TS

NOT MEASUREMENT SENSITIVE

DOE–STD–1170-2006
October 2006

DOE STANDARD

ELECTRICAL FUNCTIONAL AREA QUALIFICATION STANDARD

DOE Defense Nuclear Facilities Technical Personnel

U.S. Department of Energy
Washington, D.C. 20585

AREA TRNG

DISTRIBUTION STATEMENT. TBD

INTENTIONALLY BLANK

APPROVAL

The Federal Technical Capability Panel consists of senior U.S. Department of Energy managers responsible for overseeing the Federal Technical Capability Program. This Panel is responsible for reviewing and approving the Functional Area Qualification Standard (FAQS) for Department-wide application. Approval of this Electrical FAQS by the Federal Technical Capability Panel is indicated by signature below.

_____
Roy J. Schepens, Chairman
Federal Technical Capability Panel

TABLE OF CONTENTS

ACKNOWLEDGMENT

The U.S. Department of Energy, Richland Operations Site Office is the Champion and Sponsor for the Electrical Functional Area Qualification Standard (FAQS). The Sponsor is responsible for coordinating the development and/or review of the Electrical FAQS by subject matter experts to ensure that the technical content of the FAQS is accurate and adequate for Department-wide application for those involved in the Electrical Program. The Sponsor, in coordination with the Federal Technical Capability Panel, is also responsible for ensuring that this FAQS is maintained current.

The following subject matter experts (SMEs) participated in the development and/or review of this FAQS:

- Cliff Ashley — Richland Operations Office (Team Leader/Champion and Sponsor)
- Mike Oliver — Carlsbad Field Office
- Pat Tran — EH
- Mike Hicks — Idaho Operations Office
- Randy Unger — NNSA-SC
- Roger Kulavich — Y-12

U.S. DEPARTMENT OF ENERGY
FUNCTIONAL AREA QUALIFICATION STANDARD

PURPOSE

DOE Manual (M) 426.1-1A, *Federal Technical Capability Manual*, commits the Department to continuously strive for technical excellence. The Technical Qualification Program (TQP), along with the supporting technical qualification standards, complements the personnel processes that support the Department's drive for technical excellence. In support of this goal, the competency requirements defined in this FAQS should be aligned with and integrated into the recruitment and staffing processes for technical positions. This FAQS should form the primary basis for developing vacancy announcements, qualification requirements, crediting plans, interviewing questions, and other criteria associated with the recruitment, selection, and internal placement of personnel performing electrical duties. The U.S. Office of Personnel Management (OPM) minimum qualifications standards will be greatly enhanced by application of appropriate materials from this Electrical FAQS.

This FAQS is not intended to replace the OPM qualifications standards nor other Departmental personnel standards, rules, plans, or processes. The primary purpose of the TQP is to ensure that employees have the requisite technical competency to support the mission of the Department. The TQP forms the basis for the development and assignment of DOE personnel responsible for ensuring the safe operation of defense nuclear facilities.

APPLICABILITY

The Electrical FAQS establishes general and specific functional area competency requirements for Department of Energy personnel who provide assistance, direction, guidance, oversight, or evaluation of contractor electrical safety programs and technical activities that could impact the safe operation of DOE's defense nuclear and non-nuclear facilities. This FAQS have been developed as a tool to assist DOE Program and Field offices in the development and implementation of the DOE Electrical Qualification Program in their organization. For ease of transportability of qualifications between DOE elements, Program and Field offices are expected to use this FAQS without modification or additions. Needed additional office/site/facility specific technical competencies should be handled separately. Satisfactory and documented attainment of the competency requirements contained in this FAQS (See Appendix B for an example of the Electrical FAQS qualification card) ensures that personnel possess the requisite competence to fulfill their functional area duties and responsibilities common to the DOE complex. Office/Facility-Specific Qualification Standards should (as applicable) supplement this FAQS and establish unique operational competency requirements at the Headquarters or Field element, site, or facility level.

IMPLEMENTATION

This Electrical FAQS identifies the minimum technical competency requirements for Department of Energy personnel. Although there may be other competency requirements associated with the positions held by DOE personnel, this FAQS is limited to identifying the general technical competencies (that all candidates are expected to meet), and specific technical competencies (that are based upon the candidates assigned duties). The competency statements define the expected knowledge and/or skill that a candidate must meet. Most of the competency statements are further explained by a listing of supporting knowledge and/or skill statements that although not requirements, do describe the intent of the competency statement(s). In selected competencies, expected knowledge and/or skills have been designated as "Mandatory Performance Activities." The Mandatory Performance Activities (MPAs) in general competencies and specific competencies (based upon the candidate's assigned duties) are not optional.

The competencies identify a familiarity level, a working level, or an expert level of knowledge; or they require the candidate to demonstrate the ability to perform a task or activity. These levels are defined as follows:

> **Familiarity level** is defined as basic knowledge of or exposure to the subject or process adequate to discuss the subject or process with individuals of greater knowledge.
>
> **Working level** is defined as the knowledge required to monitor and assess operations/activities, to apply standards of acceptable performance, and to recognize the need to seek and obtain appropriate expert advice (e.g., technical, legal, safety) or consult appropriate reference materials required to ensure the safety of Departmental activities.
>
> **Expert level** is defined as a comprehensive, intensive knowledge of the subject or process sufficient to provide advice in the absence of procedural guidance.
>
> **Demonstrate the ability** is defined as the actual performance of a task or activity in accordance with policy, procedures, guidelines, and/or accepted industry or Department practices.

Headquarters and Field elements shall develop and implement a TQP plan that establishes a program and process to ensure that DOE personnel possess the competencies required of their position. That includes the competencies identified in the Electrical (FAQS). The TQP Plan shall establish the qualifying official for the Electrical candidate, and require the official to generate a Electrical FAQ qualification card (see Appendix B) based the requirements of this FAQS, and the candidates assigned duties. The candidate's qualification card shall serve as documentation of competencies completed, and included in the employee's training and qualification record.

Equivalencies should be used sparingly and with the utmost rigor and scrutiny to maintain the spirit and intent of the TQP. Equivalencies may be granted for individual competencies in accordance with the TQP Plan of the Site/Office/Headquarters organization qualifying the candidate. The supporting knowledge and/or skill statements and MPAs should be considered when granting equivalency for a competency.

Unless stated otherwise by the Site/Office/Headquarters TQP Plan, equivalencies may be granted based upon objective evidence of previous education, training, certification, or experience. Objective evidence includes a combination of transcripts, certifications, and, in some cases, a knowledge sampling through a written and/or oral examination. Equivalencies may be granted for individual competencies based upon an objective evaluation with corresponding evidence of the employees prior advanced education, experience, certification, and/or training. Equivalencies should be used sparingly and then with the utmost rigor and scrutiny to maintain the spirit and intent of the Technical Qualification Program. The supporting knowledge and/or skill statements for the individual competencies should be considered before granting equivalency for a competency. Prior experience within the last 5 years or training that had some form of examination process may be evaluated and documented to demonstrate equivalency to the specified competencies. Completion of a professional certification such as a Professional Engineering license related directly to the functional area be evaluated and documented to demonstrate equivalency for many of the competencies in a functional area, with the exception of DOE-specific processes and requirements. Satisfactory completion of undergraduate and graduate level college courses that relate directly to specific competencies may be considered equivalent. The supporting knowledge and/or skill statements, while not requirements, should be considered before granting equivalency for a competency. Applicable experience in the field may also be considered equivalent.

Training shall be provided to employees in the Technical Qualification Program who do not meet the competencies contained within their qualification card (see Appendix B). Training may include, but is not limited to, formal classroom and computer based courses, self-study, mentoring, on the job training, and special assignments. Departmental training will be based upon appropriate supporting knowledge and/or skill statements similar to the ones listed for each of the competency statements. Headquarters and Field elements should use the supporting knowledge and/or skill statements as a basis for evaluating the content of any training used to provide individuals with the requisite knowledge and/or skill required to meet the Electrical FAQS competency statements. Headquarters and Field elements should use the supporting knowledge and/or skill statements as a basis for evaluating the content of any training used to provide individuals with the requisite knowledge and/or skill required to meet the technical FAQS competency statements.

EVALUATION REQUIREMENTS

Attainment of the competencies listed in this FAQS shall be documented in accordance with the TQP Plan of the Site/Office/Headquarters organization qualifying the individual.
Unless stated otherwise within the TQP Plan, attainment of the competencies listed in the Electrical FAQS should be evaluated and documented by a qualifying official or immediate lead/supervisor (if technically qualified), using a combination of the following methods.

- Satisfactory completion of a written examination (preferred method).
- Satisfactory completion of an oral examination (preferred method).
- Satisfactory accomplishment of an observed task or activity directly related to a competency (preferred method).
- Documented evaluation of equivalencies (such as applicable experience in the field) without a written examination.

Field Element Managers shall qualify candidates as possessing technical knowledge of the complete set of disciplines and competencies contained in this FAQS. Final qualification under the FAQS should be performed using one or a combination of the following methods:

- Satisfactory completion of a comprehensive written examination. The minimum passing grade should be 80%.
- Satisfactory completion of an oral examination by a qualified Senior Technical Safety Manager (STSM) or a qualification board of technically qualified personnel to include at least one qualified STSM.
- Satisfactory completion of a walkthrough of a facility with a qualifying official for the purpose of verifying a candidate's knowledge and practical skills of selected key elements, including safety systems, structures, components, and system operating principles of the systems associated with a specific technical area.
- Documentation of applicable field experience.

For oral examinations and walkthroughs, qualifying officials or board members should ask critical questions intended to integrate identified learning objectives during qualification. Field Element Managers or designees should develop formal guidance for oral examinations and walkthroughs that includes:

- Standards for qualification;
- Use of technical advisors by a board;
- Questioning procedures or protocol;
- Pass/Fail criteria;
- Board deliberations and voting authorization procedures;
- Documentation process.

A board or qualifying official may conduct the oral interview as a group or individually. The board should document explicitly any questions and answers that result in an oral examination failure. Field Element Managers or their designees may require the candidates who fail a written or oral examination to complete a special study program designed to strengthen weaknesses revealed in the examination. Field Element Managers or their designees may direct candidate reexaminations to verify the effectiveness of actions taken to correct weak areas. Candidates who repeatedly fail examinations should be reassigned to a non-technical position.

CONTINUING EDUCATION, TRAINING, AND PROFICIENCY

DOE personnel shall participate in continuing education and training as necessary to improve their performance and ensure that they stay up-to-date on changing technology and new requirements. This may include courses and/or training provided by:

- Department of Energy;
- Other government agencies;
- Outside vendors;
- Educational institutions.

Beyond formal classroom or computer based courses, continuing training may include:

- Self Study;
- Attendance at symposia, seminars, exhibitions;
- Special assignments;
- On-the-job experience.

A description of suggested learning proficiency activities and the requirements for the continuing education and training program for Electrical personnel are included in Appendix A of this document.

DUTIES AND RESPONSIBILITIES

The following are examples of typical duties and responsibilities expected of personnel assigned to the Electrical Functional Area:

1. Electrical problem identification and trends analysis; Electrical hazards identification and classification; Implementation of appropriate codes and standards [OSHA, NEC, NFPA 70-series, IEEE (including the C-2 National Electrical Safety Code-NESC), DOE Electrical Safety Handbook, etc.]; Electrical inspection programs; Electrical safety and system assessment programs; and, Electrical safety and system operational and facilities oversight.

2. Review the management and oversight of the design and construction process.

3. Review and provide oversight of the Electrical Equipment Maintenance Management (Safety & Systems) program.

4. Maintain and update knowledge and skills in electrical codes and technology as used at a given site. Site specific electrical codes are normally defined in the contract(s).

5. Prepare and review contracting mechanisms (cost plus award fee, cost plus fixed fee, etc.), contractor performance evaluations, and contract specifications, etc.

6. Serve as a subject matter expert and technical resource for Electrical personnel in training and other technical matters.

7. Inspect/evaluate electrical systems for safe and efficient operation, maintenance and testing.

8. Conduct/perform accident investigations, root cause analysis and problem-solving activities.

9. Participate in establishing and/or reviewing Department of Energy electrical policy (as defined by applicable codes, standards, and orders) and requirements.

10. Evaluate contractor compliance with relevant Department of Energy Orders, standards, codes, Management & Operating contractor maintenance procedures, etc.

11. Evaluate electrical programs/operations/safety.

12. Review safety documentation.

13. Verify the application of quality assurance principles to electrical systems and safety.

14. Verify that safety documentation and design documentation are coordinated.

Position-specific duties and responsibilities for Electrical personnel are contained in their Office/Facility-Specific Qualification Standard or Position Description.

BACKGROUND AND EXPERIENCE

The U. S. Office of Personnel Management's Qualification Standards Handbook establishes minimum education, training, experience, or other relevant requirements applicable to a particular occupational series/grade level, as well as alternatives to meeting specified requirements. The preferred education and experience for Electrical personnel is:

1. Education:

   Bachelor of Science degree in Electrical Engineering (electrical power option preferred) from an accredited institution or meet the alternative requirements specified in the Qualification Standards Handbook for the GS-0800, Professional Engineering Series.

2. Experience:

   Industrial, military, Federal, State, or other directly related background that has provided specialized experience in electrical systems for electrical duties assigned. Specialized experience can be demonstrated through possession of the competencies outlined in this FAQS.

REQUIRED TECHNICAL COMPETENCIES

Each of the General Technical Competency statements and Specific Technical Competency statements (that are based upon the candidate's assigned duties) defines the level of expected knowledge and/or skill that a candidate must possess to meet the intent of this FAQS. Supporting knowledge and/or skill statements are not required; however further describe the intent of the competency statement(s). In selected competencies, expected knowledge and/or skills have been designated as "Mandatory Performance Activities." The Mandatory Performance Activities (MPA) in general competencies and specific competencies (based upon the candidates' assigned duties), are not optional.

NOTE: When U.S. Department of Energy (DOE) directives, Federal Regulations, Standards, or other requirements documents are referenced in this FAQS, the most recent revision should be used.

GENERAL TECHNICAL COMPETENCIES

I. KNOWLEDGE OF ELECTRICAL THEORY & EQUIPMENT

(Each competency statement is a Mandatory Performance Activity (MPA), provided that they are applicable to the candidate's assigned electrical duties. For competency statements, reference DOE Electrical Science Fundamentals Handbook 1011 (2-92) as reference source.)

1. Demonstrate a working level knowledge of electrical and circuit theory, theorems, terminology, laws, and analysis.

Supporting Knowledge and/or Skills

a. Explain the basic law of electrostatics.
b. Define the following terms and their relationship in energized circuits:
   - Resistance
   - Capacitance
   - Inductance
   - Reactance
c. Explain the following fundamental laws of circuit analysis:
   - Ohm's Law
   - Kirchoff's law
d. Explain the use of the following theorems in network analysis and describe their application in circuit reduction techniques:
   - Thevenin's Theorem
   - Norton's Theorem
   - Maximum Power Transfer Theorem
   - Superposition Theorem
e. Discuss the fundamental relationships in direct current (DC) circuits among voltage, current, resistance, and power.
f. Explain the treatment of inductance and capacitance values in steady-state direct current circuits.
g. Discuss the fundamental relationships in alternating current (AC) circuits among voltage, current, resistance, reactance, impedance, power, and power factor.
h. Describe how the following methods produce a voltage:
   - Electro-chemistry
   - Static electricity
   - Magnetic induction
   - Piezo-electric effect
   - Thermo-electricity
   - Photoelectric effect
   - Thermonic emission
i. Using appropriate data, calculate the total resistance for a circuit containing combinations of parallel and series resistance.
j. Using appropriate data for a circuit, calculate the reactance of that circuit.

2. Demonstrate a working level knowledge of basic alternating current (AC) theory.

Supporting Knowledge and/or Skills

a. Define the effective value of an alternating current relative to direct current (DC).

b. Describe the relationship between maximum, average, and root-mean-square (RMS) values of voltage and current in an alternating current waveform.
c. Using a diagram of two sine waves, describe the phase relationship between the two waves.

3. Demonstrate a working level knowledge of the construction and operation of alternating current (AC) generators, and motors (including operating characteristics, method of torque production, and the advantages of specific motor types).

Supporting Knowledge and/or Skills **(Generators)**

a. Describe the basic construction and operation of a simple alternating current generator.
b. Describe the development of a sine-wave output in an alternating current generator.
c. Define the following terms in relation to alternating current generation:
   - Radians/second
   - Hertz
   - Period
d. Using the type and application of an alternating current generator, describe the operating characteristics of that generator including methods of voltage production, advantages of each type, and methods for paralleling.
e. State the purpose of the following components of an alternating current generator:
   - Field
   - Armature
   - Prime mover
   - Rotor
   - Stator
   - Slip rings
f. Using the speed of rotation and number of poles, calculate the frequency output of an alternating current generator.
g. List the three losses found in an alternating current generator.
h. Given the prime mover input and generator output, determine the efficiency of an alternating current generator.
i. Describe the basis for the kilowatt and kilovolt-amperes ratings of an alternating current generator.
j. Describe the conditions that must be met prior to paralleling two alternating current generators including, consequences of not meeting these conditions.
k. Describe the difference between a stationary field, rotating armature alternating current generator and a rotating field, stationary armature alternating current generator.
l. Explain the differences between a wye-connected and delta-connected alternating current generator including advantages and disadvantages of each type.

Supporting knowledge and/or Skills **(Motors)**

a. Describe how an alternating current motor produces a rotating magnetic field.
b. Describe how an alternating current motor produces torque.
c. Using field speed and rotor speed, calculate percent slip in an alternating current motor.
d. Explain the relationship between speed and torque in an alternating current induction motor.
e. Describe how torque is produced in a single-phase alternating current motor.
f. Explain why an alternating current synchronous motor does not have starting torque.

g. Describe how an alternating current synchronous motor is started.
h. Describe the effects of over and under-exciting an alternating current synchronous motor.
i. State some applications of the following types of alternating current motors:
   - Induction
   - Single-phase
   - Synchronous
j. Describe the differences in starting and operating characteristics of premium efficiency motors.
k. Describe the characteristics and operation of motor controllers.
l. Explain the following motor terms:
   - Nameplate Revolutions Per Minute (RPM)
   - National Electrical Manufacturers Association (NEMA) frame size
   - Service factor
   - Insulation class
   - National Electrical Manufacturers Association (NEMA) design designation (letter)
   - Non-symmetrical load

4. Demonstrate a working level knowledge of alternating current (AC) reactive components, including inductive and capacitive reactance and phase relationships in reactive circuits.

Supporting knowledge and/or Skills

a. Define the following:
   - Inductive reactance
   - Capacitive reactance
   - Impedance
   - Resonance
   - Power factor
   - Non-symmetrical load
b. Describe the effect of the phase relationship between current (I) and voltage (E) in an inductive circuit.
c. Describe the effect on phase relationship between current (I) and voltage (E) in a capacitive circuit.
d. Determine the value for total current (IT) in a simple parallel resistance-capacitance-inductance (R-C-L) alternating current circuit.
e. Describe the relationship between apparent, true, and reactive power.
f. Describe the indications of an unbalanced load in a three-phase power system.
g. Discuss circuit considerations required for non-symmetrical loads.

5. Demonstrate a working level knowledge of electrical transmission and distribution systems, including line filtering (power line conditioning).

Supporting Knowledge and/or Skills

a. Explain the differences between transmission and distribution systems.
b. Identify and discuss the advantages and disadvantages associated with underground and above-ground distribution systems.
c. Describe the function and importance of the following control and protective devices:

- Circuit breakers
- Protective relays
- Fuses
- Transient protection

d. Compare and contrast the characteristics of three-phase and single-phase distribution systems.
e. Discuss the principles associated with ensuring continual power availability during electrical outages.
f. Explain the following terms as they relate to power systems:
   - Fault current
   - Available fault current
   - Fault duty
g. Discuss the safety considerations associated with high voltage transmission systems.
h. Explain the requirements for and uses of alternate power supplies.
i. Discuss the uses of different voltages in a facility.
j. Discuss the reasons for using single phase versus 3-phase power systems in a facility.
k. Discuss which systems would benefit from line filtering.
l. Discuss the types of noise for which systems benefiting from line filtering would be susceptible to without implementation of line filtering.
m. Define the terms, Harmonics, Positive, Negative and Zero sequence currents.
n. Describe the sources of harmonics.
o. Describe the effect of harmonics on the power system and equipment.
p. Describe the typical means of mitigating harmonics and their effects.

6. Demonstrate a working level knowledge of transformers.

Supporting Knowledge and/or Skills

a. Define the following terms as they apply to transformers:
   - Mutual induction
   - Turns ratio
   - Impedance ratio
   - Efficiency
b. Describe the differences between a wye-connected and delta-connected transformer.
c. Using the type of connection and turns ratios for the primary and secondary of a transformer, calculate voltage, current, and power for each of the following types:
   - Delta - Delta
   - Delta - Wye
   - Wye - Delta
   - Wye - Wye
d. State the applications of each of the following types of transformers:
   - Distribution
   - Power
   - Control
   - Auto
   - Isolation
   - Instrument potential
   - Instrument current
e. Describe the hazardous materials that are associated with transformers.

f. Describe the conditions that must be met prior to paralleling two transformers, including consequences of not meeting these conditions.

7. Demonstrate a working-level knowledge of Uninterruptible Power Supplies (UPS).

Supporting knowledge and/or Skills

a. Describe how a UPS works.
b. Identify the various UPS component.

8. Demonstrate a working-level knowledge of variable frequency (speed) drives (VFD).

Supporting knowledge and/or Skills

a. Describe the major components and operation of a VFD.
b. Give examples where VFD's are used.

9. Demonstrate a working level knowledge of electrical test instruments and measuring devices.

Supporting Knowledge and/or Skills

a. Describe the purpose and method of operation of the following in-place measuring devices, and knowledge of using the correct meter:
   - Voltmeter
   - Ammeter
   - Ohmmeter
   - Wattmeter
   - Ampere-hour meter
   - Power factor meter
   - Ground detector
   - Synchroscope
   - Meggar
   - Power Quality Monitors
b. Describe safe methods for using the following portable test equipment:
   - Ammeter
   - Voltmeter
   - Ohmmeter

10. Demonstrate a familiarity level knowledge of the principles and concepts of natural phenomena hazards (such as static electricity, reference NFPA 77) and their effect on personnel and electrical systems.

Supporting Knowledge and/or Skills

a. Discuss the potential impact of lightning on electrical systems at defense nuclear facilities.
b. Discuss various methods of lightning protection as preventive measures (e.g., surge suppressors, Faraday cages, etc.).

c. Briefly describe the safety measures and design features commonly used as safeguards against natural hazards and identify the relevant industry consensus standards that codify accepted design and installation practices for these safeguards.
d. Reference the following:
   - DOE-STD-1020-2002, Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities
   - DOE-STD-1021-93, Natural Phenomena Hazards Performance Categorization Guidelines for Structures, Systems, and Components
   - DOE-STD-1022-94, Natural Phenomena Hazards Site Characterization Criteria

11. Demonstrate a working level knowledge of direct current (DC) generators and motors.

Supporting Knowledge and/or Skills **(Generators)**

a. Describe the relationship between shaft speed, field flux and generated voltage.
b. Define the following:
   - Electromotive force
   - Excitation
   - Compounding
   - Armature
   - Terminal voltage
   - Load current
   - Shunt windings
   - Series windings
c. State the purpose of the following components of a direct current machine:
   - Armature
   - Rotor
   - Stator
   - Field
d. Describe self-excited and separately excited generators.
e. Describe the operation of compound-wound generators.
f. Describe how the terminal voltage of a direct current generator is adjusted.
g. State the basis behind each direct current generator rating.
h. Describe the internal losses found in a direct current generator.
i. Describe the differences in construction between a shunt-wound and a series-wound direct current generator with respect to the relationship between the field and the armature.
j. Describe the relationship between the shunt and series fields for cumulatively-compounded and differentially-compounded direct current generators.
k. Describe the voltage-versus-current characteristics for a flat-compounded, over-compounded, and under-compounded direct current generator.

Supporting Knowledge and/or Skills **(Motors)**

a. Describe the basic construction and operation of the following four types of direct current motors:
   - Shunt
   - Separately excited
   - Compound-wound
   - Series

b. State the function of torque in a direct current motor and how it is developed.
c. Describe the function of counter-electromotive force (CEMF) and how it is developed in a direct current motor.
d. Describe the relationship between field current and magnetic field size in a direct current motor.
e. Describe how to adjust the speed of a direct current motor.
f. Describe the relationship between armature current and torque produced in a direct current motor.
g. Describe the torque-versus-speed characteristics for a shunt-wound and a series-wound direct current motor.
h. Explain why starting resistors may be necessary for large direct current motors.

12. Demonstrate a working level knowledge of battery construction, voltage production, and hazards. IEEE Std 450. Maintenance, Testing and Replacement of Vented Lead-Acid Batteries for Stationary Applications.

Supporting Knowledge and/or Skills

a. Using a cutaway drawing of a simple multi-cell storage battery, identify the following components and discuss their function:
   - Positive terminal
   - Negative terminal
   - Electrode
   - Cell
b. Describe the hazards associated with storage batteries.
c. Define the following terms:
   - Voltaic cell
   - Battery
   - Electrode
   - Electrolyte
   - Specific gravity
   - Ampere-hour
   - Electrolysis
   - Equalizing Charge
   - Float Charge
   - Pilot Cell
d. Describe the operation of a simple voltaic cell.
e. Explain the relationship between specific gravity and state of charge of a lead-acid battery.
f. Describe the relationship between total battery voltage and individual cell voltage for a series-connected battery.
g. Explain the advantage of connecting a battery in parallel with respect to current-carrying capability.
h. Describe the difference between primary and secondary cells with respect to recharge capability.
i. State the advantages of each of the following types of batteries:
   - Carbon-zinc cell
   - Alkaline cell
   - Nickel-cadmium cell
   - Edison cell

- Mercury cell

j. Explain how gas generation is minimized for a lead-acid battery and the steps to prevent hydrogen buildup.
k. Explain how heat is generated in a lead-acid battery.
l. Describe the various uses of battery banks in DOE facilities.
m. Describe how batteries are tested.

II. ELECTRICAL ISSUE IDENTIFICATION & REPORTING

(Each competency statement is a MPA, provided that they are applicable to the candidate's assigned electrical duties.)

1. Demonstrate a working level knowledge of surveillance and assessment techniques; reporting; and follow up actions for electrical systems and programmatic elements of an Electrical Safety Program to include:

a. Management systems;
b. Problem remediation and trends processes;
c. Inspection programs;
d. Training and Qualification programs;
e. Oversight of Contractor Assurance Systems.

Supporting Knowledge and/or Skills

a. Describe the role of Electrical personnel in performance oversight of government-owned, contractor-operated (GOCO) facilities.
b. Describe the assessment requirements and limitations associated with the interface of Electrical personnel and contractor employees.
c. Describe how planning, observations, interviews, and document research are used during an assessment.
d. Explain the essential elements of a performance-based assessment including investigation, fact-finding, and reporting. Include a discussion of the essential elements and processes of the following assessment activities:
   - Exit interviews
   - Closure process
   - Tracking to closure
   - Follow-up
   - Contractor corrective action implementation
e. Describe the actions to be taken if the contractor challenges the assessment findings and explain how such challenges can be avoided.
f. Describe the methods by which noncompliance is determined and communicated to contractor and Department management.
g. Describe the role of Electrical personnel in the contractor performance evaluation process.
h. Participate in the evaluation of a contractor's performance.
i. Conduct an interview as part of an evaluation of an occurrence.
j. Develop an assessment report.
k. Participate in formal meetings between Department management and senior contractor management to discuss the results of Electrical assessments.

2. Demonstrate the ability to communicate (both oral and written) when working or interacting with the contractor, stakeholders, and other internal and external organizations.

Supporting Knowledge and/or Skills

a. Identify the various internal and external groups with whom Electrical personnel must interface in the performance of their duties.
b. Apply written communication skills in the development of:
   - Assessment reports
   - Technical reports
   - Technical papers
c. Apply effective and appropriate communications skills when interfacing with the contractor.

3. Become familiar with the ES&H reporting requirements as noted in DOE Order 231.1A, Environment, Safety and Health Reporting.

Supporting Knowledge and/or Skills

a. Using an occurrence report related to an electrical system or component and using DOE Order 231.1A, as a reference, identify the following:
   - Causes
   - Corrective actions
   - Lessons learned
   - Whether corrective actions have been completed
b. State the purpose of the Order.
c. Define the following terms:
   - Event
   - Condition
   - Facility
   - Notification report
   - Occurrence report
   - Reportable occurrence
d. Discuss the Department's policy regarding the reporting of occurrences as outlined in the Order.
e. State the different categories of reportable occurrences and discuss each.
f. Review a sample of Occurrence Reports and Operating Experience Weekly reports for issues on electrical safety and discuss the lessons learned.

4. Electrical systems personnel shall demonstrate a working level knowledge of problem analysis principles and the ability to apply techniques necessary to identify problems, determine potential causes of problems, and identify corrective action(s).

Supporting Knowledge and/or Skills

a. Describe and explain the application of problem analysis techniques including the following:
   - Root cause analysis
   - Causal factor analysis

- Change analysis
- Barrier analysis
- Management oversight risk tree (MORT) analysis

b. Describe and explain the application of the following root cause analysis processes in the performance of occurrence investigations:
   - Event and causal factors charting
   - Root cause coding
   - Recommendation generation

c. Using event and/or occurrence data, apply problem analysis techniques and identify the problems and how they could have been avoided.
d. Participate in at least one contractor or Department problem analysis and critique the results.
e. Using data, interpret two fault tree analyses.

5. Obtain experience in performing electrical safety and system walkdowns, and develop skills in observing and reporting NEC and NFPA-70E noncompliance's. This experience could be gained by joining a contractor NEC inspector and/or safety officer in an electrical walkdown, and observing the methodology used to address electrical safety issues.

SPECIFIC TECHNICAL COMPETENCIES

III. <u>SAFETY & HEALTH RELATED TO ELECTRICAL SYSTEMS and COMPONENTS</u>
(Applies to only candidates who are assigned oversight to electrical operations, construction, and/or maintenance activities. Each competency statement is a MPA, provided that they are applicable to the candidate's assigned electrical duties.)

1. Obtain a clear understanding how electrical hazards are addressed via the Integrated Safety Management System process. Emphasis placed on knowing all applicable site contractor(s) job planning (job hazard analysis, identification and integration of hazard controls within work package), and application of -hazard controls, during the work control process.

2. Obtain a working level knowledge of Electrical Safety-Related Work Practices (NFPA 70E, Article 110) to include the following:

a. Multiemployer relationships;
b. Electrical Training and Qualification programs;
c. Electrical Safety Program elements.

3. Observe electrical work performed by each site contractor to learn how work is performed within planned controls. Obtain a working knowledge of site contractor(s) procedure/work control program, and specific work control requirements for each job observed. The level of rigor of these jobs should allow the candidate to review the functional areas, requirements, and workscope for compliance with NFPA 70E, to include the following:

Note: To safely observe electrical work on or near energized electrical conductors, the candidate must be previously trained to the mentioned requirements. Candidates are not to cross any shock or arc flash boundary.

a. Electrical safety-related work practices and establishment of electrically safe work conditions (NFPA 70E, Article 120). To include, but not limited to lockout/tagout (LOTO), deenergization requirements, zero-energy checks, and the electrically-safe-work-condition verification process.
b. Electrical hazards/risk identification and classification processes, and the use of severity indices, in the application of electrical events analysis and trends. (NFPA 70E, Article 130)
c. Electrical work on or near live parts. To include, but not limited to energized electrical work permits (elements and exemptions), shock and arc-flash hazard analyses, arc flash calculation methodology, arc flash reduction techniques, approach boundaries, and associated PPE. (NFPA 70E, Article 130, and IEEE 1584)
d. Safety-related maintenance requirements: grounding and bonding, safety equipment, clear space requirements; substations, switchgear, panels, motor control centers; premises wiring; controller equipment; fuses and circuit breakers; rotating equipment; hazardous locations; batteries and battery rooms, portable electric tools and equipment; and personal safety and protective equipment. (NFPA 70E, Chapter 2, IEEE Std-450)
e. Safety requirements for special equipment: Such as Research & Development (R&D) electrical safety requirements; work practices for such R&D equipment (i.e. laser operations and power electronic equipment, etc.). (NFPA 70E, Article 400)
f. Installation safety requirements: Power systems protection; flash protection; guarding of live parts; wiring design and protection; wiring methods, components, and equipment; specific purpose equipment and installations (cranes and hoists, elevators, HVAC, X-ray equipment, motor controllers, etc.; hazardous locations), and so on. (NFPA 70; and NFPA 70E, Chapter 4)
g. Be aware that 29 CFR 1910 and 29 CFR 1926 (OSHA requirements documents) has many, but not all of the electrical safety requirements as NFPA 70E. For example, NFPA 70E outlines requirement for arc-flash hazard controls, however the mentioned CFR's do not.

4. From the jobs observed in Competency 3 above, assess how well contractor management systems (lessons learned and other feedback processes) are integrated with the work planning and ISM process. Develop a working knowledge of how lessons learned are addressed by each contractor's Integrated Safety Management System feedback process. (Reference DOE P 450.4 Safety Management System Policy.)

5. Obtain a working level knowledge of NFPA 70E, Article 420 requirements, to include:

a. Wiring methods – Bonding of enclosures, temporary wiring, and permitted use of cable trays;
b. Safety positioning and connection of switches;
c. Switch/panelboard location and access requirements;
d. Enclosures for damp and wet locations;
e. Conductor identification requirements;
f. Permitted and non-permitted use of flexible cords and cables;
g. Portable cables over 600 volts;
h. Motor, transformer, and capacitor general use equipment.

6. Obtain a working level knowledge of the DOE Electrical Safety Handbook for safety requirements associated with site R&D operations involving large capacity stored energy, inductor, capacitor and pulsed energy systems to include requirements relating to:

a. Hazards identification, classification, PPE, and associated work practices;
b. Equipment configuration, and operational practices;
c. R&D training and qualifications requirements.

7. Obtain a working level knowledge of requirements related to safe work practices for laser operations (NFPA 70E, Chapter 3) to include:

a. Fail-safe interlocks;
b. Controlled areas;
c. Laser characteristics;
d. Safety training and qualifications;
e. Safeguarding of personnel.

IV. ELECTRICAL MAINTENANCE MANAGEMENT FOR NUCLEAR AND NON-NUCLAR FACILITIES

(Applies only to candidates assigned oversight of electrical maintenance activities. Each competency statement is a MPA, provided that they are applicable to the candidates assigned electrical duties.)

1. Become familiar with Department of Energy (DOE) maintenance management requirements as defined in DOE Order 433.1, Maintenance Management Program, and DOE Guide 433.1-1.

Supporting Knowledge and/or Skills

a. Define each of the following maintenance-related terms and explain their relationship to each other.
   - ••Corrective
   - ••Planned
   - ••Preventive
   - ••Reliability Centered
   - ••Predictive
b. Discuss the importance of maintaining a proper balance of preventive and corrective maintenance.
c. Identify typical maintenance performance indicators, and discuss their importance.
d. Discuss the relationship between maintenance and Conduct of Operations, Quality Assurance, and Configuration Management.
e. Discuss the requirements for receiving and inspecting parts, materials, and equipment.
f. Describe the difference between temporary and permanent repairs/work and the requirements and controls in place to prevent inadvertent modifications.
g. Discuss the importance and methods of establishing acceptance criteria for inspection and testing.

2. Become familiar with NFPA 70B safety requirements for Electrical Equipment Maintenance, to include:

a. Electrical Preventive Maintenance program elements (Ch. 5);
b. Training requirements (Ch. 5);
c. Special precautions relating to electronic equipment, e.g., equipment deenergization, zero-energy checks, prevention of shock, grounding requirements for maintenance actions (Ch. 12);
d. GFCI and GFPE maintenance requirements, e.g., trip tests, records keeping, approved listing of test equipment (Ch. 14);
e. Testing and test methods: precautions and safety; qualifications of test operators; test equipment; protective device testing (Ch. 20);
f. Deenergizing and grounding of equipment to provide protection for electrical maintenance personnel, (Ch. 23); g. Grounding requirements, e.g., symptoms and causes of inadequate grounding; grounding system inspection, testing and monitoring; and, solutions to inadequate grounding (Ch. 29).
g. Maintenance and servicing of transformers, cables, breakers, and motors (Ch. 10, 11, 14, and 17 respectively).

3. Become familiar with the NFPA 70E, Chapter 2, safety-related maintenance requirements relating to:

a. Grounding and bonding;
b. Safety equipment and clear space requirements;
c. Electrical systems and components;
d. Hazardous locations;
e. PPE
f. Identify and discuss elements of an electrical safety program, including the following:
   - Two-man rule
   - ••Stored energy
   - ••Component labeling

V. <u>ELECTRICAL DESIGN & INSTALLATION (SAFETY AND SYSTEMS)</u>
(Applies only to candidates assigned oversight of electrical design and installation activities. Each competency statement is a MPA, provided that they are applicable to the candidate's assigned electrical duties.)

1. Demonstrate a working level knowledge of the current National Electrical Code, and become familiar with the requirements for wiring design and protection (NFPA 70, NFPA 70E, Chapter 4) to include:

a. Use of listed and labeled, Nationally Recognized Test Laboratory (NRTL), electrical equipment (also reference 29 CFR 1910.303 & .399, and 29 CFR 1926.403);
b. Branch circuits identification;
c. GFCI protection for personnel;
d. Outside circuits and conductors for 600 volts (or less) systems;
e. Overcurrent protection for 600 volts (or less) and greater-than 600 volts circuits;
f. Grounding and bonding requirements as noted in NFPA 70E Article 410.10.

2. Become familiar with the requirements for the Installation of Lightning Protection Systems (NFPA 780, UL 96 Lightning Protection Components, and UL 96A Installation requirements for Lightning Protection Systems).

3. Demonstrate a working level knowledge of electrical diagrams, including:

a. One-line diagrams
b. ••Schematics
c. Construction drawings
d. As-built drawings
e. Wiring diagrams

Supporting Knowledge and/or Skills

a. Using a schematic, identify an electrical component by its symbology.
b. Using a logic diagram for a control circuit, identify and describe the effects of an action taken.
c. Using a one-line diagram, identify power sources and loads.
d. Using a one-line diagram or schematic diagram, analyze the effects of a component failure in a system.
e. Using a construction drawing, identify the emergency power supplies.
f. Discuss the origin and purpose of "as-built" drawings.

4. Become knowledgeable of the Configuration Management process as applied to electrical documentation, e.g., documenting, controlling, revising, and issuance of electrical drawings. Also observed how drawings are updated and issued “as built.” (DOE STD 1073, Configuration Management, and DOE O 414.1C Quality)

Supporting Knowledge and/or Skills

a. Discuss the change control process described in DOE STD 1073.
b. Describe the purpose and objectives of the Operational Configuration Management Program, and how it relates to electrical systems.
c. Discuss the following elements of the Configuration Management Program, as it relates to electrical systems:
   - Design requirements
   - Document control
   - Change control
   - Assessments
   - Design reconstitution adjunct
   - Material condition and aging adjunct
d. Discuss the purpose, concepts, and general process for applying the graded approach to operational configuration management.
   - Using the guidance in DOE-STD-1073, discuss the System Engineer concept as it applies to oversight of safety systems. Specifically address the areas of configuration management, assessment of system status and performance, and technical support for operation and maintenance activities or for Documented Safety Analysis reviews.
   - Using DOE O 414.1C, discuss how the pedigree of electrical equipment should be maintained when supporting a nuclear related activity, and/or performing a safety function.

5. Become familiar with battery installations, maintenance, testing and replacement as described in NFPA 70E, Chapter 3, IEEE Std-450, and IEEE-C2 National Electrical Safety Code (NESC) to include:

a. Connections and capacities;
b. DC systems grounding and Ground-Fault Detection;
c. DC circuits protection and alarms.

6. Become familiar with ventilation and battery room requirements as cited in NFPA 70E, Chapter 3, IEEE Std-450 and IEEE C2-National Electrical Safety Code (NESC) to include:

a. Ventilation requirements for different battery types;
b. Battery room restrictions, barriers, illumination, and enclosure requirements;
c. Battery protection requirements.

VI. ELECTRICAL VITAL SAFETY SYSTEMS (VSS)

(Applies only to candidates who are assigned an electrical VSS, [which includes safety class and/or safety significant electrical systems]. Recommend applying, as appropriate, to candidates who are assigned an electrical system that performs a defense in depth/important to safety function and/or supports a nuclear related activity. Each competency statement is a MPA, provided that they are applicable to the candidate's assigned electrical duties.)

1. Mandatory Performance Activity: Demonstrate a familiarity level of knowledge of 10 CFR 830 (Nuclear Safety Management), and DOE O 414.1C that relate to Electrical Safety programs, processes, and systems, to include:

a. Knowledge of site Vital Safety System (VSS) interfaces for electrical, software, and instrument and control systems;
b. The basic purpose of the Unreviewed Safety Question (USQ) process;
c. General purpose and constitution of the Documented Safety Analysis;
d. Purpose and content of Technical Safety Requirements (TSR) documentation.

Supporting Knowledge and/or Skills

a. Discuss the reasons for performing an Unreviewed Safety Question determination.
b. Describe the situations for which a safety evaluation is required to be performed.
c. Define the conditions for an Unreviewed Safety Question.
d. Describe the responsibilities of contractors authorized to operate defense nuclear facilities regarding the performance of safety evaluations.
e. Describe the actions to be taken by a contractor upon identifying information that indicates a potential inadequacy of a previous safety analyses or, a possible reduction in the margin of safety, as defined in the Technical Safety Requirements.
f. Discuss the purpose of the Technical Safety Requirements.
g. Describe the responsibilities of contractors authorized to operate defense nuclear facilities regarding the Technical Safety Requirements.
h. Define the following terms and discuss the purpose of each:
   - Safety Limit
   - Limiting Control Settings

- Limiting Conditions for Operation
- Surveillance Requirements

i. Describe the general content of each of the following sections of the Technical Safety Requirements:
   - Use and Application
   - Safety Limits
   - Operating Limits
   - Surveillance Requirements
   - Administrative Controls
   - Basis
   - Design Features

j. Discuss the basic purposes and objectives of a Documented Safety Analysis.
k. Describe the responsibilities of contractors authorized to operate DOE nuclear facilities regarding the development and maintenance of a Documented Safety Analysis.
l. Define the following terms and discuss the purpose of each:
   - Safety Basis
   - Design Features
   - Safety Evaluation Report

m. Describe the requirements for the scope and content of a Documented Safety Analysis and discuss the general content of each of the required sections of a Documented Safety Analysis.
n. Discuss the uses that contractor management makes of a Documented Safety Analysis.

2. Demonstrate a familiarity level knowledge of all assigned Electrical Power Vital Safety Systems, and how they are addressed during the design, construction and operation of nuclear facilities

Supporting Knowledge and/or Skills

a. Mandatory Performance Activity: Walkdown electrical power vital safety systems and locate and identify major components, subsystems, and interfaces.
b. Identify all Electrical Power Vital Safety Systems (site specific), and then discuss the functional classifications, safety functions, and functional requirements of these systems.
c. Discuss electrical power distribution with the regard to the following elements (IEEE Red Book or other sources can be used as a guide in developing the discussion):
   - Basic design considerations and electrical distribution design
   - Voltage considerations
   - Surge voltage protection techniques
   - System protective devices
   - Power factor and its effects in electrical distribution systems
   - Power switching, transformation, and motor-control apparatus
   - Cable system basics
   - Busway design

d. Discuss protection and coordination with regard to the following elements(the IEEE Buff book or other sources can be used as a guide in developing the discussion:
   - Fault calculations
   - Short-circuit current calculations for single and three-phase circuits.
   - Instrument transformer basics
   - Protective relay selection and application

- Fuses selection and application
- Low-voltage circuit breaker fundamentals
- Ground-fault protection fundamentals
- Conductor, motor, transformer, generator, and bus and switchgear protection
- Maintenance, testing, and calibration of electrical systems

e. Discuss electrical system grounding with regard to the following elements (the IEEE Green book or other source can be used as a guide in developing the discussion):
   - Electrical system grounding fundamentals
   - Electrical equipment grounding fundamentals
   - Static and lightning grounding fundamentals

f. Discuss emergency and standby power with regard to the following elements (the IEEE Orange Book or other source can be used as a guide in developing the discussion):
   - Emergency and standby power guidelines
   - Generator and electric utility system fundamentals
   - Stored energy system fundamentals
   - Protection device fundamentals

3. Demonstrate a working level knowledge of the possible functional interfaces/relationships between all Electrical VSS and instrument and control safety software analysis safety software, and design safety software.

Supporting Knowledge and/or Skills

a. Identify how functional requirements and applicability of safety analysis and design computer codes are defined, documented, and controlled relative to modeling and data assumptions, design constraints, sizing and timing conditions and input/output parameters as described in DOE O 414.1C, *Quality Assurance,* and DOE G 414.1-4 *Safety Software Guide.*
b. Review a development project for safety analysis or design software. Explain how the problem being addressed by the software was translated into functional requirements, how the requirements were established and controlled, and how the code was reconciled with the original problem.
c. Identify how system-level requirements are established and then assigned to hardware, software, and human components of a digital instrumentation and control system.
d. Identify the typical requirements that define functional interfaces between safety software components and the system-level design, as described in DOE O 414.1C, *Quality Assurance,* and DOE G 414.1-4 *Safety Software Guide.*
e. Identify the specific records that must be maintained and the requirements for maintaining these records to document the development of safety system software.
f. Review a development project for safety system software. Explain how the functional interfaces between components and the system level design were established and controlled.

4. Document participation with the site contractor System Engineer (SE) in a quarterly walkthrough, bi-annual status walkthrough or an assessment for all assigned Electrical Vital Safety Systems (VSS).

5. Demonstrate a familiarity level knowledge of functional classifications for safety systems and the design expectations associated with electrical systems that carry

these functional classifications, as described in DOE O 420.1B, Facility Safety, and its associated guide DOE G 420.1-1.

Supporting Knowledge and/or Skills

a. Discuss the purpose, scope, and application of DOE Order 420.1B. Include in this discussion, key terms, essential elements, and personnel responsibilities and authorities.
b. Discuss the project management terminology for which definitions are provided in DOE Order 420.1B.
c. Discuss in detail the roles played by various management levels within the Department as they relate to the project management system.
d. Discuss the purpose of "critical decisions." Include in this discussion the responsible authorities for critical decisions.
e. Describe the process by which projects are designated.
f. Define the term “safety-class” and discuss the implications of an electrical system carrying this functional classification.
g. Define the term “safety-significant” and discuss the implications of an electrical system carrying this functional classification**.**

6. Demonstrate a familiarity level knowledge of electrical safety systems criteria for Vital Safety Systems (VSS) (IEEE Stds: 308-2001, 323-2003, 379-2000, 384-1992, and 603-1998; and, DOE O 420.1B and DOE G 420.1-1.)

Supporting Knowledge or Skills

a. Identify and describe the requirements for principal design criteria of electrical power systems supporting VSS (Class 1E power systems): Design Basis and Design Basis Events; Independence; the Equipment Qualification process for Class 1E power systems; Single-Failure Criterion; Requirements for connecting of non-Class 1E systems to Class 1E systems; Class 1E protection requirements.
b. Identify and describe the requirements for supplementary design criteria of electrical power systems supporting VSS (Class 1E power systems): Class 1E power systems; AC power systems; DC power systems; Instrumentation and control power systems; Execute and Sense-and-Command features.
c. Describe the relationship between surveillance and test requirements and design of electrical systems supporting the VSS.
d. Discuss the Equipment Qualification process for Class 1E power systems in support of VSS: Principles of equipment qualification; Qualification methods; the Qualification Program; and, documentation requirements.
e. Discuss the concept of ‘Independence’: Identify some of the general criteria for attaining ‘Independence’, e.g., physical separation, electrical isolation and devices, methods of achieving independence, and associated circuits; Describe the general concept of ‘Specific Separation Criteria, e.g., area classification and separation distances; Discuss the major requirements for circuit breakers and fuses to be considered as ‘isolation’ devices.
f. State the general requirement for the single-failure criterion (SFC) and identify the major conditions used to apply the SFC to safety systems design: independence and redundancy; nondetectable, cascaded, common-cause failures; Design Basis Events; and shared systems.

7. Demonstrate a familiarity level knowledge of electrical safety design requirements for Emergency, Standby, and UPS systems for VSS (IEEE Stds 387-1984, 650-1990, and 944-1986; and, DOE O 420.1B and DOE G 420.1-1).

Supporting Knowledge or Skills

a. Identify and discuss the principal design criteria for standby power supplies supporting VSS: capability; ratings; interactions; design and application considerations; design features.
b. Identify and discuss some of the design application requirements for Uninterruptible Power Supplies supporting VSS: performance requirements; UPS sizing and capacities; and UPS configurations.
c. Identify some of the key Class 1E performance characteristics for Class 1E static battery chargers and inverters supporting VSS: Input conditions; Output requirements; Surge withstand capability; and, reverse current flow prevention.

8. Demonstrate a familiarity level knowledge of electrical safety design requirements for VSS Accident Monitoring Instrumentation (IEEE Std 497-2002; and, DOE O 420.1B and DOE G 420.1-1).

Supporting Knowledge or Skills

a. Identify and discuss the selection criteria used for identifying the 'type variables' for Accident Monitoring Instrumentation.
b. Identify some key performance criteria of Accident Monitoring Instrumentation.

9. Demonstrate a familiarity level knowledge of electrical safety design requirements for VSS Motor Control Centers (MCC) (IEEE Std 649-1991; and, DOE O 420.1B and DOE G 420.1-1).

Supporting Knowledge or Skills

a. Identify the three qualification alternatives for VSS MCC equipment.
b. Identify the three major elements of the qualification process for VSS MCC: Equipment specification; the Qualification Program; and, the documentation requirement.
c. Discuss the Qualification Procedural requirements for VSS MCCs relating to Aging, Seismic Qualification, and Harsh Environment Events.

10. Demonstrate a familiarity level knowledge of electrical safety design requirements for Digital Computers supporting VSS (IEEE Std 7-4.3.2-2003, Annex E; and, DOE O 420.1B and DOE G 420.1-1).

Supporting Knowledge or Skills

a. Discuss some of the configuration requirements for communications independence relating to communications between computers in different safety channels.
b. Discuss some of the configuration requirements for communications independence relating to communications between safety and non-safety computers.

11. Demonstrate a familiarity level knowledge of electrical safety design requirements for VSS Protection Systems (IEEE Std 741-1997, and 833-1988; and, DOE O 420.1B and DOE G 420.1-1).

Supporting Knowledge or Skills

a. Identify the key general design criteria for VSS Protection Systems (see IEEE Std 741, Section 4.)
b. Identify the major criteria for establishing bus voltage monitoring schemes (see IEEE Std 741, Section 5.1.2 a) - h)).
c. Identify the major requirement for selecting protective devices for direct-geared valve actuator motors (IEEE Std 741, Section 5.5, first paragraph, first sentence).

12. Demonstrate a familiarity level knowledge of electrical safety design requirements for Instrumentation and Control (I&C) Equipment Grounding of VSS (IEEE Std 1050-1996; and, DOE O 420.1B and DOE G 420.1-1).

Supporting Knowledge or Skills

a. Discuss some design considerations for electrical noise minimization: Noise sources; noise-coupling methods; and techniques for electrical noise minimization.
b. Describe the purpose or use of, and advantages and disadvantages for: Single-point ground systems; multi-point ground systems; and floating ground systems.
c. Identify the IEEE Standard citing requirements for VSS I&C equipment signal cable shield grounding requirements (IEEE Std 1050-1996).

13. Demonstrate a familiarity level knowledge of electrical safety design requirements for VSS Motor Operated Valves (IEEE Std 1290-1996; and, DOE O 420.1B and DOE G 420.1-1).

Supporting Knowledge or Skills

a. Identify the IEEE Standard, citing requirements for motor applications, protection, and control for Motor Operated Valve (MOV) motor applications (IEEE Std 1290).

ADDITIONAL REQUIRED READING

1. Obtain a clear understanding of electrical safety requirements and practices in the following list of regulatory and consensus standards documents, including the relationship between these documents and which are "enforceable" in your site's contractors contract. OSHA (29 CFR 1910 and Subpart S, and 29 CFR 1926 Subparts K and V), NFPA 70E, Standard for Electrical Safety in the Workplace/Maintenance, NFPA-70B, Recommended Practice of Electrical Equipment Maintenance, DOE-HDBK-1092, DOE Electrical Safety Handbook; and 10 CFR 851, Worker Safety and Health Program.

Supporting Knowledge and/or Skills

a. Describe the purpose, scope, and application of the requirements detailed in the listed standards and Orders.
b. Discuss the graded approach process that Department line management uses to determine an appropriate level of coverage by Electrical personnel. Include in this discussion the factors that may influence the level of coverage.
c. Determine contractor compliance with the listed documents as they apply to contract design requirements and electrical system activities at a defense nuclear facility.

2. Demonstrate a familiarity level knowledge of Department of Energy, DOE Order 414.1C, Quality Assurance, as it pertains to electrical systems.

Supporting Knowledge and/or Skills

a. **Mandatory Performance Activity:** Describe how electrical equipment is procured based upon its safety function and/or nuclear related activity using quality assurance criteria and appropriate national or international consensus standards.
b. Describe what is meant by implementing quality assurance criteria using a graded approach.
c. Describe the types of documents related to electrical systems that should be controlled by a document control system.
d. Discuss the requirements for revision and distribution of controlled documents.
e. Discuss the determination of calibration frequency for electrical test equipment.
f. Describe the effect of using inappropriate calibration standards on electrical test equipment.
g. Discuss the key elements of the procurement process for electrical systems as described in DOE Order 414.1C, Quality Assurance.

3. Demonstrate a familiarity level of knowledge of Department of Energy, DOE Order 430.1B, Real Property Asset Management, with regard to life cycle asset management.

Supporting Knowledge and/or Skills

a. Explain the Department's role in the oversight of contractor maintenance operations.
b. Identify the key elements of a contractor maintenance plan as required by the DOE Orders referenced above.
c. Describe configuration control and its relationship to the maintenance work control process and the maintenance history file.
d. Describe the mechanisms for feedback of relevant information, such as trend analysis and instrumentation performance/reliability data, to identify necessary program modifications.
e. Review a contractor preventive maintenance activity and describe the preventive maintenance factors to be considered as the activity is planned.
f. Discuss the importance of post-maintenance testing and the elements of an effective post-maintenance testing program.
g. Review the results of post-maintenance testing activities and discuss the acceptance of post-maintenance testing.
h. Discuss the importance of maintaining a maintenance history.
i. Review a maintenance history file and discuss the potential implications of repeat maintenance items.
j. Explain the intent of a Maintenance Problem Analysis Program and discuss a maintenance problem where this program has been employed.

APPENDIX A
CONTINUING EDUCATION, TRAINING AND PROFICIENCY PROGRAM

The following list represents suggested continuing education, training, and other opportunities that are available for DOE personnel after completion of the competency requirements in this technical FAQS. It is extremely important that personnel involved with this program maintain their proficiency through continuing education, training, reading, or other activities such as workshops, seminars, and conferences. The list of suggested activities was developed by the Subject Matter Experts involved in the development of the FAQS and is not all-inclusive.

LIST OF CONTINUING EDUCATION, TRAINING, AND OTHER ACTIVITIES

Electrical personnel shall participate in an Office/Facility-specific continuing training and qualification program that includes the following elements:

1. Continuing technical education and/or training covering topics directly related to the electrical area as determined appropriate by management. This may include courses/training provided by Department of Energy, other government agencies, outside vendors, or local educational institutions. Continuing training topics should also address identified weaknesses in the knowledge or skills of the individual personnel.

2. Attend seminars, symposia, or technical meetings related to electrical safety and/or systems.

3. Engage in self-study of new regulations, requirements, or advances related to Electrical Systems.

4. Participation in practical exercises such as emergency or operational drills, simulations, or laboratory-type exercises.

5. Specific continuing training requirements shall be documented in Individual Development Plans.

6. Review of lessons learned publications.

Resources:

Institute of Electrical and Electronics Engineers, Inc. (IEEE)
3 Park Avenue, 17th Floor
New York, New York 10016-5997
http://www.ieee.org

The Instrumentation, Systems, and Automation Society (ISA)
67 Alexander Drive

PO Box 12277
Research Triangle Park, NC 27709
http://www.isa.org

National Fire Protection Association (NFPA)
(NFPA 70 - National Electrical Code)
1 Batterymarch Park
P.O. Box 9101
Quincy, Massachusetts 02269-9101
http://www.nfpa.org/nec/nechome.asp

AVO International Training Institute
4271 Bronze Way,
Dallas, Texas 75237-1017 USA
http://www.avointl.com/us/training

Electrical Self Study Guide
http://cted.inel.gov/cted/tq_tm_index.html

Technical Qualification Program (TQP)

ELECTRICAL FUNCTIONAL AREA QUAL. STD (10/2006 Revision)

General & Specific Technical Competencies	Competency Completion Verification Method (Oral checkout, Equivalency, etc.)	Competency Achieved (Verification signature and date of Supervisor or SME)
I. KNOWLEDGE OF ELECTRICAL THEORY & EQUIPMENT [Each competency statement is a Mandatory Performance Activity (MPA), provided that they are applicable to the candidate's assigned electrical duties. For all competency statements, reference DOE Electrical Science Fundamentals Handbook 1011 (2-92) as the reference source.]		
1. Demonstrate a working level knowledge of electrical and circuit theory, theorems, terminology, laws, and analysis.		
2. Demonstrate a working level knowledge of basic alternating current (AC) theory.		
3. Demonstrate a working level knowledge of the construction and operation of alternating current (AC) generators, and motors (including operating characteristics, method of torque production, and the advantages of specific motor types).		
4. Demonstrate a working level knowledge of alternating current (AC) reactive components, including inductive and capacitive reactance and phase relationships in reactive circuits.		
5. Demonstrate a working level knowledge of electrical transmission and distribution systems, including line filtering (power line conditioning).		
6. Demonstrate a working level knowledge of transformers.		
7. Demonstrate a working-level knowledge of Uninterruptible Power Supplies (UPS).		
8. Demonstrate a working-level knowledge of variable frequency (speed) drives (VFD).		
9. Demonstrate a working level knowledge of electrical test instruments and measuring devices.		

Technical Qualification Program (TQP)

ELECTRICAL FUNCTIONAL AREA QUAL. STD (10/2006 Revision)

General & Specific Technical Competencies	Competency Completion Verification Method (Oral checkout, Equivalency, etc.)	Competency Achieved (Verification signature and date of Supervisor or SME)
10. Demonstrate a familiarity level knowledge of the principles and concepts of natural phenomena hazards (such as static electricity, reference NFPA 77) and their effect on personnel and electrical systems.		
11. Demonstrate a working level knowledge of direct current (DC) generators and motors.		
12. Demonstrate a working level knowledge of battery construction, voltage production, and hazards. IEEE Std 450. Maintenance, Testing and Replacement of Vented Lead-Acid Batteries for Stationary Applications.		
II. ELECTRICAL ISSUE IDENTIFICATION & REPORTING (Each competency statement is a MPA, provided that they are applicable to the candidate's assigned electrical duties.)		
1. Demonstrate a working level knowledge of surveillance and assessment techniques; reporting; and follow up actions for electrical systems and programmatic elements of an Electrical Safety Program to include: a. Management systems; b. Problem remediation and trends processes; c. Inspection programs; d. Training and Qualification programs; e. Oversight of Contractor Assurance Systems.		
2. Demonstrate the ability to communicate (both oral and written) when working or interacting with the contractor, stakeholders, and other internal and external organizations.		
3. Become familiar with the ES&H reporting requirements as noted in DOE Order 231.1A, Environment, Safety and Health Reporting.		

Technical Qualification Program (TQP)

ELECTRICAL FUNCTIONAL AREA QUAL. STD (10/2006 Revision)

General & Specific Technical Competencies	Competency Completion Verification Method (Oral checkout, Equivalency, etc.)	Competency Achieved (Verification signature and date of Supervisor or SME)
4. Electrical systems personnel shall demonstrate a working level knowledge of problem analysis principles and the ability to apply techniques necessary to identify problems, determine potential causes of problems, and identify corrective action(s).		
5. Obtain experience in performing electrical safety and system walkdowns, and develop skills in observing and reporting NEC and NFPA-70E noncompliances. This experience could be gained by joining a contractor NEC inspector and/or safety officer in a electrical walkdown, and observing the methodology used to address electrical safety issues.		
III. SAFETY & HEALTH RELATED TO ELECTRICAL SYSTEMS and COMPONENTS (Applies to only candidates who are assigned oversight to electrical operations, construction, and/or maintenance activities. Each competency statement is a MPA, provided that they are applicable to the candidate's assigned electrical duties.)		
1. Obtain a clear understanding how electrical hazards are addressed via the Integrated Safety Management System process. Emphasis placed on knowing all applicable site contractor(s) job planning (job hazard analysis, identification and integration of hazard controls within work package), and application of -hazard controls, during the work control process.		
2. Obtain a working level knowledge of Electrical Safety-Related Work Practices (NFPA 70E, Article 110) to include the following: a. Multiemployer relationships; b. Electrical Training and Qualification programs; c. Electrical Safety Program elements.		

Technical Qualification Program (TQP)

ELECTRICAL FUNCTIONAL AREA QUAL. STD (10/2006 Revision)

General & Specific Technical Competencies	Competency Completion Verification Method (Oral checkout, Equivalency, etc.)	Competency Achieved (Verification signature and date of Supervisor or SME)
3. Observe electrical work performed by each site contractor to learn how work is performed within planned controls. Obtain a working knowledge of site contractor(s) procedure/work control program, and specific work control requirements for each job observed. The level of rigor of these jobs should allow the candidate to review the functional areas, requirements, and workscope for compliance with NFPA 70E, to include the following: Note: To safely observe electrical work on or near energized electrical conductors, the candidate must be previously trained to the mentioned requirements. Candidates are not to cross any shock or arc flash boundary.		
a. Electrical safety-related work practices and establishment of electrically safe work conditions (NFPA 70E, Article 120). To include, but not limited to lockout/tagout (LOTO), deenergization requirements, zero-energy checks, and the electrically-safe-work-condition verification process.		
b. Electrical hazards/risk identification and classification processes, and the use of severity indices, in the application of electrical events analysis and trends. (NFPA 70E, Article 130)		
c. Electrical work on or near live parts. To include, but not limited to energized electrical work permits (elements and exemptions), shock and arc-flash hazard analyses, arc flash calculation methodology, arc flash reduction techniques, approach boundaries, and associated PPE. (NFPA 70E, Article 130, and IEEE 1584)		
d. Safety-related maintenance requirements: grounding and bonding, safety equipment, clear space requirements; substations, switchgear, panels, motor control centers; premises wiring; controller equipment; fuses and circuit breakers; rotating equipment; hazardous locations; batteries and battery rooms, portable electric tools and equipment; and personal safety and protective equipment. (NFPA 70E, Chapter 2)		

Technical Qualification Program (TQP)

ELECTRICAL FUNCTIONAL AREA QUAL. STD (10/2006 Revision)

General & Specific Technical Competencies	Competency Completion Verification Method (Oral checkout, Equivalency, etc.)	Competency Achieved (Verification signature and date of Supervisor or SME)
e. Safety requirements for special equipment: Such as Research & Development (R&D) electrical safety requirements; work practices for such R&D equipment (i.e. laser operations and power electronic equipment, etc.). (NFPA 70E, Article 400)		
f. Installation safety requirements: Power systems protection; flash protection; guarding of live parts; wiring design and protection; wiring methods, components, and equipment; specific purpose equipment and installations (cranes and hoists, elevators, HVAC, X-ray equipment, motor controllers, etc.; hazardous locations), and so on. (NFPA 70; and NFPA 70E, Chapter 4)		
g. Be aware that 29 CFR 1910 and 29 CFR 1926 (OSHA requirements documents) has many, but not all of the electrical safety requirements as NFPA 70E. For example, NFPA 70E outlines requirement for arc-flash hazard controls, however the mentioned CFR's do not.		
4. From the jobs observed in Competency 3. above, assess how well contractor management systems (lessons learned, and other feedback processes) are integrated with the work planning and ISM process. Develop a working knowledge of how lessons learned are addressed by each contractors Integrated Safety Management System feedback process. (Reference DOE P 450.4 Safety Management System Policy.)		

Technical Qualification Program (TQP)

ELECTRICAL FUNCTIONAL AREA QUAL. STD (10/2006 Revision)

General & Specific Technical Competencies	**Competency Completion Verification Method** (Oral checkout, Equivalency, etc.)	**Competency Achieved** (Verification signature and date of Supervisor or SME)
5. Obtain a working level knowledge of NFPA 70E, Article 420 requirements, to include: a. Wiring methods – Bonding of enclosures, temporary wiring, and permitted use of cable trays; b. Safety positioning and connection of switches; c. Switch/panelboard location and access requirements; d. Enclosures for damp and wet locations; e. Conductor identification requirements; f. Permitted and non-permitted use of flexible cords and cables; g. Portable cables over 600 volts; h. Motor, transformer, and capacitor general use equipment.		
6. Obtain a working level knowledge of the DOE Electrical Safety Handbook for safety requirements associated with site R&D operations involving large capacity stored energy, inductor, capacitor and pulsed energy systems to include requirements relating to: a. Hazards identification, classification, PPE, and associated work practices; b. Equipment configuration, and operational practices; c. R&D training and qualifications requirements.		
7. Obtain a working level knowledge of requirements related to safe work practices for laser operations (NFPA 70E, Chapter 3) to include: a. Fail-safe interlocks; b. Controlled areas; c. Laser characteristics; d. Safety training and qualifications; e. Safeguarding of personnel.		

Technical Qualification Program (TQP)

ELECTRICAL FUNCTIONAL AREA QUAL. STD (10/2006 Revision)

General & Specific Technical Competencies	Competency Completion Verification Method (Oral checkout, Equivalency, etc.)	Competency Achieved (Verification signature and date of Supervisor or SME)
IV. ELECTRICAL MAINTENANCE MANAGEMENT FOR NUCLEAR AND NON-NUCLAR FACILITIES (Applies only to candidates assigned oversight of electrical maintenance activities. Each competency statement is a MPA, provided that they are applicable to the candidate's assigned electrical duties.)		
1. Become familiar with Department of Energy (DOE) maintenance management requirements as defined in DOE Order 433.1, Maintenance Management Program, and DOE Guide 433.1-1.		
2. Become familiar with NFPA 70B safety requirements for Electrical Equipment Maintenance, to include: a. Electrical Preventive Maintenance program elements (Ch. 5); b. Training requirements (Ch. 5); c. Special precautions relating to electronic equipment, e.g., equipment deenergization, zero-energy checks, prevention of shock, grounding requirements for maintenance actions (Ch. 12); d. GFCI and GFPE maintenance requirements, e.g., trip tests, records keeping, approved listing of test equipment (Ch. 14); e. Testing and test methods: precautions and safety; qualifications of test operators; test equipment; protective device testing (Ch. 20); f. Deenergizing and grounding of equipment to provide protection for electrical maintenance personnel, (Ch. 23); g. Grounding requirements, e.g., symptoms and causes of inadequate grounding; grounding system inspection, testing and monitoring; and, solutions to inadequate grounding (Ch. 29). g. Discuss the importance and methods of establishing acceptance criteria for inspection and testing.		

Technical Qualification Program (TQP)

ELECTRICAL FUNCTIONAL AREA QUAL. STD (10/2006 Revision)

General & Specific Technical Competencies	Competency Completion Verification Method (Oral checkout, Equivalency, etc.)	Competency Achieved (Verification signature and date of Supervisor or SME)
3. Become familiar with the NFPA 70E, Chapter 2, safety-related maintenance requirements relating to: a. grounding and bonding; b. safety equipment and clear space requirements; c. electrical systems and components; d. hazardous locations; e. PPE; f. Identify and discuss elements of an electrical safety program , including the following • Two-man rule • Stored Energy • Component labeling		
V. ELECTRICAL DESIGN & INSTALLATION (SAFETY AND SYSTEMS) (Applies only to candidates assigned oversight of electrical design and installation activities. Each competency statement is a MPA, provided that they are applicable to the candidate's assigned electrical duties.)		

Technical Qualification Program (TQP)

ELECTRICAL FUNCTIONAL AREA QUAL. STD (10/2006 Revision)

General & Specific Technical Competencies	Competency Completion Verification Method (Oral checkout, Equivalency, etc.)	Competency Achieved (Verification signature and date of Supervisor or SME)
1. Demonstrate a working level knowledge of the current National Electrical Code, and become familiar with the requirements for wiring design and protection (NFPA 70, NFPA 70E, Chapter 4) to include: a. Use of Nationally Recognized Test Laboratory (NRTL) electrical equipment (also reference 29 CFR 1910.303 & .399, and 29 CFR 1926.403); b. Branch circuits identification; c. GFCI protection for personnel; d. Outside circuits and conductors for 600 volts (or less) systems; e. Overcurrent protection for 600 volts (or less) and greater-than 600 volts circuits; f. Grounding and bonding requirements as noted in NFPA 70E Article 410.10.		
2. Become familiar with the requirements for the Installation of Lightning Protection Systems (NFPA 780, UL 96 Lightning Protection Components, and UL 96A Installation requirements for Lightning Protection Systems).		
3. Demonstrate a working level knowledge of electrical diagrams, including: a. One-line diagrams b. Schematics c. Construction drawings d. As-built drawings e. Wiring diagrams		
4. Become knowledgeable of the Configuration Management process as applied to electrical documentation, e.g., documenting, controlling, revising, and issuance of electrical drawings. Also observed how drawings are updated and issued “as built.” (DOE STD 1073, Configuration Management, and DOE O 414.1C Quality)		

Technical Qualification Program (TQP)

ELECTRICAL FUNCTIONAL AREA QUAL. STD (10/2006 Revision)

General & Specific Technical Competencies	Competency Completion Verification Method (Oral checkout, Equivalency, etc.)	Competency Achieved (Verification signature and date of Supervisor or SME)
5. Become familiar with battery installations, maintenance, testing and replacement as described in NFPA 70E, Chapter 3, IEEE Std-450, and IEEE-C2 National Electrical Safety Code (NESC) to include: a. Connections and capacities; b. DC systems grounding and Ground-Fault Detection; c. DC circuits protection and alarms.		
6. Become familiar with ventilation and battery room requirements as cited in NFPA 70E, Chapter 3, IEEE Std-450 and IEEE C2-National Electrical Safety Code (NESC) to include: a. Ventilation requirements for different battery types; b. Battery room restrictions, barriers, illumination, and enclosure requirements; c. Battery protection requirements.		
VI. ELECTRICAL VITAL SAFETY SYSTEMS (VSS) (Applies only to candidates who are assigned an electrical VSS. Recommend applying, as appropriate, to candidates who are assigned an electrical system that performs a defense in depth/important to safety function and/or supports a nuclear related activity. Each competency statement is a MPA, provided that they are applicable to the candidate's assigned electrical duties.)		

Technical Qualification Program (TQP)

ELECTRICAL FUNCTIONAL AREA QUAL. STD (10/2006 Revision)

General & Specific Technical Competencies	**Competency Completion Verification Method** (Oral checkout, Equivalency, etc.)	**Competency Achieved** (Verification signature and date of Supervisor or SME)
1. Mandatory Performance Activity: Demonstrate a familiarity level of knowledge of 10 CFR 830 (Nuclear Safety Management), and DOE O 414.1C that relate to Electrical Safety programs, processes, and systems, to include: a. Knowledge of site Vital Safety System (VSS) interfaces for electrical, software, and instrument and control systems; b. The basic purpose of the Unreviewed Safety Question (USQ) process; c. General purpose and constitution of the Documented Safety Analysis; d. Purpose and content of Technical Safety Requirements (TSR) documentation.		
2. Demonstrate a familiarity level knowledge of all assigned Electrical Power Vital Safety Systems, and how they are addressed during the design, construction and operation of nuclear facilities. a. Mandatory Performance Activity: Walkdown electrical power vital safety systems and locate and identify major components, subsystems, and interfaces.		
3. Demonstrate a working level knowledge of the possible functional interfaces/relationships between all Electrical VSS and instrument and control safety software analysis safety software, and design safety software.		
4. Document participation with the site contractor System Engineer (SE) in a quarterly walkthrough, bi-annual status walkthrough or an assessment for all assigned Electrical Vital Safety Systems (VSS).		

Technical Qualification Program (TQP)

ELECTRICAL FUNCTIONAL AREA QUAL. STD (10/2006 Revision)

General & Specific Technical Competencies	Competency Completion Verification Method (Oral checkout, Equivalency, etc.)	Competency Achieved (Verification signature and date of Supervisor or SME)
5. Demonstrate a familiarity level knowledge of functional classifications for safety systems and the design expectations associated with electrical systems that carry these functional classifications, as described in DOE O 420.1B, Facility Safety, and its associated guide DOE G 420.1-1.		
6. Demonstrate a familiarity level knowledge of electrical safety systems criteria for Vital Safety Systems (IEEE Stds: 308-2001, 323-2003, 379-2000, 384-1992, and 603-1998; and, DOE O 420.1B and DOE G 420.1-1.)		
7. Demonstrate a familiarity level knowledge of electrical safety design requirements for Emergency, Standby, and UPS systems for VSS (IEEE Stds 387-1984, 650-1990, and 944-1986; and, DOE O 420.1B and DOE G 420.1-1).		
8. Demonstrate a familiarity level knowledge of electrical safety design requirements for VSS Accident Monitoring Instrumentation (IEEE Std 497-2002; and, DOE O 420.1B and DOE G 420.1-1).		
9. Demonstrate a familiarity level knowledge of electrical safety design requirements for VSS Motor Control Centers (IEEE Std 649-1991; and, DOE O 420.1B and DOE G 420.1-1).		
10. Demonstrate a familiarity level knowledge of electrical safety design requirements for Digital Computers supporting VSS (IEEE Std 7-4.3.2-2003, Annex E; and, DOE O 420.1B and DOE G 420.1-1).		
11. Demonstrate a familiarity level knowledge of electrical safety design requirements for VSS Protection Systems (IEEE Std 741-1997, and 833-1988; and, DOE O 420.1B and DOE G 420.1-1).		
12. Demonstrate a familiarity level knowledge of electrical safety design requirements for Instrumentation and Control Equipment Grounding of VSS (IEEE Std 1050-1996; and, DOE O 420.1B and DOE G 420.1-1).		

Technical Qualification Program (TQP)

ELECTRICAL FUNCTIONAL AREA QUAL. STD (10/2006 Revision)

General & Specific Technical Competencies	Competency Completion Verification Method (Oral checkout, Equivalency, etc.)	Competency Achieved (Verification signature and date of Supervisor or SME)
13. Demonstrate a familiarity level knowledge of electrical safety design requirements for VSS Motor Operated Valves (IEEE Std 1290-1996; and, DOE O 420.1B and DOE G 420.1-1).		
ADDITIONAL REQUIRED READING		
1. Obtain a clear understanding of electrical safety requirements and practices in the following list of regulatory and consensus standards documents, including the relationship between these documents and which are "enforceable" in your site's contractors contract. OSHA (29 CFR 1910 and Subpart S, and 29 CFR 1926 Subparts K and V), NFPA 70E, Standard for Electrical Safety in the Workplace/Maintenance, NFPA-70B, Recommended Practice of Electrical Equipment Maintenance, DOE-HDBK-1092, DOE Electrical Safety Handbook; and 10 CFR 851, Worker Safety and Health Program.		
2. Demonstrate a familiarity level knowledge of Department of Energy, DOE Order 414.1C, Quality Assurance, as it pertains to electrical systems. a. Mandatory Performance Activity: Describe how electrical equipment is procured based upon its safety function and/or nuclear related activity using quality assurance criteria and appropriate national or international consensus standards.		
3. Demonstrate a familiarity level of knowledge of Department of Energy, DOE Order 430.1B, Real Property Asset Management, with regard to life cycle asset management.		

Technical Qualification Program (TQP)
ELECTRICAL FUNCTIONAL AREA QUAL. STD (10/2006 Revision)

Electrical Safety and Systems Functional Area Qualification Standard

I have reviewed the TQP and understand/concur with its commitments.

_____
Candidate Date

I have completed all activities as outlined in the TQP.

_____
Candidate Date

Final Approval Sign Off

1st Level Supervisor Sign Off: _____

2nd Level Supervisor Sign Off: _____

HRM Review

HRM TQP Coordinator: _____

Date: _____

CONCLUDING MATERIAL

Review Activity:
DOE
DP-NNSA
EH
EM
NE
NN-NNSA
SC
FE

Field and Operations Offices
AL
CH
ID
Fernald
NV
OAK
OH
OR
RF
RL
SF
SR
Carlsbad Field Office (CBFO)
Office of River Protection (ORP)

Preparing Activity:
RL

Project Number:
TRNG-0050

Area Offices:
Amarillo Area Office
Argonne Area Office
Brookhaven Area Office
Fermi Area Office
Kirtland Area Office
Los Alamos Area Office
Princeton Area Office
Rocky Flats Area Office
Y-12 Area Office