



12 Hour 2023 NEC Code Theory and NFPA 70 E Safety

Course Outline and Objectives

Section 1: Electrical Theory and Fundamental Code Principles (1 Hour 20 Minutes)

- **Subsection 1:** Basic Electrical Theory and the Role of the NEC – Understanding voltage, current, resistance, and power as applied in electrical work.
- **Subsection 2:** Series and Parallel Circuits – Reviewing circuit behavior, load distribution, and voltage drop considerations.
- **Subsection 3:** Ohm's Law and Power Calculations – Applying formulas to determine electrical system efficiency and safety.
- **Subsection 4:** Understanding Alternating Current (AC) and Direct Current (DC) Systems – Exploring differences in applications and code requirements.
- **Subsection 5:** Conductor Resistance and Voltage Drop Calculations – Importance of proper conductor sizing to maintain efficiency and compliance.
- **Subsection 6:** Electrical System Grounding and Bonding Principles – A deeper look at NEC requirements for safe electrical grounding practices.
- **Subsection 7:** Overcurrent Protection and Coordination – Understanding circuit breakers, fuses, and short-circuit current ratings.
- **Subsection 8:** Arc Flash Hazards and Code-Mandated Safety Practices – Importance of personal protective equipment (PPE) and safe work distances.
- **Subsection 9:** Electrical Load Calculations for Residential and Commercial Applications – Applying NEC tables for service sizing and circuit design.
- **Subsection 10:** Oregon-Specific Electrical Code Amendments and Regulations – Examining state-specific deviations from the NEC.

Section 2: Electrical Installations in Residential and Commercial Buildings (1 Hour 20 Minutes)

- **Subsection 1:** Service Entrance Equipment and Metering Requirements – Installation standards for safe and code-compliant service entrances.
 - **Subsection 2:** Panelboard and Load Center Installations – Proper placement, working space, and circuit breaker arrangements.
 - **Subsection 3:** Branch Circuit and Feeder Sizing – Understanding NEC requirements for conductor ampacity and protection.
 - **Subsection 4:** Wiring Methods and Materials – Reviewing different conduit types, cable selections, and NEC-approved wiring techniques.
 - **Subsection 5:** Outlet and Receptacle Placement in Residential and Commercial Buildings – Understanding minimum requirements and special location considerations.
 - **Subsection 6:** Switching and Lighting Control Requirements – Ensuring proper controls, occupancy sensors, and energy efficiency compliance.
 - **Subsection 7:** GFCI and AFCI Protection Requirements Beyond the NEC Updates – Understanding where these protective devices are required.
 - **Subsection 8:** Emergency Systems and Standby Power Requirements – Reviewing NEC mandates for emergency power generation and backup systems.
 - **Subsection 9:** Special Occupancies and Uses in Residential and Commercial Settings – Applying NEC articles related to healthcare facilities, hotels, and retail spaces.
 - **Subsection 10:** Common Code Violations in Residential and Commercial Installations – Avoiding mistakes that lead to failed inspections and safety risks.
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Section 3: Electrical Equipment, Motors, and Transformers (1 Hour 20 Minutes)

- **Subsection 1:** General Installation Requirements for Electrical Equipment – NEC guidelines for safe placement and operation.
- **Subsection 2:** Electrical Motor Installation and Protection – Overcurrent protection, grounding, and thermal overload considerations.
- **Subsection 3:** Motor Control Circuits and NEC Compliance – Wiring diagrams, starter types, and troubleshooting best practices.
- **Subsection 4:** Industrial Control Panels and Enclosures – Understanding UL 508A requirements and NEC applications.
- **Subsection 5:** Transformer Sizing, Placement, and Protection – Key considerations for safely integrating transformers into electrical systems.
- **Subsection 6:** Energy Efficiency Standards for Motors and Transformers – Code-driven requirements for high-efficiency electrical equipment.

- **Subsection 7:** Hazardous Location Considerations for Motors and Equipment – Understanding Class I, II, and III locations and safe installations.
 - **Subsection 8:** Short-Circuit and Ground-Fault Protection for Motors and Transformers – NEC requirements for fault mitigation.
 - **Subsection 9:** Power Factor Correction and Demand Load Considerations – Optimizing electrical systems for efficiency and cost savings.
 - **Subsection 10:** Harmonics, Interference, and Power Quality Issues – NEC standards for mitigating electrical noise and power disturbances.
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Section 4: Specialized Electrical Installations and Code Compliance (1 Hour 20 Minutes)

- **Subsection 1:** Industrial and Commercial Kitchen Electrical Systems – NEC requirements for food service electrical installations.
 - **Subsection 2:** Agricultural and Farm Installations – Unique challenges and NEC requirements for barns, irrigation, and outdoor structures.
 - **Subsection 3:** Marinas and Boatyard Electrical Systems – NEC guidelines for safe electrical installations in marine environments.
 - **Subsection 4:** Swimming Pools, Hot Tubs, and Fountains – Electrical safety and compliance for water-related installations.
 - **Subsection 5:** Wiring for Theaters, Stages, and Entertainment Venues – Special considerations for temporary and permanent installations.
 - **Subsection 6:** Temporary Electrical Installations for Construction Sites – NEC rules for job site power distribution and safety.
 - **Subsection 7:** Signage, Billboards, and Outdoor Advertising Electrical Work – Understanding NEC Article 600 for illuminated signs.
 - **Subsection 8:** Wiring for Medical and Healthcare Facilities – NEC rules for patient care areas, operating rooms, and life-support systems.
 - **Subsection 9:** Electrical Installations for Elevators, Escalators, and Lifts – Understanding NEC Article 620 for vertical transportation.
 - **Subsection 10:** Common Errors and Best Practices for Specialized Electrical Work – Ensuring compliance in unique electrical applications.
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Section 5: Electrical Safety, Testing, and Troubleshooting (1 Hour 20 Minutes)

- **Subsection 1:** Lockout/Tagout (LOTO) and Electrical Work Safety Practices – NEC and OSHA regulations for de-energizing systems.

- **Subsection 2:** Testing and Verification of Electrical Systems – Best practices for using meters, megohm testers, and diagnostic tools.
 - **Subsection 3:** Grounding System Testing and Performance Verification – Ensuring compliance through proper testing techniques.
 - **Subsection 4:** Power Quality Analysis and Voltage Drop Testing – Diagnosing common power issues and ensuring system efficiency.
 - **Subsection 5:** Identifying and Resolving Neutral and Grounding Issues – NEC requirements for properly installed grounding conductors.
 - **Subsection 6:** Troubleshooting Circuit Breakers and Overcurrent Protection Devices – Diagnosing tripping issues and coordination failures.
 - **Subsection 7:** Inspection and Compliance Checklists for Electrical Contractors – Ensuring jobs meet NEC and local code requirements.
 - **Subsection 8:** Safety Considerations for High-Voltage Installations – Understanding special precautions for working with high-voltage systems.
 - **Subsection 9:** Electrical Code Requirements for Fire Alarm Systems – NEC guidelines for fire alarm wiring and integration.
 - **Subsection 10:** Arc Flash Risk Assessments and Mitigation Strategies – Understanding NFPA 70E and NEC requirements for electrical hazard reduction.
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Section 6: Emerging Technologies and Future Code Considerations (1 Hour 20 Minutes)

- **Subsection 1:** Advancements in Smart Electrical Panels and Load Management – How modern electrical panels integrate with automation.
- **Subsection 2:** Energy Storage Systems (ESS) and Battery Technology – NEC rules for lithium-ion and alternative energy storage.
- **Subsection 3:** Electric Vehicle (EV) Charging Infrastructure – NEC requirements for residential and commercial EV charging stations.
- **Subsection 4:** Microgrid and Distributed Energy Resource (DER) Integration – How NEC provisions are evolving to accommodate these technologies.
- **Subsection 5:** Renewable Energy Electrical Code Considerations – Compliance for wind, solar, and hydroelectric energy installations.
- **Subsection 6:** Lighting Control and Energy Efficiency Regulations – The role of the NEC in LED technology and advanced control systems.
- **Subsection 7:** Home Automation and Smart Home Wiring Methods – NEC requirements for interconnected devices and IoT applications.

- **Subsection 8:** Alternative Wiring Systems and Flexible Conduit Applications – Emerging NEC trends in modular and prefabricated wiring.
- **Subsection 9:** Cybersecurity Considerations for Electrical Systems – Protecting electrical infrastructure from digital threats.
- **Subsection 10:** Future NEC Revisions and Expected Code Changes – Preparing for updates in upcoming NEC cycles.

Section 7: Fundamentals of Electrical Safety and NFPA 70E (1 Hour)

1. **Purpose and Scope of NFPA 70E** – Understanding its role in protecting personnel from electrical hazards
 2. **Relationship Between OSHA and NFPA 70E** – How NFPA 70E supports OSHA enforcement and employer responsibilities
 3. **Key Definitions and Terminology** – Arc flash, arc blast, shock hazard, approach boundaries, etc.
 4. **Hierarchy of Risk Controls** – Elimination, substitution, engineering controls, administrative controls, and PPE
 5. **Responsibilities of Employers and Employees** – Safety program development, documentation, and training obligations
 6. **Applicable Work Environments** – Facilities, job sites, industrial and commercial applications of NFPA 70E
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Section 8: Shock and Arc Flash Hazard Identification and Risk Assessment (1 Hour)

1. **Identifying Electrical Hazards** – Distinguishing shock, arc flash, and arc blast hazards
 2. **Shock Risk Assessment** – Voltage, approach boundaries, and likelihood of injury
 3. **Arc Flash Risk Assessment Process** – Determining incident energy and likelihood of occurrence
 4. **Establishing and Using Boundaries** – Limited, restricted, and arc flash boundaries explained
 5. **Labeling and Signage Requirements** – Proper equipment labeling per Article 130.5
 6. **Documentation and Risk Assessment Records** – Maintaining compliance and audit trails
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Section 9: Safe Work Practices and Energized Work Requirements (1 Hour)

1. **Justification for Energized Work** – When de-energizing is not feasible or introduces increased risk
2. **Energized Work Permits** – When required, what must be included, and who authorizes them

3. **Establishing an Electrically Safe Work Condition** – Lockout/tagout procedures and verification steps
 4. **Job Briefings and Pre-Task Planning** – Communication, scope of work, PPE, and hazard control
 5. **Tools and Test Equipment Safety** – Use of insulated tools and voltage-rated instruments
 6. **Human Error and Situational Awareness** – Preventive practices and behavioral safety
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Section 10: Personal Protective Equipment (PPE) and Emergency Response (1 Hour)

1. **Arc-Rated PPE Categories and Selection** – Understanding arc ratings, clothing layers, and Category 1–4
2. **Shock Protection PPE** – Insulated gloves, mats, shields, and dielectric footwear
3. **Proper Use, Care, and Maintenance of PPE** – Inspection, testing, cleaning, and replacement timelines
4. **Electrical Incident Response Planning** – Arc flash injuries, burns, and emergency medical protocols
5. **Training and Retraining Requirements** – Frequency, documentation, and qualification standards
6. **Recent Changes in NFPA 70E (2021–2024 Editions)** – Summary of important updates and how they affect field practices

Course Objectives

Upon successful completion of this course, the licensee will be able to:

1. **Demonstrate applied knowledge of fundamental electrical theory**, including Ohm's Law, AC/DC systems, conductor resistance, voltage drop, and power calculations, as they relate to code-compliant installations and system performance.
2. **Interpret and apply 2023 NEC requirements** to residential, commercial, and specialized installations, including service equipment, panelboards, grounding and bonding systems, branch circuit design, and emergency/standby systems.
3. **Identify and correct common electrical code violations** and ensure compliance with NEC articles for special occupancies, including healthcare, agricultural, marine, and construction environments.

4. **Evaluate NEC code standards related to motors, transformers, control circuits, hazardous locations, and energy-efficient equipment**, with attention to safe operation, protection strategies, and system coordination.
5. **Apply electrical safety practices and testing protocols**, including lockout/tagout procedures, grounding system verification, troubleshooting techniques, and inspection checklists to ensure safe, code-compliant electrical work.
6. **Analyze NEC code updates related to emerging technologies**, such as electric vehicle charging, energy storage systems, smart panels, renewable energy, and microgrid integration, and anticipate the impact of future code cycles.
7. **Understand the purpose, structure, and practical application of NFPA 70E**, including its relationship to OSHA requirements and its role in protecting workers from shock, arc flash, and arc blast hazards in energized environments.
8. **Conduct effective risk assessments** using NFPA 70E methods to identify electrical hazards, define appropriate approach boundaries, label equipment, and maintain compliance documentation for energized work tasks.
9. **Implement safe work practices for energized systems**, including the use of energized work permits, establishing electrically safe work conditions, planning job briefings, and controlling for human error and behavioral safety risks.
10. **Select and maintain appropriate personal protective equipment (PPE)** for electrical tasks based on arc flash category levels and NFPA 70E requirements, and prepare for emergency response in case of arc-related injury or exposure.