

LEVEL I DESCRIPTORS – ETT CERTIFICATION ELEMENTS

I. Safety

- First aid procedures
Understand the basic rules and procedures of first aid.
- Cardiovascular Pulmonary Resuscitation (CPR)
Understand basic procedures.
- Fire protection procedures
Know fire extinguishers, classifications, and use. Recognize the four classes of fires and understand use of portable fire extinguishers.
- Basic individual safety
Follow standard safety practices in performing job tasks. Recognize and call attention to improper safety practices at the work site. Understand electrical hazards, shock, arc-flash, and arc-blast.
- Personal protective equipment
Correctly use safety equipment such as eye protection, gloves, hard hats, hearing protection, and safety shoes.
- Individual lockout/tagout
Understand basic lockout/tagout procedures.
- Recognize an electrically safe work condition (ESWC)
Understand the definition of an electrically safe work condition (ESWC) and be capable of recognizing when/where an ESWC has been established.

I. Communications

- Basic communication skills
Use correct punctuation, vocabulary, spelling, and sentence structure. Follow written instructions.

I. Mathematics

- Basic mathematics
Solve mathematical problems requiring simple addition, subtraction, multiplication, division, and raising numbers to exponential powers. Round to the appropriate number of significant digits, calculate percentages, read graphs, and use simple geometric definitions and formulas.
- Basic metric units and conversions
Perform conversions to and from basic metric (SI) units.

I. Tools and Equipment

- Basic tools and equipment
Recognize and name basic electrical power-related equipment. Select the correct tools for each job. Follow safe operating procedures for basic hand and power tools and equipment. Locate information in manufacturers' published data.

I. Electrical and Physical Theory

- Basic electrical terms and definitions
Understand the concepts of voltage, current, and impedance.



LEVEL II DESCRIPTORS – ETT CERTIFICATION ELEMENTS

II. Safety

- Intermediate safety
Follow safe work practices in regard to hazardous materials. Understand materials safety data sheets (MSDS) and the right-to-know law. Recognize potential sources of fire ignition. Know the use of correct extinguishing materials and techniques. Recognize the symptoms of substance abuse. Follow OSHA guidelines in regard to the erection and use of scaffolds. Identify safe and unsafe working conditions. Understand correct tool usage.
- Confined space
Recognize confined space and its hazards. Recognize when a confined space becomes a permit required confined space along with the associated requirements. Follow OSHA test procedures. Evaluate conditions and control the hazards.
- Electrical personal protective equipment
Have knowledge of the correct use of personal grounds and safety equipment such as sleeves, rubber gloves, flash suits, blankets, insulated tools and sticks and testing of same.
- Switching and grounding
Understand correct OSHA lockout/tagout requirements. Know types of voltage detection equipment and the safe use of same. When temporary grounds are required, apply correct rating.
- NFPA 70 Requirements
Recognize the location and application of shock and arc-flash protection boundaries.
- Electrical Hazard PPE Selection
Understand the Arc-Flash Hazard/Risk Categories, Shock Protection Boundaries, and PPE Matrix.

II. Communications

- Read and record data
Record, compute, and process electrical test information in accordance with accepted, standard practice.

II. Mathematics

- Intermediate mathematics
Perform mathematical calculations utilizing basic algebra (fundamental laws, algebraic expressions), geometry, and the trigonometric functions of right triangles.

II. Tools and Equipment

- Basic test equipment
Understand the operation, application, and care of commonly used test equipment such as insulation resistance test set, contact resistance test set, and high potential test set.
- Multimeter use
Select correct multimeter scales and ranges. Recognize the limitations of ohm, voltage, and current scales. Recognize basic problems such as weak batteries or defective leads.

II. Electrical and Physical Theory

- Basic physical science
Apply terms, definitions, and concepts from mechanics, electricity, heat, and chemistry. (Solutions



may involve simple formulas found in basic physics texts but will not involve algebraic manipulation or trigonometry.)

- Fundamentals of electricity
Recognize and define the standard units used to describe electrical circuits, energy, and power. Apply Ohm's Law to simple circuits.

II. Electrical and Physical Theory - Continued

- AC circuit
Identify series and parallel circuits and apply Ohms Law to simple single-loop ac circuits with linear components. Calculate equivalent capacitance and inductance. Measure and/or calculate impedance and power.
- DC circuits
Identify series and parallel circuits and apply Ohm's Law to simple series dc circuits with linear nonreactive components. Calculate equivalent resistance of and power consumed by resistive devices.

II. System Analysis and Operation

- Basic drawings and diagrams
Read and interpret electrical drawings and one-line diagrams.

II. Codes and Standards

- Standards-making organizations
Recognize the standards and regulatory organizations in the country of residency. In the United States, these would include organizations such as OSHA, ANSI, ASTM, IEEE, NETA, NFPA, EPA, and related areas of authority. Indicate familiarity with NFPA 70B Electrical Equipment Maintenance, and NFPA70 National Electrical Code, and NFPA 70E Standard for Electrical Safety in the Workplace.
- NETA Standards
Have basic knowledge of the technical requirements of ANSI/NETA Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems (ANSI/NETA ATS) and the ANSI/NETA Standard for Maintenance Testing Specifications for Electrical Power Distribution Equipment and Systems (ANSI/NETA MTS).

II. General

- Simple ac and dc equipment
Identify the functions and components of common types of electrical motors, generators, transformers, solenoids and contactors. Be familiar with their uses in single phase, three-phase or dc systems.
- Basic testing procedures
Recognize and understand basic requirements for the evaluation and assessment of electrical apparatus.

II. Switchgear, Switchboards and Motor Control Centers

- General maintenance
Use correct techniques to clean, visually inspect, torque, and lubricate assembly and components. This includes racking, handling, and insertion of breakers and contactors.



II. Transformers

- Types and Uses
Identify the types, classification, and application of transformers and electrical circuits. Understand the differences between dry-type, cast-coil, and liquid-filled transformers. Understand the application of power substation, distribution, instrument, and control transformers. Recognize that power circuit breakers and transformers are generally equipped with instrument transformers.

II. Wires, Cables and Buses

- Properties and types
Understand the basic construction, properties and application of low-, medium-, and high-voltage conductors.

II. Circuit Breakers and Circuit Switchers

- Types and ratings
Identify the types, classification, and applications. Be able to understand the differences between air, oil, vacuum, and gas insulated construction. Be able to define voltage class, interruption, basic impulse level, fault close, and other ratings.

II. Electrical Protective Devices

- Basic devices
Have the ability to recognize and define fuses, protective relays, breaker trip devices, and surge suppressors and to understand their differences and uses.

II. Metering

- Basic devices
Have the ability to check correct connections of volt, ampere, watt and watt-hour meters and meter switches. Check current and voltage circuits and connections.

II. Grounding Systems

- Basic Systems
Understand basic theory of grounding electrical systems and elementary ground-grid and ground-rod installations.

II. Direct-Current Systems

- Basic devices and sources
Recognize and understand the use and application of batteries, generators and rectifiers.

II. Insulating Liquids

- Properties, types, and sampling procedures
Recognize the different insulating and cooling mediums and uses. Have the ability to perform correct sampling procedures.

LEVEL III DESCRIPTORS – ETT CERTIFICATION ELEMENTS

III. Safety

- Lockout/Tagout
Expanded knowledge. Prepare and implement job-specific lockout/tagout procedures.
- Thorough Knowledge of NFPA 70E

III. Communications

- Technical communications
- Preparation of technical reports

III. Mathematics

- Electrical calculations
Expanded knowledge.

III. Tools and Equipment

- Test Equipment
Selection of appropriate test instruments, tools, and equipment to perform testing.

III. Electrical And Physical Theory

- Intermediate electrical terms and definitions
Calculate electrical forces and fields involving one or two charges and one or two dimensions. Solve problems involving Ohm's Law, ac and dc current, resistance, conductance, capacitance, inductance, and potential in series and parallel circuits. Have the ability to recognize the sources and effects of magnetic fields. Find electrical impedance and power in simple circuits with linear elements.
- Electrical relationships
Perform calculations related to electrical power, transformation, measurement, and monitoring to includes watts, vars, phase angles, power factor, and phase shifting.

III. System Analysis and Operation

- Electrical drawings and symbols
Read and interpret ac and dc schematic diagrams, ac three-line diagrams, connection and interconnection drawings, electrical symbols, and ANSI device numbers.
- Manufacturers' product data
Select and apply the data found in manufacturers' published data to testing, troubleshooting, maintenance, and/or repair. Interpret time-current curves.

III. Codes and Standards

- Be familiar with codes and standards in the country of residency
In the United States this would include understanding the content of National Fire Protection Association (NFPA) Codes as they apply to electrical power distribution equipment, systems, work practices, etcetera.



III. General Test Equipment

- Insulation tests
Perform, interpret, and evaluate insulation tests including resistance, dielectric absorption, polarization index, tip-up, and applied voltage withstand.
- Thermographic survey
Have the ability to perform, interpret, and evaluate a thermographic survey on electrical distribution systems. Interpret results in order to evaluate the condition of the equipment surveyed.
- Ratio and relative polarity
Correctly apply voltage or current to one set of windings and measure the output of associated windings to determine ratio, polarity, and/or phase relationship. Evaluate test results.
- Power-factor/dissipation-factor testing
Perform, interpret, and evaluate standard insulation power-factor/dissipation-factor tests on electrical power equipment, including transformers, breakers, cables, bushings, rotating equipment, and insulating liquids.

III. Emergency/Standby Systems

- Automatic Transfer Switches
Confirm and apply settings provided by others. Collect and record identifying nameplate data, construction, design, ratings, and components. Compare to project plans and specifications. Perform mechanical services necessary to assure device operates as intended. Perform tests to confirm correct operation of all functions.

III. Switchgear, Switchboards, and Motor Control Centers

- Types and construction
Confirm correct construction and ratings to meet specifications, standards, and project requirements. Determine and perform testing and inspection requirements.

III. Transformers

- Inspection and maintenance
Identify type and record nameplate data. Inspect pumps, fans, auxiliary control components, connections, tank, nitrogen apparatus, gauges and levels, grounding, shipping braces, gaskets, bushings, insulators, barriers, and other accessible components.
- Connections and ratings
Determine the correct ratings, winding connections and taps for specific application. Have knowledge of scott-t, zig-zag, open delta, broken-delta, wye, and other configurations and phase relationship considerations.
- Power transformers - general
Perform standard field test procedures for a power transformer. Understand methods of treatment of fluid insulation to improve characteristics. Perform electrical and functional tests of insulating, auxiliary, and control components.
- Instrument transformers - general
Perform current and voltage transformer polarity, ratio, burden and saturation, and dielectric tests. Analyze the test results.

III. Wires, Cables, and Buses

- Inspection and maintenance
Verify correct type and ratings for the installation and use. Confirm correct bending radius, spacing, support, environment, connections, connectors, and terminations.
- Cable Testing
Perform insulation resistance, ac, dc, or VLF applied-voltage and partial-discharge tests. Also perform cable and shield continuity tests. Interpret the test data.

III. Circuit Breakers and Circuit Switchers

- Inspection and maintenance
Collect and record identifying nameplate data, construction, design, ratings, and components. Compare to project plans and specifications. Perform mechanical services and control component services necessary to assure device operates as intended. Adjust and lubricate as required.
- Testing
Apply insulation, vacuum integrity, gas, liquid, contact, timing, time-travel, operational, interlock, control, and other tests as applicable.

III. Electrical Protective Devices

- Low-voltage breakers
Confirm and/or apply settings provided by others. Perform applicable tests to determine functions and characteristics of each operating element and expected reaction; evaluate the results. Confirm correct insulation and connection.
- Current relays
Confirm and/or apply settings provided by others. Perform applicable tests to determine functions and characteristics of each operating element and expected reaction; evaluate the results. Relays can include phase overcurrent, current balance, negative sequence, zero sequence, thermal, and ground fault.
- Directional and power relays
Confirm and/or apply settings provided by others. Perform applicable tests to determine functions and characteristics of each operating element and expected reaction; evaluate the results. Relays can include directional-power, directional-overcurrent, watt, var, and power-factor types.
- Voltage relays
Confirm and/or apply settings provided by others. Perform applicable tests to determine functions and characteristics of each operating element and expected reaction; evaluate the results. Relays can include overvoltage, undervoltage, phase-sequence, and negative-sequence voltage types.
- Differential relays
Confirm and/or apply settings provided by others. Perform applicable tests to determine functions and characteristics of each operating element and expected reaction; evaluate the results. Relays can include line, transformer, bus, unit, and rotating machine protection.
- Other relay types
Confirm and/or apply settings provided by others. Perform applicable tests to determine functions and characteristics of each operating element and expected reaction; evaluate the results. Relays can include timing, reclosing, temperature, auxiliary, lockout, alarm, and control types.

III. Electrical Protective Devices - Continued

- Fuses
Confirm correct type, rating and application for project use and specifications. Measure fuse resistance and evaluate.

III. Metering

- Complex metering
Connect and test watt, var, kilowatt-hour, and power-factor meters. Program and confirm correct functioning of power monitoring devices.

III. Controls

- Basic systems
Inspect, test, and operate various ac and dc control and protection wiring, schemes, and components as found in electrical apparatus and assemblies. Evaluate scheme and results.
- Motor control
Inspect, test, and operate motor control systems specific to reduced voltage starting, variable frequency, variable voltage, dc drive, wound rotor, synchronous, and other motor applications.
- Knowledge of PLCs, networking, and automated control systems.

III. Grounding Systems

- Types, application, and testing
Identify circuit and equipment grounding and bonding components and systems. Inspect and test as applicable. Measure ground resistance, ground impedance, ground continuity, and soil resistivity. Compare to specification and code requirements in the country of residency.

III. Rotating Machinery

- Types, inspection and testing
Identify and record type, construction, characteristics and ratings. Inspect housing, mounting, grounding, connections, and alignment. Perform insulation, vibration, surge comparison, loading, and winding resistance tests on auxiliary control and protection systems.

III. Direct Current Systems

- Servicing and testing
Identify and record, type, construction, characteristics, and ratings. Inspect connections, conductors, mounting, housing, ventilation and general conditions. Measure and/or perform connection resistance, specific gravity, liquid level, impedance, load, voltage, and discharge test, as applicable. Inspect and test battery chargers with regard to charging rates, float and equalize voltages, and operations.

III. Capacitors, Reactors and Surge Protection

- Use, application, and testing
Identify and record type, construction, characteristics and ratings. Perform insulation, inductance, capacitance, and conductance tests. Confirm correct capacitor discharge rate in accordance with National Electrical Code requirements.

III. Insulating Liquids

- Tests and evaluation
Understand liquid tests including dielectric breakdown, neutralization, interfacial tension, color, visual condition, power-factor, and water-content tests, as applicable. Perform oxygen content tests in transformers. Recognize fault gases commonly found in insulating liquids.

III. Troubleshooting

- Knowledge and skills
Perform testing required to identify, locate, and correct electrical circuit abnormalities.

LEVEL IV DESCRIPTORS – ETT CERTIFICATION ELEMENTS

IV. Safety

- Safety equipment selection
Identify the safety needs of the project and specify equipment and practices required.
- Demonstrate advanced knowledge and skills in the application of safety equipment
- Be knowledgeable of NFPA 70E including uncommon safety situations

IV. Communications

- Project management
Lay out job procedures. Determine scheduling. Interface with customer and contractors. Supervise technicians on the project.
- Review technical reports
Evaluate test data collected. Prepare and review presentations and reports.

IV. Mathematics

- Advanced knowledge and skills concerning electrical calculations as demonstrated in Levels II and III

IV. Tools and Equipment

- Tool and equipment selection
Select and designate appropriate test equipment and/or tools required to perform work outlined under project management.

IV. Electrical and Physical Theory

- AC and DC circuits
Understand complex ac and dc circuits and the effects of variable speed controllers.
- Dielectric theory
Understand dielectric properties of various types of insulations.

IV. System Analysis and Operation

- Short-circuit and coordination studies
Interpret and apply data extracted from the short circuit and coordination pertaining to the project.
- Equipment failure analysis
Investigate power or protective system faults or malfunctions to determine cause and corrective action required.
- SCADA/DCS
Recognize and understand basic requirements, equipment, and configuration of SCADA/DCS systems.
- Microprocessor-based power monitoring and control systems

IV. Codes and Standards

- Be familiar with manufacturers' codes as well as other applicable standards in the country of residency
In the United States this would include but is not limited to IEEE, NEMA, ISO, and ASTM standards.

IV. General Test Equipment

- Advanced knowledge and skills
Know the application and uses of oscilloscopes, phase-angle meters, and dynamic test equipment.

IV. Emergency/Standby Systems

- Paralleling Switchgear
Understand operational requirements and test procedures required to confirm proper functioning.
- UPS Systems
Understand overall concepts and principal component functions. Perform commissioning and maintenance tests as required by configurations employed and manufacturers' recommendations.

IV. Switchgear, Switchboards, and Motor Control Centers

- Advanced knowledge
Understand advanced control schemes and arc-resistant switchgear.

IV. Transformers

- Advanced knowledge
Understand applications of specialty transformers such as Scott or T-connected, arc furnace, and zig-zag.

IV. Wires, Cables and Buses

- Fault locating
Identify characteristics of cable system and types of faults. Select and utilize appropriate equipment and technology to locate fault.
- Advanced knowledge
Application of appropriate insulations, shields, and jackets.

IV. Circuit Breakers and Circuit Switchers

- Analyze time travel
Interpret recorded data acquired during circuit-breaker/circuit-switcher operation for determination of suitability for service.

IV. Electrical Protective Devices

- Motor Management Systems
Confirm and/or apply settings provided by others. Perform applicable tests to determine functions and characteristics of each operating element and expected reaction; evaluate the results. Relays can include but are not limited to negative sequence, loss of excitation, synchronization, thermal model.
- Generation relays
Confirm and/or apply settings provided by others. Perform applicable tests to determine functions



and characteristics of each operating element and expected reaction; evaluate the results. Relays can include but are not limited to negative sequence, loss of excitation, synchronization, and overspeed.

- **Transmission relays**
Confirm and/or apply settings provided by others. Perform applicable tests to determine functions and characteristics of each operating element and expected reaction; evaluate the results. Relay functions can include but are not limited to phase- and ground-overcurrent, distance, phase comparison, current differential, reclosing, and breaker failure.
- **Advanced knowledge and skills**
Perform dynamic relay testing; evaluate relay operations. Perform end-to-end testing of communications assisted relay schemes with GPS controlled test equipment.

IV. Advanced Metering

- **Microprocessor-based meters**
Connect, set, and test microprocessor-based metering equipment.

IV. Controls

- **Complex control systems**
Understand application and programming of programmable logic controllers (PLCs). Analyze and understand complex and overlapping sequential operation of protective device control schemes, metering schemes, and PLCs.
- **Complex motor control**
Be knowledgeable of variable speed drives.

IV. Grounding Systems

- **Ground system enhancement**
Be knowledgeable of methods of enhancing effectiveness of grounding systems.

IV. Rotating Machinery

- **Advanced knowledge and skills**
Be knowledgeable of vibration analysis and correction requirements. Be able to analyze data found in Level III.

IV. Direct-Current Systems

- **Be knowledgeable of testing requirements and operation of UPS systems**

IV. Capacitors, Reactors and Surge Protection

- **Advanced knowledge**
Understand calculation of capacitor sizing for power-factor correction. Understand reactor sizing for fault limiting. Understand calculation for correct surge protection rating.

IV. Insulating Liquid and Gases

- Complex analysis and trending
*Analyze insulating liquid and/or gas test results for the purpose of evaluating the equipment.
Understand the physical properties of insulating liquids and gases.*

IV. Troubleshooting

- Advanced knowledge and skills
Be able to recognize and correct improperly-designed control schemes.