



Certification Exams

Detailed Content Outlines

Level 2 Certified Assistant Technician

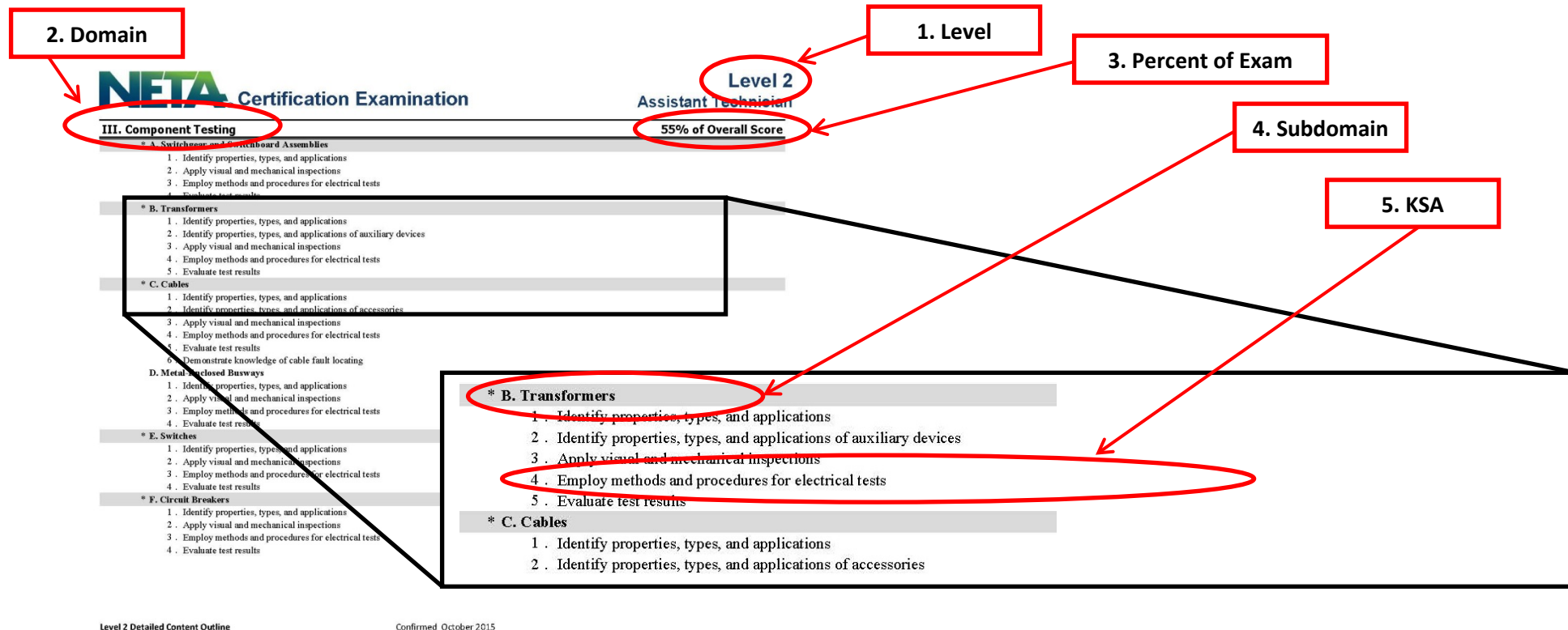
Level 3 Certified Technician

Level 4 Certified Senior Technician

These Detailed Content Outlines (DCOs) were developed in accordance with certification industry standards and best practices by subject matter experts and certified electrical testing technicians with the guidance of examination development professionals. The DCOs should be used in conjunction with the ANSI/NETA ETT *Standard for Certification of Electrical Testing Technicians* when preparing for the NETA Certification Exams.

Each outline is divided into different areas to help you determine what subject matter to study as you prepare for your exam.

1. Level
2. Domains
3. Percent of Exam Content
4. Subdomains
5. KSAs (knowledge, skills, abilities)



Levels

- NETA offers three levels of certification that are achieved through meeting pre-requisites designated in the ANSI/NETA ETT, by achieving a passing score on the certification exams, and by maintaining employment with a NETA Accredited Company or NETA Approved Military Organization
- Level 2 – Certified Assistant Technician
- Level 3 – Certified Technician
- Level 4 – Certified Senior Technician

Domains

- Domains are designated by a Roman numeral, I, II, III, or IV, on the DCO
 - Safety
 - Electrical Testing Fundamentals and Theory
 - Component Testing
 - Systems and Commissioning
- Each Domain also has a corresponding percentage of content on each exam
- These percentages vary by exam level

Subdomains

- Subdomains are designated by an Arabic numeral under each Domain on the exam
- Subdomains may vary depending on exam level
- Some subdomains are designated as core subjects within the Component Testing subdomain

Core Subjects Within Domain III., Component Testing

* B. Transformers

- 1 . Identify properties, types, and applications
- 2 . Identify properties, types, and applications of auxiliary devices
- 3 . Apply visual and mechanical inspections
- 4 . Employ methods and procedures for electrical tests
- 5 . Evaluate test results

* C. Cables

- 1 . Identify properties, types, and applications
- 2 . Identify properties, types, and applications of accessories

Core Subjects Within Domain III., Component Testing

- Certain Subdomains within Domain 3, Component Testing, have been identified as core subjects and therefore will be found on every certification exam for that particular level of certification.
- These core subjects are identified with an asterisk and are highlighted in grey.
- For example, the Level 2 Certification Exam will always contain questions within the Subdomains of Switchgear and Switchboard Assemblies, Transformers, Cables, Switches, Circuit Breakers, Protective Relays, Instrument Transformers, Grounding Systems, Ground-Fault Protection Systems, Motor Control Centers and Motor Starters, Direct-Current Systems, Insulating Liquids and Gasses, and Fuses.
- **NOTE: to achieve a passing score, it is important to focus on all areas within the detailed content outlines, not just the subdomains that are designated as core competencies**

KSAs

- KSAs are specific sets of knowledge, skills, and abilities that have been identified as pertinent to each specific exam level, domain, and subdomain
- The KSAs provide detailed descriptions of the types of questions a technician may see on the certification exam

I. Safety

15% of Overall Score

A. Risk Assessment

- 1 . Identify safe work practices with regard to hazards encountered on the job
- 2 . Identify requirements to create a safe work environment
- 3 . Determine the location and implications of shock and arc-flash protection boundaries

B. Establishing an Electrically Safe Work Condition

- 1 . Apply requirements of *NFPA 70E, Article 120: Establishing an Electrically Safe Work Condition*

C. Lockout/Tagout Procedures

- 1 . Apply OSHA lockout/tagout requirements

D. Personal Protective Equipment

- 1 . Recognize and assess Arc-Flash Hazard/Risk Categories and Shock Protection Boundaries
- 2 . Apply correct use, storage, and testing of personal protective equipment

E. Safety Equipment Selection

- 1 . Identify the safety equipment needs of the project (e.g., hotstick, voltage detectors, insulated tools, fire extinguisher, etc.)

F. Confined Space

- 1 . Recognize confined space and its hazards
- 2 . Recognize when a confined space becomes a permit-required confined space along with the associated requirements
- 3 . Apply OSHA requirements

G. Switching and Temporary Protective Grounding

- 1 . Select and apply correct voltage detection equipment
- 2 . Select and apply correct temporary protective grounding equipment
- 3 . Interpret and apply system switching procedures

H. Incident Energy Analysis

- 1 . Interpret field-marked equipment labels
- 2 . Identify hazards where no field-marked labels exist
- 3 . Demonstrate knowledge of incident energy calculation methods
- 4 . Demonstrate knowledge of the variables involved in incident energy calculation methods

I. Codes and Standards

- 1 . Apply standards and regulatory organizations (e.g., OSHA, ANSI, ASTM, IEEE, NETA, NFPA, NEMA, etc.)
- 2 . Recognize key provisions of NFPA 70 (e.g., Articles 90, 110.16, 110.21, 225.56, 230.95(C), 250, and 310) and 70E (i.e. Chapter 1: Safety-Related Work Practices and Chapter 2: Safety-Related Maintenance Requirements, etc.)
- 3 . Apply technical requirements of ANSI/NETA Acceptance and Maintenance Testing Standards
- 4 . Practice compliance with manufacturer's published data

II. Electrical Testing Fundamentals and Theory

25 % of Overall Score

A. Fundamentals of Electricity

- 1 . Define and apply terms and concepts from physics, electricity, heat, and chemistry
- 2 . Recognize and define the standard units used to describe electrical circuits, energy, and power
- 3 . Identify series and parallel circuits
- 4 . Recognize the sources and effects of electromagnetic fields
- 5 . Demonstrate knowledge of dielectric properties of various types of insulations
- 6 . Demonstrate knowledge of phasing and phase rotation

B. Electrical Calculations

- 1 . Perform mathematical calculations utilizing basic algebra, geometry, and trigonometry
- 2 . Apply fundamental electrical laws to simple circuits (e.g., Ohm's law, Kirchhoff's law, etc.)
- 3 . Apply conversions between units (e.g., microhms to milliohms, horsepower to kilowatts, etc.)

C. AC and DC Circuits

- 1 . Calculate simple single-loop ac circuits with RLC components
- 2 . Calculate equivalent resistance of and power consumed by resistive circuits
- 3 . Calculate equivalent capacitance and inductance
- 4 . Apply methods for measuring and calculating impedance and power
- 5 . Demonstrate knowledge of complex ac and dc circuits (e.g., voltage drop, current flow, power, etc.)
- 6 . Demonstrate knowledge of phase angle, power factor, and vectors

D. Insulation Testing

- 1 . Employ methods and procedures for insulation tests and analyze results

E. Resistance Testing

- 1 . Employ methods and procedures for resistance tests and analyze results (e.g., winding resistance, contact resistance, bolted connections, etc.)

F. Thermographic Survey

- 1 . Employ methods and procedures for thermographic surveys and analyze results (e.g., emissivity, reflection, delta-T, etc.)

G. Current Testing

- 1 . Employ methods and procedures for current tests and analyze results (e.g., overcurrent pickup, circuit burden, voltage drop,

H. System Tests, Analysis, and Operation

- 1 . Interpret electrical one-line diagrams
- 2 . Interpret ac and dc schematic diagrams, ac three-line diagrams, and connection and interconnection drawings
- 3 . Identify electrical symbols and ANSI device numbers
- 4 . Interpret time-current curves
- 5 . Recognize essential components of short-circuit and coordination studies (e.g., cable size and length, available protective device settings, raceway type, utility fault contribution, etc.)
- 6 . Demonstrate knowledge of short-circuit and coordination studies

III. Component Testing

55% of Overall Score

* A. Switchgear and Switchboard Assemblies

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results

* B. Transformers

- 1 . Identify properties, types, and applications
- 2 . Identify properties, types, and applications of auxiliary devices
- 3 . Apply visual and mechanical inspections
- 4 . Employ methods and procedures for electrical tests
- 5 . Evaluate test results

* C. Cables

- 1 . Identify properties, types, and applications
- 2 . Identify properties, types, and applications of accessories
- 3 . Apply visual and mechanical inspections
- 4 . Employ methods and procedures for electrical tests
- 5 . Evaluate test results
- 6 . Demonstrate knowledge of cable fault locating

D. Metal-Enclosed Busways

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results

* E. Switches

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results

* F. Circuit Breakers

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results

III. Component Testing (Continued)

G. Circuit Switchers

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results

H. Network Protectors

- 1 . Identify properties, types, and applications

*** I. Protective Relays**

- 1 . Identify types and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results

*** J. Instrument Transformers**

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results

K. Metering Devices

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results

L. Regulating Apparatus

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections

*** M. Grounding Systems**

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results
- 5 . Employ methods of enhancing effectiveness of grounding systems

*** N. Ground-Fault Protection Systems**

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results

III. Component Testing (Continued)

O. Rotating Machinery

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results

*** P. Motor Control Centers and Motor Starters**

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results

Q. Adjustable-Speed Drive Systems

- 1 . Identify properties, types, and applications

*** R. Direct-Current Systems**

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results

S. Surge Arresters

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results

T. Capacitors and Reactors

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results

U. Outdoor Bus Structures

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results

V. Emergency Systems

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results

III. Component Testing (Continued)

W. Automatic Circuit Reclosers and Line Sectionalizers

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections

X. Fiber-Optic Cables

- . Recognize and correctly handle fiber-optic cables

*** Y. Insulating Liquids and Gases**

- 1 . Identify properties, types, and applications
- 2 . Apply sampling procedures
- 3 . Employ methods and procedures in compliance with ASTM
- 4 . Evaluate test results

*** Z. Fuses**

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results

IV. Systems and Commissioning

5% of Overall Score

A. Troubleshooting

- 1 . Investigate power or protective system faults or malfunctions to determine cause and corrective action required

B. Functional Testing

- 1 . Employ methods and procedures for system-function tests upon completion of the individual component tests defined, as system conditions allow
- 2 . Apply concepts of functionality for electrical systems

I. Safety

13% of Overall Score

A. Risk Assessment

- 1 . Identify safe work practices with regard to hazards encountered on the job
- 2 . Identify requirements to create a safe work environment
- 3 . Determine the location and implications of shock and arc-flash protection boundaries

B. Establishing an Electrically Safe Work Condition

- 1 . Apply requirements of *NFPA 70E, Article 120: Establishing an Electrically Safe Work Condition*

C. Lockout/Tagout Procedures

- 1 . Apply OSHA lockout/tagout requirements

D. Personal Protective Equipment

- 1 . Recognize and assess Arc-Flash Hazard/Risk Categories and Shock Protection Boundaries
- 2 . Apply correct use, storage, and testing of personal protective equipment

E. Safety Equipment Selection

- 1 . Identify the safety equipment needs of the project (e.g., hotstick, voltage detectors, insulated tools, fire extinguisher, etc.)

F. Confined Space

- 1 . Recognize confined space and its hazards
- 2 . Recognize when a confined space becomes a permit-required confined space along with the associated requirements
- 3 . Apply OSHA requirements

G. Switching and Temporary Protective Grounding

- 1 . Select and apply correct voltage detection equipment
- 2 . Select and apply correct temporary protective grounding equipment
- 3 . Interpret and apply system switching procedures

H. Incident Energy Analysis

- 1 . Interpret field-marked equipment labels
- 2 . Identify hazards where no field-marked labels exist
- 3 . Demonstrate knowledge of incident energy calculation methods
- 4 . Demonstrate knowledge of the variables involved in incident energy calculation methods

I. Codes and Standards

- 1 . Apply standards and regulatory organizations (e.g., OSHA, ANSI, ASTM, IEEE, NETA, NFPA, NEMA, etc.)
- 2 . Recognize key provisions of NFPA 70 (e.g., Articles 90, 110.16, 110.21, 225.56, 230.95(C), 250, and 310) and 70E (i.e. Chapter 1: Safety-Related Work Practices and Chapter 2: Safety-Related Maintenance Requirements, etc.)
- 3 . Apply technical requirements of ANSI/NETA Acceptance and Maintenance Testing Standards
- 4 . Practice compliance with manufacturers' published data

II. Electrical Testing Fundamentals and Theory

23% of Overall Score

A. Fundamentals of Electricity

- 1 . Define and apply terms and concepts from physics, electricity, heat, and chemistry
- 2 . Recognize and define the standard units used to describe electrical circuits, energy, and power
- 3 . Identify series and parallel circuits
- 4 . Recognize the sources and effects of electromagnetic fields
- 5 . Demonstrate knowledge of dielectric properties of various types of insulations
- 6 . Demonstrate knowledge of phasing and phase rotation

B. Electrical Calculations

- 1 . Perform mathematical calculations utilizing basic algebra, geometry, and trigonometry
- 2 . Apply fundamental electrical laws to simple circuits (e.g., Ohm's law, Kirchhoff's law, etc.)
- 3 . Apply conversions between units (e.g., microhms to milliohms, horsepower to kilowatts, etc.)

C. AC and DC Circuits

- 1 . Calculate simple single-loop ac circuits with RLC components
- 2 . Calculate equivalent resistance of and power consumed by resistive circuits
- 3 . Calculate equivalent capacitance and inductance
- 4 . Apply methods for measuring and calculating impedance and power
- 5 . Calculate variables of complex ac and dc circuits (e.g., voltage drop, current flow, power, etc.)
- 6 . Calculate phase angle, power factor, and vectors

D. Insulation Testing

- 1 . Employ methods and procedures for insulation tests and analyze results

E. Resistance Testing

- 1 . Employ methods and procedures for resistance tests and analyze results (e.g., winding resistance, contact resistance, bolted connections, etc.)

F. Thermographic Survey

- 1 . Employ methods and procedures for thermographic surveys and analyze results (e.g., emissivity, reflection, delta-T, etc.)

G. Current Testing

- 1 . Employ methods and procedures for current tests and analyze results (e.g., overcurrent pickup, circuit burden, voltage drop, etc.)

II. Electrical Testing Fundamentals and Theory (Continued)

H. System Tests, Analysis, and Operation

- 1 . Interpret electrical one-line diagrams
- 2 . Interpret ac and dc schematic diagrams, ac three-line diagrams, and connection and interconnection drawings
- 3 . Identify electrical symbols and ANSI device numbers
- 4 . Interpret time-current curves
- 5 . Recognize essential components of short-circuit and coordination studies (e.g., cable size and length, available protective device settings, raceway type, utility fault contribution, etc.)
- 6 . Apply data extracted from short-circuit and coordination studies
- 7 . Recognize cause and effects of power system harmonics

III. Component Testing

47% of Overall Score

*** A. Switchgear and Switchboard Assemblies**

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results

*** B. Transformers**

- 1 . Identify properties, types, and applications
- 2 . Identify properties, types, and applications of auxiliary devices
- 3 . Apply visual and mechanical inspections
- 4 . Employ methods and procedures for electrical tests
- 5 . Evaluate test results

*** C. Cables**

- 1 . Identify properties, types, and applications
- 2 . Identify properties, types, and applications of accessories
- 3 . Apply visual and mechanical inspections
- 4 . Employ methods and procedures for electrical tests
- 5 . Evaluate test results
- 6 . Demonstrate knowledge of cable fault locating

D. Metal-Enclosed Busways

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results

E. Switches

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results

*** F. Circuit Breakers**

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results

G. Circuit Switchers

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results

III. Component Testing (Continued)

H. Network Protectors

- 1 . Identify properties, types, and applications of protection and control
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results

*** I. Protective Relays**

- 1 . Identify types and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results

*** J. Instrument Transformers**

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results

K. Metering Devices

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results

L. Regulating Apparatus

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results

*** M. Grounding Systems**

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results
- 5 . Employ methods of enhancing effectiveness of grounding systems

*** N. Ground-Fault Protection Systems**

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results

III. Component Testing (Continued)

*** O. Rotating Machinery**

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results

P. Motor Control Centers and Motor Starters

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results

Q. Adjustable-Speed Drive Systems

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results

*** R. Direct-Current Systems**

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results

S. Surge Arresters

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results

T. Capacitors and Reactors

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results

U. Outdoor Bus Structures

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results

*** V. Emergency Systems**

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results

III. Component Testing (Continued)

W. Automatic Circuit Reclosers and Line Sectionalizers

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results

X. Fiber-Optic Cables

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections

*** Y. Insulating Liquids and Gases**

- 1 . Identify properties, types, and applications
- 2 . Apply sampling procedures
- 3 . Employ methods and procedures in compliance with ASTM
- 4 . Evaluate test results

Z. Fuses

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results

IV. Systems and Commissioning

17% of Overall Score

A. Troubleshooting

- 1 . Investigate power or protective system faults or malfunctions to determine cause and corrective action required

B. SCADA

- 1 . Recognize basic requirements, equipment, and configuration of SCADA/DCS systems

C. Monitoring/DCS Systems

- 1 . Apply procedures for microprocessor-based power monitoring and control systems

D. Functional Testing

- 1 . Employ methods and procedures for system-function tests upon completion of the individual component tests defined, as system conditions allow

- 2 . Apply concepts of functionality for electrical systems

I. Safety

10% of Overall Score

A. Risk Assessment

- 1 . Identify safe work practices with regard to hazards encountered on the job
- 2 . Identify requirements to create a safe work environment
- 3 . Determine the location and implications of shock and arc-flash protection boundaries

B. Establishing an Electrically Safe Work Condition

- 1 . Apply requirements of *NFPA 70E, Article 120: Establishing an Electrically Safe Work Condition*

C. Lockout/Tagout Procedures

- 1 . Apply OSHA lockout/tagout requirements

D. Personal Protective Equipment

- 1 . Recognize and assess Arc-Flash Hazard/Risk Categories and Shock Protection Boundaries
- 2 . Apply correct use, storage, and testing of personal protective equipment

E. Safety Equipment Selection

- 1 . Identify the safety equipment needs of the project (e.g., hotstick, voltage detectors, insulated tools, fire extinguisher, etc.)

F. Confined Space

- 1 . Recognize confined space and its hazards
- 2 . Recognize when a confined space becomes a permit-required confined space along with the associated requirements
- 3 . Apply OSHA requirements

G. Switching and Temporary Protective Grounding

- 1 . Select and apply correct voltage detection equipment
- 2 . Select and apply correct temporary protective grounding equipment
- 3 . Interpret and apply system switching procedures

H. Incident Energy Analysis

- 1 . Interpret field-marked equipment labels
- 2 . Identify hazards where no field-marked labels exist
- 3 . Demonstrate knowledge of incident energy calculation methods
- 4 . Demonstrate knowledge of the variables involved in incident energy calculation methods

I. Codes and Standards

- 1 . Apply standards and regulatory organizations (e.g., OSHA, ANSI, ASTM, IEEE, NETA, NFPA, NEMA, etc.)
- 2 . Recognize key provisions of NFPA 70 (e.g., Articles 90, 110.16, 110.21, 225.56, 230.95(C), 250, and 310) and 70E (i.e. Chapter 1: Safety-Related Work Practices and Chapter 2: Safety-Related Maintenance Requirements, etc.)
- 3 . Apply technical requirements of ANSI/NETA Acceptance and Maintenance Testing Standards
- 4 . Practice compliance with manufacturer's published data

II. Electrical Testing Fundamentals and Theory

15 % of Overall Score

A. Fundamentals of Electricity

- 1 . Define and apply terms and concepts from physics, electricity, heat, and chemistry
- 2 . Recognize and define the standard units used to describe electrical circuits, energy, and power
- 3 . Identify series and parallel circuits
- 4 . Recognize the sources and effects of electromagnetic fields
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- 4 . Apply methods for measuring and calculating impedance and power
- 5 . Calculate variables of complex ac and dc circuits (e.g., voltage drop, current flow, power, etc.)
- 6 . Calculate phase angle, power factor, and vectors

D. Insulation Testing

- 1 . Employ methods and procedures for insulation tests and analyze results

E. Resistance Testing

- 1 . Employ methods and procedures for resistance tests and analyze results (e.g., winding resistance, contact resistance, bolted connections, etc.)

F. Thermographic Survey

- 1 . Employ methods and procedures for thermographic surveys and analyze results (e.g., emissivity, reflection, delta-T, etc.)

G. Current Testing

- 1 . Employ methods and procedures for current tests and analyze results (e.g., overcurrent pickup, circuit burden, voltage drop, etc.)

H. System Tests, Analysis, and Operation

- 1 . Interpret electrical one-line diagrams
- 2 . Interpret ac and dc schematic diagrams, ac three-line diagrams, and connection and interconnection drawings
- 3 . Identify electrical symbols and ANSI device numbers
- 4 . Interpret time-current curves
- 5 . Recognize essential components of short-circuit and coordination studies (e.g., cable size and length, available protective device settings, raceway type, utility fault contribution, etc.)
- 6 . Apply data extracted from short-circuit and coordination studies
- 7 . Recognize cause and effects of power system harmonics

III. Component Testing

55% of Overall Score

A. Switchgear and Switchboard Assemblies

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results

* B. Transformers

- 1 . Identify properties, types, and applications
- 2 . Identify properties, types, and applications of auxiliary devices
- 3 . Apply visual and mechanical inspections
- 4 . Employ methods and procedures for electrical tests
- 5 . Evaluate test results

C. Cables

- 1 . Identify properties, types, and applications
- 2 . Identify properties, types, and applications of accessories
- 3 . Apply visual and mechanical inspections
- 4 . Employ methods and procedures for electrical tests
- 5 . Evaluate test results
- 6 . Demonstrate knowledge of cable fault locating

D. Metal-Enclosed Busways

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results

E. Switches

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results

* F. Circuit Breakers

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results

III. Component Testing (Continued)

G. Circuit Switchers

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results

H. Network Protectors

- 1 . Identify properties, types, and applications of protection and control
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results

*** I. Protective Relays**

- 1 . Identify types and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results

*** J. Instrument Transformers**

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results

K. Metering Devices

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results

L. Regulating Apparatus

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results

M. Grounding Systems

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results
- 5 . Employ methods of enhancing effectiveness of grounding systems

III. Component Testing (Continued)

N. Ground-Fault Protection Systems

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results

*** O. Rotating Machinery**

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results

P. Motor Control Centers and Motor Starters

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results

Q. Adjustable-Speed Drive Systems

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results

R. Direct-Current Systems

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results

S. Surge Arresters

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results

T. Capacitors and Reactors

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results

III. Component Testing (Continued)

U. Outdoor Bus Structures

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results

*** V. Emergency Systems**

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results

W. Automatic Circuit Reclosers and Line Sectionalizers

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results

X. Fiber-Optic Cables

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for optical tests
- 4 . Evaluate test results

*** Y. Insulating Liquids and Gases**

- 1 . Identify properties, types, and applications
- 2 . Apply sampling procedures
- 3 . Employ methods and procedures in compliance with ASTM
- 4 . Evaluate test results

Z. Fuses

- 1 . Identify properties, types, and applications
- 2 . Apply visual and mechanical inspections
- 3 . Employ methods and procedures for electrical tests
- 4 . Evaluate test results

IV. Systems and Commissioning

20% of Overall Score

A. Troubleshooting

- 1 . Investigate power or protective system faults or malfunctions to determine cause and corrective action required

B. SCADA

- 1 . Recognize basic requirements, equipment, and configuration of SCADA/DCS systems

C. Monitoring/DCS Systems

- 1 . Apply procedures for microprocessor-based power monitoring and control systems

D. Functional Testing

- 1 . Employ methods and procedures for system-function tests upon completion of the individual component tests defined, as system conditions allow
- 2 . Apply concepts of functionality for electrical systems