



# Electrical Power Testing

## Level IV Certification Content Outline Standard Model Program with Computer-Based Testing

*The candidate for NICET certification as a Level IV Electrical Power Testing technician should have the knowledge and experience to:*

Conduct tests of complex metering and relay systems; evaluate tests, test equipment, test results, and power system performance; recommend actions to maintain or improve system performance; and lead multi-team projects.

*Note: For each exam, the skills and knowledge listed under each task are suggestive of those involved in that task, but are not intended to constitute an exhaustive listing.*

### 4.1 Field Testing

*(Approximately 55-60% of the exam)*

#### 4.1a Transformers and Regulators

##### 4.1a.1 Perform evaluation of complex electrical tests.

**Knowledge:**

NETA ATS/MTS  
IEEE C57

Electrical characteristics of various parts of the insulating materials and systems, including power windings, tertiary windings, transformer cores, insulating media, and bushings of various types of transformers and regulators, and how they affect overall electrical performance.

**Skills:**

Evaluate results of power-factor/dissipation-factor tip-up tests.  
Evaluate electrical test results to evaluate abnormal test results.

##### 4.1a.2 Perform internal visual inspection and filling.

**Knowledge:**

NETA ATS/MTS  
Internal construction mechanics of windings, tap changers, cores, bracing, insulations, and cooling systems

**Skills:**

Access and check various internal locations in transformers.  
Open and fill transformers with insulating liquids.  
Recognize signs of problems, and recommend corrective actions.

##### 4.1a.3 Evaluate dissolved gas-in-oil results.

**Knowledge:**

Oil degasification procedures  
Vacuum oil filling procedures  
NETA ATS/MTS  
IEEE C57.104

**Skills:**

Analyze test data trending and transformer acceptability for continued service.  
Recommend insulating liquids.

#### 4.1b Breakers and Contactors

Combined with 4.1d at this level

#### 4.1c Cables and Busways

##### 4.1c.1 Investigate medium- and high-voltage cable and busway faults.

**Knowledge:**

IEEE 400  
NETA ATS/MTS  
Effects of water trees on cable insulation

**Skills:**

Perform a time domain reflectometer test.  
Perform a cable impulse test to locate faults.

#### 4.1d Switchgear, Switchboards, Motor Control Centers, Switching Devices, Breakers, & Fuses

##### 4.1d.1 Evaluate proposed repairs, modifications, or upgrades, for adherence to applicable standards.

**Knowledge:**

NETA ATS/MTS  
IEEE C37.59  
NEMA SG 4  
NEMA Guideline for Handling Water-Damaged Electrical Equipment  
NFPA 70  
Actions that could void a UL listing

**Skills:**

Recognize improper applications of protective device functions, settings, and ratings.  
Recognize improper load and fault levels.  
Recognize improper bus clearances and support.  
Recognize improper cable bend radius and support.  
Recognize and evaluate water damage.  
Analyze system impacts of proposed modification.



# Electrical Power Testing

## 4.1e Protective Relays and Metering

### 4.1e.1 Specify appropriate tests and equipment for generation, transmission, SCADA, carrier, transfer trip, and other complex multifunction relay applications.

**Knowledge:**

Operating characteristics of power systems  
Electrical characteristics of various parts of the electrical pathways of these devices, and how they affect overall electrical performance  
Factors that constrain the application of various tests  
NETA ATS/MTS  
IEEE 141, Sections 5.3 and 5.9  
IEEE 242, Sections 4, 11.4, 15.5  
NFPA 70B, Chapters 8 and 11

**Skills:**

Develop testing sequences to document that control circuit components operate correctly, including programming of digital relays.  
Select the test equipment needed to analyze system parameters.  
Operate automated test equipment capable of providing currents, voltages, frequencies, and phase angle relationships.  
Simulate electrical power system disturbance characteristics.  
Calculate relay test parameters to determine expected results and compare with measured values.

### 4.1e.2 Perform functional tests on generation, transmission, SCADA, carrier, transfer trip, and other complex multifunction relays.

**Knowledge:**

Functions of the equipment and systems to be tested, and how they are implemented  
NETA ATS/MTS  
IEEE 141, Sections 5.3 and 5.9  
IEEE 242, Sections 4, 11.4, 15.5  
NFPA 70B, Chapters 11 and 31

**Skills:**

Develop procedures to test protection control circuits.  
Measure current and voltage phase relationship to verify conformance with the design application.

### 4.1e.3 Perform mechanical and electrical tests on generation, transmission, SCADA, carrier, transfer trip, and other complex multifunction relays.

**Knowledge:**

NETA ATS/MTS  
IEEE 141, Sections 5.3 and 5.9  
IEEE 242, Sections 4, 11.4, 15.5  
NFPA 70B, Chapters 8 and 11  
Electrical characteristics of various parts of the electrical pathways of these devices, and how they affect overall electrical performance

How the various components of relays affect each other mechanically, electrically, and thermally

**Skills:**

Determine appropriate test characteristics and sequence.  
Apply voltage or current, or both, in the proper phase relationship to test and prove each relay function.  
Program digital relays for CT/PT ratio, significant parameters, communication protocols, and any other functions required for the application.  
Follow instruction manuals for the device being tested as well as for the test equipment being used.

### 4.1e.4 Develop and evaluate complex metering applications.

**Knowledge:**

NETA ATS/MTS  
IEEE 141, Sections 3 and 10  
NFPA 70B, Chapter 11  
Meters and connections required to achieve various metering objectives

**Skills:**

Make specialized connections of power monitoring equipment.  
Check connections and physical condition.  
Test and evaluate meter accuracy using a single and three-phase relay test set.  
Verify meter indication at cardinal points of meter scale.  
Program digital meters for CT/PT ratio, significant parameters, communication protocols, and any other functions required for the application.

## 4.1f Rotating Machinery

### 4.1f.1 Select appropriate tests and test equipment for rotating machinery.

**Knowledge:**

NETA ATS/MTS  
NFPA 70B, Chapter 11  
IEEE 43, Section 95  
NEMA MG 1  
Construction of rotating machinery  
Electrical characteristics of various parts of the electrical pathways of rotating machinery, and how they affect overall electrical performance  
How the various components of rotating machinery affect each other mechanically, electrically, thermally, or chemically  
Factors that constrain the application of various tests

**Skills:**

Perform and evaluate partial discharge test.  
Supervise testing and evaluate test data.  
Perform vibration analysis.  
Perform current signature analysis.  
Perform and evaluate static exciter tests.



# Electrical Power Testing

## 4.1g Battery Systems

### 4.1g.1 Evaluate batteries and battery charging systems.

**Knowledge:**

NETA ATS/MTS  
IEEE 450, 1106, 1188  
NFPA 70, Article 480

**Skills:**

Evaluate state-of-charge determination.  
Evaluate existing design for adherence to specification.  
Evaluate ventilation systems for compliance with specifications.

### 4.1h Surge Arresters, Capacitors, and Reactors

None at this level

## 4.1i Grounding Systems

### 4.1i.1 Evaluate grounding systems and make recommendations for improved performance.

**Knowledge:**

NETA ATS/MTS  
IEEE 81  
IEEE 141, Section 7  
IEEE 142, Section 4.4  
IEEE 1100, Sections 4.6 and 5  
NEMA GR 1

**Skills:**

Review grounding system test data and system configuration for conformance with specifications and standards.  
Make appropriate recommendations for improvement of grounding system performance.

### 4.1j Infrared Surveys

None at this level

## 4.2 Safety

*(Approximately 1-5% of the exam)*

### 4.2a General Safety

#### 4.2a.1 Specify and evaluate testing of safety equipment.

**Knowledge:**

Importance of various characteristics of safety equipment  
Test methods required to determine the functionality of safety equipment

**Skills:**

Evaluate equipment test results.

#### 4.2a.2 Perform on-site or in-house safety audit of personnel.

**Knowledge:**

OSHA 29 CFR Part 1910.332(b)  
NFPA 70E, Articles 110 and 120  
Symptoms of substance abuse

**Skills:**

Verify existence of adequate safety plans and reports.  
Monitor compliance with established safety plans and drug policies.  
Determine conformance with lockout, tagout, and switching plans.  
Determine conformance of lockout, tagout, and switching with OSHA.  
Investigate incidents and complete appropriate paperwork in accordance with OSHA.

### 4.2b Lockout and Tagout

None at this level

## 4.3 Troubleshooting and Analysis

*(Approximately 20-25% of the exam)*

### 4.3.1 Determine failure mode and cause.

**Knowledge:**

How external and system factors can affect equipment performance

**Skills:**

Provide field data and analysis to determine root cause failure modes.  
Research data collected on similar equipment and analyze trends to determine potential misapplication of equipment.

### 4.3.2 Perform power quality analysis.

**Knowledge:**

NETA ATS/MTS  
IEEE 142, Section 5  
IEEE 1100  
NFPA 70B, Chapter 10

**Skills:**

Select correct power quality analysis equipment for the desired task.  
Install power quality analysis equipment and set parameters to capture desired information.  
Verify that power quality data is complete and accurate.

### 4.3.3 Analyze and interpret Level IV test results to determine serviceability of equipment, and recognize deficiencies.

**Knowledge:**

NETA ATS/MTS  
How to determine the operating characteristics and requirements of electrical equipment being analyzed  
Acceptable test methods, voltages, currents, and other parameters



# Electrical Power Testing

Effects of test voltages, currents, temperature, humidity, and external conditions on test results for all electrical tests

Equipment, procedures, test levels, and limits for specialized tests

**Skills:**

Research technical literature.

Review test results, and compare to manufacturer's specifications and industry standards to determine suitability of equipment for initial energization.

Review test results and compare to manufacturers' specifications and industry standards to determine suitability of equipment for continued service.

Review test results to determine deterioration or failure trends.

Identify and recommend additional tests that will further define potential problems or imminent failures.

## 4.3.4 Recommend corrective measures.

**Knowledge:**

Equipment parameters and the requirements of various applications

How to determine insulation requirements

The range of component adjustment, repair, and replacement activities possible for the equipment being tested

**Skills:**

Evaluate test results against desired equipment parameters, manufacturer's specifications, and industry standards, to determine suitability of equipment for adjustment, repair, or replacement.

Determine the ramifications of various corrective measures.

## 4.4 Documentation

*(Approximately 1-5% of the exam)*

### 4.4.1 Integrate Level II and III reports and research documentation into a final report.

**Knowledge:**

Purpose and content of a final report

Purpose and significance of trending

NETA MTS, NETA ATS 5.4 (Test Report)

**Skills:**

Develop trending as appropriate.

Document recommendations for serviceability or non-serviceability, and for remaining life.

Confirm that anomalies and problems are noted, and that recommendations are correct.

## 4.5 Management and Planning

*(Approximately 10-15% of the exam)*

### 4.5.1 Plan multi-team jobs.

**Knowledge:**

OSHA 29 CFR, Parts 1910 and 1926: requirements for multi-employer work sites

Elements of a project that require research and planning prior to the project start

Personnel and resource requirements of various tests, environments, and client objectives

**Skills:**

Determine site-specific client needs.

Assess the conditions and requirements of the project site.

Review and coordinate personnel needs.

Review and coordinate test equipment needs.

Review and coordinate vehicle needs.

Review and coordinate safety equipment needs.

### 4.5.2 Train and assign personnel.

**Knowledge:**

Advantages of different types of training techniques including hands-on, demonstration, lecture, or the use of books, CDs, and online training

**Skills:**

Determine gaps between existing and required skills and knowledge.

Locate and organize information and resources for effective presentation.

Provide formal training and documentation.

Compare skill levels of personnel with tasks required.

### 4.5.3 Manage projects.

**Knowledge:**

Project management process

How an unexpected occurrence in one team's work process can affect the work of other teams

Roles and responsibilities of those involved in the project

**Skills:**

Develop and record a project plan.

Schedule work and resources.

Supervise and coordinate multiple teams.

Maintain communications accessibility of teams and supervisor.

Monitor progress of work.

Review and approve technical reports and identify deficiencies.

Keep customers informed and maintain favorable customer relations.

Evaluate work in progress and results.

**Note on Standards:** A number of technical standards are listed in this Content Outline because they stand as authoritative sources of some of the critical knowledge required to properly perform a particular task. Successful candidates are expected to have a working knowledge of the relevant parts of the referenced standards. In other words, the candidate is expected to have the same knowledge of a referenced standard when taking a NICET test as he or she should have available by recall and interpretive thought when performing the task. (In some cases, standards are listed because they are the ultimate source of knowledge that is more typically acquired through secondary sources.)