEC.



5.1.10. Apply dedicated space requirements to electrical equipment to include the area that is to be clear of foreign

5.1.11. Determine the working clearances of any installation using the NEC.

5.1.12. State the difference between a branch circuit and a feeder.

5.1.13. State the difference between "grounded" and "grounding" as it applies to a conductor.

5.1.14. Define what "in sight" means in the NEC.

5.1.15. Give examples of damp, wet, and dry locations using the codebook.

5.1.16. Determine which conductors are the neutral conductors.

5.1.17. Define a separately derived system using the NEC.

Performance Standard 5.2: Boxes and Enclosures--NEC Articles 312, 314, and other

Appropriate NEC Sections

5.2.1. Determine the cubic inch capacity of boxes when installing conductors# 6 AWG and smaller.

5.2.2. State which items use volume allowances of conductor fill when calculating box fill.

5.2.3. State how identical switches or receptacles can be mounted side by side in a two-gang box can have different

5.2.4. Determine the box size when the number of conductors is known.

5.2.5. Know the minimum conductor length to be left inside a box.

5.2.6. Explain what must be accessible after installation.

5.2.7. State the mounting and supporting provisions for boxes and conduit bodies using the NEC.

5.2.8. Determine the type of box needed for various applications using the NEC.

5.2.9. Calculate for junction box sizing containing #4 AWG and larger conductors using the NEC

Performance Standard 5.3: Cables--NEC Articles 320 through 340, and other appropriate NEC sections

5.3.1. State the distance from the edge of the wood framing member a cable can be installed unless a steel plate is installed.

5.3.2. State the requirements for protection of cable in metal framing using the NEC.

5.3.3. State the sealing requirements in fire-resistant-rated construction when electrical penetrations are made.

5.3.4. Identify what cables are permitted in spaces used for environmental air.

5.3.5. Determine the support requirements for MC, AC, and nonmetallic-sheathed cable using the NEC.

5.3.6. Identify the conductors in a cable and use the NEC to state how certain conductors can be re-identified.

5.3.7. Determine underground installation provisions per the NEC.

5.3.8. Identify special application cables using the NEC (This is not to be for installation requirements as this is for

Performance Standard 5.4: Raceways and Conductors--NEC Sections 11.14, 240.4, 300.19; NEC Articles 310, 342 through 378; Chapter 9 Tables; Annex C, and other appropriate NEC section

5.4.1. Determine the general provisions for any raceway installation using the NEC.

5.4.2. Determine the type of raceways suited for individual installations.

5.4.3. Determine the support requirements for various raceways using the NEC.

5.4.4. Determine the provisions for nonmetallic and metallic flexible conduit using the NEC.

5.4.5. Calculate the electrical trade size conduit required for any circuit or feeder.

5.4.6. Determine basic conductor properties using the NEC.



- 5.4.7. *Show conductor temperature limitations.*
 - 5.4.8. *Determine the provisions for conductors connected in parallel.*
 - 5.4.9. *Apply conductor ampacity correction factors to include continuous loads.*
- Performance Standard 5.5: General Provisions for One-Family Dwellings--NEC Articles 210, 220, 240, 250, 315, 402, 404, 406, 410, 422, and other appropriate NEC Sections*
- 5.5.1. *Calculate the minimum number of 15 and 20 amp branch circuits in a one-family dwelling.*
 - 5.5.2. *Determine the requirements for single receptacles on individual branch circuits.*
 - 5.5.3. *Determine the branch-circuit ratings allowed for general-purpose receptacles.*
 - 5.5.4. *Demonstrate the layout of general-purpose receptacles in a dwelling.*
 - 5.5.5. *Determine the receptacle rating allowed on various size branch circuits using the NEC.*
 - 5.5.6. *Determine the requirements for receptacles around sink areas using the NEC.*
 - 5.5.7. *Determine the requirements for lighting and switching using the NEC.*
 - 5.5.8. *Determine how and when to use the white conductor as an ungrounded conductor.*
 - 5.5.9. *Determine any general requirement for boxes using the NEC.*
 - 5.5.10. *Determine any illumination requirement for entrances and exits.*
 - 5.5.11. *Determine the allowable use of vegetation such as trees for the mounting of outlets.*
- Performance Standard 5.6: Specific Provisions for One-Family Dwellings--NEC Articles 210, 410, 422, and other appropriate NEC sections*
- 5.6.1. *Determine the required ampere rating for any receptacle or branch circuit in kitchens, pantries, dining rooms, breakfast rooms, and similar locations.*
 - 5.6.2. *Determine the requirements for countertop receptacle placement using the NEC.*
 - 5.6.3. *State the minimum number of small appliance branch circuits required and their application.*
 - 5.6.4. *Determine the requirements for appliances both cord and plug and permanently connected.*
 - 5.6.5. *Calculate the load requirements for appliance branch circuits.*
 - 5.6.6. *State the specific provisions for GFCI placement.*
 - 5.6.7. *Identify luminaires permitted in closets and its placement.*
 - 5.6.8. *Define a bathroom by the NEC and discuss the circuit requirements for receptacles, lights and fans.*
 - 5.6.9. *Determine the requirements for receptacles and lighting in attached garages, detached garages, and*
 - 5.6.10. *Determine the requirements for laundry rooms to include the clothes dryer.*
 - 5.6.11. *Determine the lighting and receptacle requirements for attic, crawl space, and HVAC equipment.*
- Performance Standard 5.7: Load Calculations for One-Family Dwellings—NEC Articles, 210, 220, 230, 250, 310, and other appropriate NEC sections*
- 5.7.1. *Calculate the general lighting for a one-family dwelling.*
 - 5.7.2. *Specify the volt-amp requirements for small appliance and laundry branch circuits.*
 - 5.7.3. *Apply demand factors to the general lighting load.*
 - 5.7.4. *Apply demand factors to fastened-in-place appliances.*
 - 5.7.5. *Calculate feeder demand loads for household clothes dryers.*
 - 5.7.6. *Calculate feeder demand loads for household cooking equipment.*
 - 5.7.7. *Calculate feeder demand loads for HVAC equipment.*
 - 5.7.8. *Calculate a one-family dwelling or feeder using the standard method.*
 - 5.7.9. *Calculate a one-family dwelling or feeder using the optional method.*



- 5.7.10. Calculate service and feeder conductors.
- 5.7.11. Calculate the minimum size neutral conductor.
- 5.7.12. Select the proper grounding electrode conductor.
- Performance Standard 5.8: Services and Electrical Equipment for One-Family Dwellings-- NEC Articles 110, 225, 230, 240, 250, 300, 310, and other appropriate NEC sections*
- 5.8.1 Determine adequate strength for a mast supporting service-drop conductors.
- 5.8.2. Explain the use of service-entrance cable.
- 5.8.3. Define a service lateral and underground service conductors, and explain their provisions.
- 5.8.4. Determine clearances for service and outside overhead wiring.
- 5.8.5. Determine workspace required for electrical equipment, services, and panels.
- 5.8.6. Define a panel board, an enclosure, and a cutout box.
- 5.8.7. Determine the proper application and use of circuit breakers and fuses using the NEC.
- 5.8.8. Determine the appropriate conductor sizing using 310.15(8) (7) or Table 310.15 (8) (16).
- 5.8.9. Size the grounding electrode conductor, equipment grounding conductor, main bonding jumper, bonding
- 5.8.10. Properly install grounded and grounding conductors in subpanels.
- 5.8.11. Prevent objectionable current flow in grounding conductors and equipment.
- 5.8.12. Properly install a panel board in a separate building or structure.
- Performance Standard 5.9: Comprehensive Provisions for Multi-Family Dwellings-- NEC Articles 210, 230, 240, 250, 310, Chapter 9, Tables 8 and 9, and other appropriate NEC sections*
- 5.9.1. Determine when more than one service can be installed on a multifamily building.
- 5.9.2. Determine the proper number of disconnects allowed on a service.
- 5.9.3. Determine proper access to a unit's disconnecting means by any occupant.
- 5.9.4. Properly install the grounding electrode conductors to the grounding electrode.
- 5.9.5. Determine the appropriate service or feeder conductor sizing using 310.15(8)(7) or Table 310.15 (8) (16) Determine outdoor receptacle placement.
- 5.9.6. Calculate voltage-drop.
- Performance Standard 5.10: General Provisions for Commercial Locations--NE Articles 210, 220, 310, 410 430. 440. 600 and other appropriate NEC sections*
- 5.10.1. Compare receptacle placement with that of one-family dwellings to show the difference.
- 5.10.2. Determine the receptacle requirements in a commercial bathroom.
- 5.10.3. Determine the sign outlet requirements in a commercial installation.
- 5.10.4. Determine the branch circuit requirements for motors and HVAC equipment.
- 5.10.5. Determine the volt-amp ratings for receptacles (single, duplex, quad, etc.).
- 5.10.6. Determine the maximum number of receptacles permitted on a 15 amp or 20-amp circuit.
- 5.10.7. Identify the NEC accessibility requirements for receptacles in guest rooms of hotels and motels.
- 5.10.8. Determine NEC requirements for showcase and show window.
- 5.10.9. Calculate general lighting load based on square-foot area.
- 5.10.10. Determine the provisions for fluorescent, HID, recessed LED, and track lighting provisions.
- 5.10.11. Determine the proper use and restrictions when using luminaires as raceways.
- 5.10.12. Determine hand hole access requirements.



Performance Standard 5.11: Provisions for Services, Feeders, and Provisions for Commercial Locations--NEC Articles 110, 215, 230, 250, 368, 408, and other appropriate NEC sections

5.11.1. Properly install both grounding and grounded conductors on the line side and load side

of the service supply conductors.

5.11.2. Determine the conditions that require ground-fault protection of equipment.

5.11.3. Recognize separately derived systems.

5.11.4. Explain how to properly ground and bond separately derived systems.

5.11.5. Recognize and explain the use of busways.

CONTENT STANDARD 6: SPECIAL OCCUPANCIES

Performance Standards 6.1: Hazardous Locations--NEC Articles 500 through 516

6.1.1 Explain what a hazardous location is.

6.1.2. Determine if a classified location is Class I, II or III and if it is Division 1 or 2 using the NEC.

6.1.3. Identify the NEC requirements pertaining to commercial garages and repair and storage facilities.

6.1.4. Identify the NEC requirements for buildings in which aircraft are stored and repaired.

6.1.5. Identify the NEC requirements for a motor fuel dispensing facility.

Performance Standards 6.2: Health Care--NEC Articles 500 through 517

6.2.1. Identify basic health care terminology used in NEC.

6.2.2. Determine the grounding and bonding requirements of any health care facility.

6.2.3. Identify patient care areas as general care or critical care and their branch circuit requirements.

6.2.4. Determine the tamper -resistant requirements of pediatric facilities.

6.2.5. Define the types of essential systems.

Performance Standard 6.3: Other Special Occupancies--NEC Articles 518 through 551

6.3.1. Define "places of assembly" according to the NEC.

6.3.2. Determine manufactured building requirements.

6.3.3. Determine agricultural building requirements.

6.3.4. Determine requirements for mobile home parks and recreational vehicle parks.

2 Electrical Program Standards – Year 2

144

CONTENT STANDARD 1.0: INTRODUCTION TO ELECTRICAL WORK SAFETY

Performance Standard 1.1: General Safety

1.1.1 Explain what a material safety data sheet (MSDS/SDS) is and its requirements.

1.1.2 Explain safety procedures for trenches.

1.1.3 Explain safety for confined space.

1.1.4 Explain lockout and tagout.

1.1.5. Explain protective clothing to include eye and hearing protection.

1.1.6. Explain the use of a safety harness.

1.1.7. Explain safety for ladders and scaffolds.

1.1.8. State the purpose of arc-fault and ground-fault circuit interrupters.

1.1.9. Identify safety handling and use of hand and power tools.

CONTENT STANDARD 2: ELECTRICAL THEORY

Performance Standard 2.1: Electrical Qualities and Ohm's Law

2.1.1. Explain the structure of the atom.

2.1.2. Explain electron flow.

2.1.3. State the difference between insulators and conductors.



- 2.1.4. Explain the basic methods of producing electricity.
 - 2.1.5. Describe electrical effects such as magnetism, light, and heat.
 - 2.1.6. Define a coulomb.
 - 2.1.7. Define an ampere.
 - 2.1.8. Define an ohm.
 - 2.1.9. Define a watt.
 - 2.1.10. Determine the resistance of a resistor using the color code or an ohmmeter.
 - 2.1.11. Determine whether a resistor is operating within its power rating.
 - 2.1.12. Calculate different electrical values using Ohm's law.
 - 2.1.13. Select the proper Ohm's law formula from a chart.
- Performance Standard 2.2: Static Electricity and Magnetism**
- 2.2.1. Discuss the nature of static electricity.
 - 2.2.2. Discuss lightning protection.
 - 2.2.3. Give examples of both nuisance and useful static charges.
 - 2.2.4. Discuss the properties of permanent magnets.
 - 2.2.5. Discuss the operation of electromagnets.
 - 2.2.6. Determine the polarity of an electromagnet when the direction of the current is known.
- CONTENT STANDARD 3: ELECTRICAL CIRCUITS**
- Performance Standard 3.1: Series**
- 3.1.1. Discuss the properties of series circuits.
 - 3.1.2. List three rules for solving electrical values of series circuits.
 - 3.1.3. Calculate values of voltage, current, resistance, and power for series circuits.
- Performance Standard 3.2: Parallel**
- 3.2.1. Discuss the characteristics of parallel circuits.
 - 3.2.2. State three rules for solving electrical values of parallel circuits.
 - 3.2.3. Solve the missing values in a parallel circuit using the three rules and Ohm's law.
 - 3.2.4. Calculate current values using the current divider formula.
- Performance Standard 3.3: Combination**
- 3.3.1. Define a combination circuit.
 - 3.3.2. List the rules for parallel circuits.
 - 3.3.3. List the rules for series circuits.
 - 3.3.4. Solve combination circuits using the rules for parallel circuits, rules for series circuits, and Ohm's law.
- CONTENT STANDARD 4: TOOLS**
- Performance Standard 4.1: Electrical Testing Equipment**
- 4.1.1. Identify the use of Category I through Category IV meters.
 - 4.1.2. Use an ohmmeter and measure any resistance in electrical equipment or conductor.
 - 4.1.3. Measure voltage between phases and phase to ground.
 - 4.1.4. Take an ampere reading of any load.
 - 4.1.5. Diagram the proper connection of a wattmeter.
 - 4.1.6. State the operation characteristics of analog and digital meters.
 - 4.1.7. Recognize the waveform on an oscilloscope.
- Performance Standard 4.2: Bending Conduit**
- 4.2.1. Identify the parts of tools used for bending.
 - 4.2.2. Identify the methods and tools used in bending raceways.
 - 4.2.3. Define and identify saddle, offset, concentric, and 90-degree bends.
- CONTENT STANDARD 5: INTRODUCTION TO THE NATIONAL ELECTRICAL CODE (NEC)**
- Performance Standard 5.1: NEC Articles 90, 100, and 110**
- 5.1.1. Understand how the NEC began and its purpose.



- 5.1.2. *Understand how changes to the code evolve.*
 - 5.1.3. *Understand the terminology, and format of the NEC.*
 - 5.1.4. *State the roles of nationally recognized testing laboratories, the National Electrical Manufacturers Association, and the National Fire Protection Association.*
 - 5.1.5. *Accurately evaluate a location as accessible, readily accessible, or not readily accessible.*
 - 5.1.6. *Identify equipment classified as appliances.*
 - 5.1.7. *State the four categories of branch circuits.*
 - 5.1.8. *State the difference between a continuous load and a non-continuous load.*
 - 5.1.9. *Determine minimum vertical clearances for each installation using the NEC.*
 - 5.1.10. *Apply dedicated space requirements to electrical equipment to include the area that is to be clear of foreign objects.*
 - 5.1.11. *Determine the working clearances of any installation using the NEC.*
 - 5.1.12. *State the difference between a branch circuit and a feeder.*
 - 5.1.13. *State the difference between "grounded" and "grounding" as it applies to a conductor.*
 - 5.1.14. *Define what "in sight" means in the NEC.*
 - 5.1.15. *Give examples of damp, wet, and dry locations using the codebook.*
 - 5.1.16. *Determine which conductors are the neutral conductors.*
 - 5.1.17. *Define a separately derived system using the NEC.*
- Performance Standard 5.2: Boxes and Enclosures--NEC Articles 312, 314, and other appropriate NEC Sections*
- 5.2.1. *Determine the cubic inch capacity of boxes when installing conductors # 6 AWG and smaller.*
 - 5.2.2. *State which items use volume allowances of conductor fill when calculating box fill.*
 - 5.2.3. *State how identical switches or receptacles can be mounted side by side in a two-gang box can have different functions.*
 - 5.2.4. *Determine the box size when the number of conductors is known.*
 - 5.2.5. *Know the minimum conductor length to be left inside a box.*
 - 5.2.6. *Explain what must be accessible after installation.*
 - 5.2.7. *State the mounting and supporting provisions for boxes and conduit bodies using the NEC.*
 - 5.2.8. *Determine the type of box needed for various applications using the NEC.*
 - 5.2.9. *Calculate for junction box sizing containing #4 AWG and larger conductors using the NEC.*
- Performance Standard 5.3: Cables--NEC Articles 320 through 340, and other appropriate NEC sections*
- 5.3.1. *State the distance from the edge of the wood framing member a cable can be installed unless a steel plate is installed.*
 - 5.3.2. *State the requirements for protection of cable in metal framing using the NEC.*
 - 5.3.3. *State the sealing requirements in fire-resistant-rated construction when electrical penetrations are made.*
 - 5.3.4. *Identify what cables are permitted in spaces used for environmental air.*
 - 5.3.5. *Determine the support requirements for MC, AC, and nonmetallic-sheathed cable using the NEC.*
 - 5.3.6. *Identify the conductors in a cable and use the NEC to state how certain conductors can be re-identified.*
 - 5.3.7. *Determine underground installation provisions per the NEC.*
 - 5.3.8. *Identify special application cables using the NEC (This is not to be for installation requirements as this is for special applications.)*



Performance Standard 5.4: Raceways and Conductors--NEC Sections 11.14, 240.4, 300.19; NEC Articles 310, 342 through 378; Chapter 9 Tables; Annex C, and other appropriate NEC section

- 5.4.1. Determine the general provisions for any raceway installation using the NEC.*
- 5.4.2. Determine the type of raceways suited for individual installations.*
- 5.4.3. Determine the support requirements for various raceways using the NEC.*
- 5.4.4. Determine the provisions for nonmetallic and metallic flexible conduit using the NEC.*
- 5.4.5. Calculate the electrical trade size conduit required for any circuit or feeder.*
- 5.4.6. Determine basic conductor properties using the NEC.*
- 5.4.7. Show conductor temperature limitations.*
- 5.4.8. Determine the provisions for conductors connected in parallel.*
- 5.4.9. Apply conductor ampacity correction factor *s* to include continuous loads.*

Performance Standard 5.5: General Provisions for One-Family Dwellings--NEC Articles 210, 220, 240, 250, 315, 402, 404, 406, 410, 422, and other appropriate NEC Sections

- 5.5.1. Calculate the minimum number of 15 and 20 amp branch circuit *s* in a one-family dwelling.*
- 5.5.2. Determine the requirements for single receptacles on individual branch circuit *s*.*
- 5.5.3. Determine the branch-circuit ratings allowed for general-purpose receptacles.*
- 5.5.4. Demonstrate the layout of general-purpose receptacles in a dwelling.*
- 5.5.5. Determine the receptacle rating allowed on various size branch circuits using the NEC.*
- 5.5.6. Determine the requirements for receptacles around sink areas using the NEC.*
- 5.5.7. Determine the requirements for lighting and switching using the NEC.*
- 5.5.8. Determine how and when to use the white conductor as an ungrounded conductor.*
- 5.5.9. Determine any general requirement for boxes using the NEC.*
- 5.5.10. Determine any illumination requirement for entrances and exits.*
- 5.5.11. Determine the allowable use of vegetation such as trees for the mounting of outlet *s*.*

Performance Standard 5.6: Specific Provisions for One-Family Dwellings--NEC Articles 210, 410, 422, and other appropriate NEC sections

- 5.6.1. Determine the required ampere rating for any receptacle or branch circuit in kitchens, pantries, dining rooms, breakfast rooms, and similar location *s*.*
- 5.6.2. Determine the requirements for countertop receptacle placement using the NEC.*
- 5.6.3. State the minimum number of small appliance branch circuit *s* required and their application.*
- 5.6.4. Determine the requirements for appliances both cord and plug and permanently connected.*
- 5.6.5. Calculate the load requirements for appliance branch circuit *s*.*
- 5.6.6. State the specific provisions for GFCI placement.*
- 5.6.7. Identify luminaries permitted in closets and its placement.*
- 5.6.8. Define a bathroom by the NEC and discuss the circuit requirements for receptacles, lights and fans.*
- 5.6.9. Determine the requirements for receptacles and lighting in attached garages, detached garages, and*
- 5.6.10. Determine the requirements for laundry rooms to include the clothes dryer.*
- 5.6.11. Determine the lighting and receptacle requirements for attic, crawl space, and HVAC equipment.*

Performance Standard 5.7: Load Calculations for One-Family Dwellings—NEC Articles, 210,220, 230,250, 310, and other appropriate NEC sections



- 5.7.1. Calculate the general lighting for a one-family dwelling.
 - 5.7.2. Specify the volt-amp requirements for small appliance and laundry branch circuits.
 - 5.7.3. Apply demand factors to the general lighting load.
 - 5.7.4. Apply demand factors to fastened-in-place appliances.
 - 5.7.5. Calculate feeder demand loads for household clothes dryers.
 - 5.7.6. Calculate feeder demand loads for household cooking equipment.
 - 5.7.7. Calculate feeder demand loads for HVAC equipment.
 - 5.7.8. Calculate a one-family dwelling or feeder using the standard method.
 - 5.7.9. Calculate a one-family dwelling or feeder using the optional method.
 - 5.7.10. Calculate service and feeder conductors.
 - 5.7.11. Calculate the minimum size neutral conductor.
 - 5.7.12. Select the proper grounding electrode conductor.
- Performance Standard 5.8: Services and Electrical Equipment for One-Family Dwellings-- NEC Articles 110, 225, 230, 240, 250, 300, 310, and other appropriate NEC sections*
- 5.8.1. Determine adequate strength for a mast supporting service-drop conductors.
 - 5.8.2. Explain the use of service-entrance cable.
 - 5.8.3. Define a service lateral and underground service conductors, and explain their provisions.
 - 5.8.4. Determine clearances for service and outside overhead wiring.
 - 5.8.5. Determine workspace required for electrical equipment, services, and panels.
 - 5.8.6. Define a panel board, an enclosure, and a cutout box.
 - 5.8.7. Determine the proper application and use of circuit breakers and fuses using the NEC.
 - 5.8.8. Determine the appropriate conductor sizing using 310.15(8) (7) or Table 310.15 (8)(16).
 - 5.8.9. Size the grounding electrode conductor, equipment grounding conductor, main bonding jumper, bonding
 - 5.8.10. Properly install grounded and grounding conductors in subpanels.
 - 5.8.11. Prevent objectionable current flow in grounding conductors and equipment.
 - 5.8.12. Properly install a panel board in a separate building or structure.
- Performance Standard 5.9: Comprehensive Provisions for Multi-Family Dwellings-- NEC Articles 210, 230, 240, 250, 310, Chapter 9, Tables 8 and 9, and other appropriate NEC sections*
- 5.9.1. Determine when more than one service can be installed on a multifamily building.
 - 5.9.2. Determine the proper number of disconnects allowed on a service.
 - 5.9.3. Determine proper access to a unit's disconnecting means by any occupant.
 - 5.9.4. Properly install the grounding electrode conductors to the grounding electrode.
 - 5.9.5. Determine the appropriate service or feeder conductor sizing using 310.15(8)(7) or Table 310.15 (8) (16) Determine outdoor receptacle placement.
 - 5.9.6. Calculate voltage-drop.
- Performance Standard 5.10: General Provisions for Commercial Locations--NEC Articles 210, 220, 310, 410 430. 440. 600 and other appropriate NEC sections*
- 5.10.1. Compare receptacle placement with that of one-family dwellings to show the difference.
 - 5.10.2. Determine the receptacle requirements in a commercial bathroom.
 - 5.10.3. Determine the sign outlet requirements in a commercial installation.
 - 5.10.4. Determine the branch circuit requirements for motors and HVAC equipment.
 - 5.10.5. Determine the volt-amp ratings for receptacles (single, duplex, quad, etc.).



- 5.10.6. Determine the maximum number of receptacles permitted on a 15 amp or 20-amp circuit.
- 5.10.7. Identify the NEC accessibility requirements for receptacles in guest rooms of hotels and motels.
- 5.10.8. Determine NEC requirements for showcase and show window.
- 5.10.9. Calculate general lighting load based on square-foot area.
- 5.10.10. Determine the provisions for fluorescent, HID, recessed LED, and track lighting provisions.
- 5.10.11. Determine the proper use and restrictions when using luminaires as raceways.
- 5.10.12. Determine hand hole access requirements.
- Performance Standard 5.11: Provisions for Services, Feeders, and Provisions for Commercial Locations--NEC Articles 110, 215, 230, 250, 368, 408, and other appropriate NEC sections
- 5.11.1. Properly install both grounding and grounded conductors on the line side and load side of the service supply conductors.
- 5.11.2. Determine the conditions that require ground-fault protection of equipment.
- 5.11.3. Recognize separately derived systems.
- 5.11.4. Explain how to properly ground and bond separately derived systems.
- 5.11.5. Recognize and explain the use of busways.
- CONTENT STANDARD 6: SPECIAL OCCUPANCIES
- Performance Standards 6.1: Hazardous Locations--NEC Articles 500 through 516
- 6.1.1 Explain what a hazardous location is.
- 6.1.2. Determine if a classified location is Class I, II or III and if it is Division 1 or 2 using the NEC.
- 6.1.3. Identify the NEC requirements pertaining to commercial garages and repair and storage facilities.
- 6.1.4. Identify the NEC requirements for buildings in which aircraft are stored and repaired.
- 6.1.5. Identify the NEC requirements for a motor fuel dispensing facility.
- Performance Standards 6.2: Health Care--NEC Articles 500 through 517
- 6.2.1. Identify basic health care terminology used in NEC.
- 6.2.2. Determine the grounding and bonding requirements of any health care facility.
- 6.2.3. Identify patient care areas as general care or critical care and their branch circuit requirements.
- 6.2.4. Determine the tamper -resistant requirements of pediatric facilities.
- 6.2.5. Define the types of essential systems.
- Performance Standard 6.3: Other Special Occupancies--NEC Articles 518 through 551
- 6.3.1. Define "places of assembly" according to the NEC.
- 6.3.2. Determine manufactured building requirements.
- 6.3.3. Determine agricultural building requirements.
- 6.3.4. Determine requirements for mobile home parks and recreational vehicle parks.

3 Electrical Program Standards - Year 3

144

- 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 s.*
- 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 view s, 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 drawing s.*

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, measurement s, 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,*

2.3.2. *Plans, foundation plans, structural plans, and utility plans.*

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.*

3.1.2. *Calculate the general lighting, general use receptacle, small appliance, and laundry demand load for a dwelling.*

3.1.3. *Calculate the appliance demand load for a dwelling.*

3.1.4. *Determine the dryer demand load for a dwelling.*

3.1.5. *Determine the cooking appliance demand load for a dwelling.*

3.1.6. *Determine the heating and air conditioning demand load for a dwelling.*



3.1.7. Properly size the service equipment and service conductors for a dwelling using the standard calculation as per Article 220.

3.1.8. Properly size feeder conductors (main to sub-panel) for a dwelling.

3.1.9. Use the optional calculation for a dwelling as per Article 220.

3.1.10. 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.

3.2.2. Calculate the general lighting, general use receptacle, small appliance, and laundry demand load for a multifamily dwelling.

3.2.3. Calculate the appliance demand load for a multifamily dwelling.

3.2.4. Determine the dryer demand load for a multifamily dwelling.

3.2.5. Determine the cooking appliance demand load for a multifamily dwelling.

3.2.6. Determine the heating and air conditioning demand load for a multifamily dwelling. Properly size the service equipment and service conductors for a multifamily dwelling

3.2.7. Using the standard calculation as per Article 220.

3.2.8. Properly size feeder conductors (main to sub-panel) for a multifamily dwelling

3.2.9. Use the optional calculation for a multifamily dwelling as per Article 220.

3.2.10. 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 wire way 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.

4.3.2. Use the information in Chapter 9, Table 8 to calculate the resistance of any conductor 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 nameplate to size overloads.

4.4.5 Explain the difference between overload protection and short-circuit/ground-fault 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.

4.5.2. Calculate the primary and secondary line current of single- and three-phase transformers.

4.5.3. Calculate the primary and secondary overcurrent protection for a transformer.

4.5.4. Calculate and select the proper conductor size for the primary and secondary of a 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.

5.1.4. Use and interpret definitions, abbreviations, and graphic symbols used on motor control diagrams.

5.1.5. Describe the function of pushbutton stations, solenoids, flow switches, pressure 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*
- 5.7.2. Diagrams.*
- 5.7.3. Compare the applications and component arrangements of wiring diagrams and schematic diagrams.*

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*
- 5.8.3 each one.*



CONTENT STANDARD 1.0: GENERAL NEC REQUIREMENTS

Performance Standard 1.1: Electrical Installation Requirements: Articles 90, 100, and 110

- 1.1.1. Identify scope of the NEC.
- 1.1.2. Define terms as they apply to the NEC.
- 1.1.3. Determine the proper termination of conductors.
- 1.1.4. Determine the kinds of warnings, markings, and identification a given installation requires.
- 1.1.5. Determine the proper working clearance for any installation.
- 1.1.6. Determine proper voltage rating.

CONTENT STANDARD 2.0: WIRING AND PROTECTION

Performance Standard 2.1: Use and Identification of Grounded Conductors, Branch Circuits, and Feeders: Articles 200, 210 and 215

- 2.1.1. Properly identify a grounded conductor.
 - 2.1.2. Properly apply the general provisions of Article 210.
 - 2.1.3. Properly apply the branch circuit's ratings of Article 210.
 - 2.1.4. Properly install the required outlets of Article 210.
 - 2.1.5. Calculate the minimum size and ampacity of any feeder.
- ### **Performance Standard 2.2: Branch Circuit, Feeder, and Service Calculations: Article 220**
- 2.2.1. Calculate the loads for a single-family dwelling.
 - 2.2.2. Calculate the loads for a multifamily dwelling.
 - 2.2.3. Calculate the loads for a commercial or industrial installation.

Performance Standard 2.3: Outside Branch Circuits and Feeders, Services: Articles 225 and 230

- 2.3.1. Determine the proper installation for conductors and lighting installed outdoors.
- 2.3.2. Determine vertical and horizontal clearance of overhead conductors.
- 2.3.3. Determine proper disconnecting means and installation.
- 2.3.4. Determine the proper installation and protection of conductors.

Performance Standard 2.4: Overcurrent Protection: Article 240

- 2.4.1. Properly size a standard overcurrent device to any conductor.
- 2.4.2. Properly apply the small conductor rules.
- 2.4.3. Calculate transformer secondary conductor protection.
- 2.4.4. Reference requirements for appliance protection.
- 2.4.5. Calculate tap conductor protection.
- 2.4.6. Reference protection for motors and air conditioners.

Performance Standard 2.5: Grounding and Bonding: Article 250

- 2.5.1. Define the difference between grounding and bonding.
- 2.5.2. Determine the proper grounding and bonding requirements of any system.
- 2.5.3. Properly size the main bonding jumper.
- 2.5.4. Properly size the grounding electrode conductor.
- 2.5.5. Properly size equipment-grounding conductors.
- 2.5.6. Determine the various types of grounding conductors.
- 2.5.7. Design a proper grounding electrode system.

Performance Standard 2.6: Surge Protective Devices: Article 285

- 2.6.1. Determine the installation requirements of SPDs.
- 2.6.2. Discuss the difference between Type 1, Type 2, Type 3, and Type 4 SPDs and their use.

CONTENT STANDARD 3.0 : WIRING METHODS AND MATERIALS

Performance Standard 3.1: Wiring Methods and Conductors for General Wiring: Articles 300 and 310

- 3.1.1. Determine how to route, splice, protect, and secure conductors and raceways.



3.1.2. Determine the general requirements for conductors such as insulation markings, ampacity ratings, and conductors to use in specific installations.

3.1.3. Properly use the Article 310 tables.

3.1.4. Apply Chapter 9 tables.

Apply adjustment factors to any conductor based on wire fill, temperature, and

3.1.5. Continuous load.

3.1.6. Define the meaning of conductor insulation lettering.

3.1.7. Determine when a neutral conductor is to be counted as a current-carrying conductor.

Performance Standard 3.2: Enclosures: Articles 312 and 314

3.2.1. Determine the use of any enclosure based on the conditions of use.

3.2.2. Determine the installation requirements for any enclosure.

3.2.3. Properly use boxes and fittings based on internal volume.

3.2.4. Determine the requirements for fill of boxes and fittings.

3.2.5. Properly size pull and junction boxes for No. 4 AWG conductors and larger.

Performance Standard 3.3: Cables: Articles 320, 330, 334, 338, and 340

3.3.1. Determine the installation requirements of Armored Cable.

3.3.2. Determine the installation requirements of Metal-Clad Cable.

3.3.3. Determine the installation requirements of Nonmetallic-Sheathed Cable.

3.3.4. Determine the installation requirements of Service-Entrance Cable.

3.3.5. Determine the installation requirements of Underground Feeder and Branch – Circuit Cable (Type UF).

3.3.6. Relate temperature concerns, derating, etc. to other appropriate articles in the NEC.

Performance Standard 3.4: Metal Raceways: Articles 342, 344, 348, 350, 352, 356, 358, and 362

3.4.1. Determine the installation requirements of Intermediate Metal conduit.

3.4.2. Determine the installation requirements of Ridged Metal Conduit.

3.4.3. Determine the installation requirements of Flexible Metal Conduit.

3.4.4. Determine the installation requirements of Liquid tight Flexible Metal Conduit.

3.4.5. Determine the installation requirements of Rigid Polyvinyl Chloride Conduit.

3.4.6. Determine the installation requirements of Liquid tight Flexible Nonmetallic Conduit.

3.4.7. Determine the installation requirements of Electrical Metallic Tubing.

3.4.8. Determine the installation requirements of Electrical Nonmetallic Tubing.

3.4.9. Relate conductor fill, derating, etc. to other appropriate articles in the NEC.

Performance Standard 3.5: Metal Wireways, Multi outlet Assemblies, Surface Metal Raceways, Cable Trays: Articles 376, 380, 388, 392

3.5.1. Determine the proper installation of a metal wireway.

3.5.2. Calculate the proper conductor fill of a metal wireway.

3.5.3. Calculate the proper size of a metal wireway based on conductor size and conduit entries.

3.5.4. Determine provisions for properly splicing conductors in a metal wireway.

3.5.5. Determine the proper installation of multi-outlet assemblies.

3.5.6. Determine the proper installation of surface metal raceways.

3.5.7. Determine the proper installation and use of cable trays.

CONTENT STANDARD 4.0: EQUIPMENT FOR GENERAL USE

Performance Standard 4.1: Flexible Cords, Flexible Cables, and Fixture Wires: Articles 400 and 402

4.1.1. Identify requirements, applications, and construction specifications of cords and cables.



- 4.1.2. *Select cords, cables, and fittings listed for specific applications.*
- 4.1.3. *Identify requirements and specifications of fixture wires.*
- Performance Standard 4.2: Switches, Receptacles, Cord Connectors, and Attachment Plugs:*
Articles 404 and 406
 - 4.2.1. *Determine types and uses of switches.*
 - 4.2.2. *Determine types and uses of receptacles.*
- Performance Standard 4.3: Switchboards, Switchgear, and Panel boards: Article 408*
 - 4.3.1. *Determine the specific requirements for switchboards, switchgear, and panel boards that control power and lighting circuits.*
 - 4.3.2. *Properly identify the labeling requirements of each circuit in a panel board or switchboard.*
 - 4.3.3. *Determine proper termination of conductors in panel boards and switchboards.*
- Performance Standard 4.4: Luminaires, Lamp holders, and Lamps: Article 410*
 - 4.4.1. *Determine the general requirements of Article 410.*
- Performance Standard 4.5: Lighting Systems Operating at 30 Volts or Less: Article 411*
 - 4.5.1. *Determine proper installation of low voltage lighting.*
- Performance Standard 4.6: Appliances, Fixed Electric Space Heating Equipment: Articles 422 and 424*
 - 4.6.1. *Calculate and determine proper branch circuit ratings for any appliance.*
 - 4.6.2. *Calculate and determine proper overcurrent protection for any appliance.*
 - 4.6.3. *Determine the requirements for non-motor appliances.*
 - 4.6.4. *Determine proper disconnecting means.*
 - 4.6.5. *Determine requirements for heating installations.*
- Performance Standard 4.7: Motors, Motor Circuits, and Controllers; Air-conditioning and Refrigeration Equipment: Articles 430 and 440*
 - 4.7.1. *Determine the proper conductor size for any motor.*
 - 4.7.2. *Determine the proper overcurrent protection for any motor.*
 - 4.7.3. *Determine the proper disconnect for any motor.*
 - 4.7.4. *Determine the proper overload protection for any motor and condition (easy start, hard start, etc.).*
 - 4.7.5. *Determine the minimum size feeder for a group of motors.*
 - 4.7.6. *Determine the feeder overcurrent protection.*
 - 4.7.7. *Determine proper size of circuits and overcurrent devices for air conditioning and refrigeration equipment.*
 - 4.7.8. *Determine the requirements for the disconnecting means of refrigeration equipment.*
- CONTENT STANDARD 5.0: SPECIAL OCCUPANCIES**
- Performance Standard 5.1: Hazardous Locations: Articles 500 through 504*
 - 5.1.1. *Determine proper wiring of a hazardous location.*
- Performance Standard 5.2: Commercial Garages, Motor Fuel Dispensing Facilities: Articles 511 and 514*
 - 5.2.1. *Define a major repair garage.*
 - 5.2.2. *Define a minor repair garage.*
 - 5.2.3. *Classify hazardous areas.*
 - 5.2.4. *Determine proper wiring methods for a commercial garage of any type.*
 - 5.2.5. *Define a Motor Fuel Dispensing Facility.*
 - 5.2.6. *Determine proper wiring methods for Motor Fuel Dispensing Facilities.*
- Performance Standard 5.3: Health Care Facilities: Article 517*
 - 5.3.1. *Define health care facility types.*
 - 5.3.2. *Define General Care Areas and Critical Care Areas.*



- 5.3.3. *Discuss Essential Electrical Systems.*
- 5.3.4. *Determine proper wiring and grounding for a health care facility.*
- Performance Standard 5.4: Assembly Occupancies, Carnivals, Fairs and Similar Events: Articles 518 through 525*
- 5.4.1. *Discuss the proper wiring methods for places of assembly.*
- 5.4.2. *Discuss the proper wiring of carnivals, fairs, and similar events.*
- Performance Standard 5.5: Agricultural Buildings: Article 547*
- 5.5.1. *Determine the proper wiring method for any agricultural building.*
- 5.5.2. *Determine proper grounding for any agricultural building.*
- Performance Standard 5.6: Marinas and Boatyards: Article 555*
- 5.6.1. *Determine marina requirements using the NEC.*
- Performance Standard 5.7: Temporary Installations: Article 590*
- 5.7.1. *Determine the requirements for temporary installations.*
- CONTENT STANDARD 6.0: SPECIAL EQUIPMENT**
- Performance Standard 6.1: Electric Signs and Outline Lighting, Manufactured Wiring Systems: Articles 600 and 604*
- 6.1.1. *Determine proper installation and requirements of electric signs and associated lighting.*
- 6.1.2. *Determine proper installation of manufactured wiring systems.*
- Performance Standard 6.2: Cranes and Hoists: Article 610*
- 6.2.1. *Determine proper wiring of cranes and hoists.*
- Performance Standard 6.3: Elevators, Escalators, and Moving Walks: Article 620*
- 6.3.1. *Determine proper installation requirements of elevators, escalators, and moving walks.*
- Performance Standard 6.4: Audio Signal Processing, Amplification, Reproduction Equipment: Article 640*
- 6.4.1. *Determine proper wiring methods for audio equipment.*
- Performance Standard 6.5: Information Technology Equipment: Article 645*
- 6.5.1. *Define an IT room.*
- 6.5.2. *Determine proper installation of wiring in IT rooms.*
- Performance Standard 6.6: Swimming Pools, Spas, Hot Tubs, Fountains, and Similar Locations: Article 680*
- 6.6.1. *Determine proper electrical installations for swimming pools.*
- 6.6.2. *Determine proper electrical installations for spas and hot tubs.*
- 6.6.3. *Determine proper electrical installations for fountains.*
- CONTENT STANDARD 7.0: SPECIAL CONDITIONS**
- Performance Standard 7.1: Emergency Standby Power Systems, Legally Required Power Systems, Optional Standby Power Systems: Articles 700 through 702*
- 7.1.1. *Determine the proper installation of standby power systems.*
- 7.1.2. *Determine the difference between emergency standby, legally required standby, and optional standby power systems.*
- Performance Standard 7.2: Remote-Control, Signaling, and Power-Limited Circuits: Article 725*
- 7.2.1. *Define circuit classes.*
- 7.2.2. *Determine proper installation and requirements of different circuit classes.*
- Performance Standard 7.3: Fire Alarm Systems: Article 760*
- 7.3.1. *Define non-power-limited fire alarm circuits.*
- 7.3.2. *Define power-limited fire alarm circuits.*



7.3.3. Determine the proper installation of fire alarm wiring using the NEC.

7.3.4. Determine where the use of GFCI and AFCI are restricted.

7.3.5. Determine proper cable types.

CONTENT STANDARD 8.0: COMMUNICATION SYSTEMS

Performance Standard 8.1: Optical Fiber Cables and Raceways; Communications Systems:

Articles 770 and 800 through 820

8.1.1. Determine proper installation of optical fiber cables.

8.1.2. Determine proper grounding of communications wiring and equipment.

8.1.3. Determine proper installations of communication wiring.

TOTAL MINIMUM HOURS 576

TOTAL MINIMUM HOURS _____