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Photovoltaic System Inspector Job Task Analysis Guide

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NABCEP Photovoltaic System Inspector

Job Task Analysis

Introduction

This document presents a comprehensive Job Task Analysis (JTA) for individuals who inspect photovoltaic systems on buildings. It is important to note that these tasks are applicable to individuals assessing the safety and operation of PV systems. Individuals who are familiar with PV systems and are knowledgeable of associated codes and ordinances must be able to verify code compliance via interpretation of design plans and building documents, conduct on-site inspections, and report results.

This JTA introduces a specialty credential providing a mechanism for inspection professionals to demonstrate their knowledge in the solar energy industry. The industry has grown and matured over the past decade and this document reflects these changes in job roles.

Content Domains and Examination Specifications

The NABCEP PV System Inspector JTA comprises 15 tasks organized into four performance domains. The domains and their respective examination weights are listed below.

I.	***Inspecting Electrical Components and Systems (44%)***
II.	***Inspecting Energy Storage Components and Systems (21%)***
III.	***Inspecting Mechanical/Structural Components and Systems (21%)***
IV.	***Documentation for the System Inspection (14%)***

NABCEP expects candidates for the PV System Inspector Exam to be experienced renewable energy practitioners. Those working in an Authority Having Jurisdiction (AHJ), must also be familiar with PV solar energy designs, systems and health and safety measures.

Job Description

for NABCEP PV System Inspectors

A Photovoltaic System Inspector (PVSI) is responsible for inspecting residential and commercial photovoltaic systems. They provide inspection services for Authorities Having Jurisdiction (AHJ), utilities, state incentive programs, and financing companies. A PVSI is familiar with PV systems and knowledgeable of applicable codes and ordinances, and is tasked with assessing the safety and operation of a PV system. They verify code compliance via interpretation of design plans and building documents, conduct on-site inspections, and report results.

It is expected that all individuals who achieve NABCEP PV System Inspector Certification will be familiar with and capable of executing all the tasks described as “critical.” It is further expected that all individuals will be familiar with all the tasks described as “important”. These tasks may not be performed on all installations but are an important part of the PV System Inspector’s body of knowledge. Those tasks that are described as “useful” may or may not be present during an inspection and are listed in the Job Task Analysis primarily for the benefit of those wishing to ensure they have the broadest possible knowledge of the tasks associated with PV System Inspections.

Category and Priority of Task Steps Used by Photovoltaic System Inspectors

I. INSPECTING ELECTRICAL COMPONENTS AND SYSTEMS

I. A. Visually Verify System Labeling Meets Applicable Codes To Ensure Safety

1.1	Confirm AC interconnection point is properly labeled.	Critical
1.2	Confirm labels are of sufficient durability to withstand the environment involved.	Critical
1.3	Confirm DC raceways are properly labeled.	Important
1.4	Confirm DC disconnects are properly labeled.	Important
1.5	Confirm AC disconnects are properly labeled.	Important
1.6	Confirm the main service panel is properly labeled.	Important
1.7	Confirm the inverter or other power conditioning units are properly labeled.	Important
1.8	Confirm labels pertaining to the ungrounded system are in place (if applicable).	Important
1.9	Confirm the rapid shutdown system is properly labeled (if applicable).	Important
1.10	Confirm labels are the proper color and in legible print (not handwritten).	Useful

Knowledge of

a. PV system components and circuits
b. NEC Code labeling requirements
c. Local AHJ and utility labeling requirements
d. Basic electrical safety
e. Manufacturers' specifications and technical documentation

I. B. Visually And Physically Verify Installed Components Match Those On The Approved Plans And Adhere To Applicable Codes And Standards.

2.1	Verify working clearances on components.	Critical
2.2	Ensure all components are listed, labeled, and identified for use.	Critical
2.3	Verify model numbers of components.	Important
2.4	Confirm the number of PV modules.	Important
2.5	Verify the National Electrical Manufacturer's Association (NEMA) rating (indoor/outdoor/hazardous environment).	Important
2.6	Confirm the location of components matches the plans.	Important

Knowledge of

a. PV system components and circuits
b. Applicable codes and standards
c. Manufacturers' specifications and technical documentation
d. Required working clearances for components
e. Design documentation
f. NEMA ratings
g. Basic electrical safety

I.C. Visually And Physically Inspect Conductors And Raceways To Ensure Safety And Compliance To Applicable Codes.

3.1	Verify conductor ampacity is appropriate for circuit current.	Critical
3.2	Verify the conductor type is suitable for the location and environment.	Critical
3.3	Verify the conductor voltage rating for the circuit.	Critical
3.4	Verify installation of conduit expansion joints based on length.	Critical
3.5	Ensure raceway connections are suitable for the location and environment.	Critical
3.6	Verify conductor color is correct.	Important
3.7	Verify conduit size is suitable based on conduit fill.	Important
3.8	Verify raceway type is suitable for the location and environment.	Important
3.9	Ensure raceways are secured and supported properly.	Important

Knowledge of

a. PV system components and circuits
b. Circuit current calculations
c. Conductor ampacity calculations
d. Conductor coloring
e. System voltage calculations
f. Conduit fill calculations
g. Raceway suitability for environmental conditions
h. Expansion joint calculations
i. Raceway support code requirements
j. Basic electrical safety
k. Conductor properties
l. Manufacturers' specifications and technical documentation

I. D. Assess Conductor Terminations For Integrity And Compatibility Of Components To Ensure Safety

4.1	Verify conductor size and type are appropriate for the terminal.	Critical
4.2	Verify the conductor and terminal materials are compatible.	Critical
4.3	Verify the connection is secure.	Critical
4.4	Verify the termination device is rated for the voltage and current of the circuit.	Critical

Knowledge of

a. PV system components and circuits
b. Terminal and conductor compatibilities
c. Basic electrical safety
d. Conductor properties
e. Manufacturers' specifications and technical documentation

I. E. Ensure The Integrity Of The Grounding System By Visually And Physically Verifying Continuity To Ensure Safety And Compliance With Applicable Codes

5.1	Ensure all non-current carrying metallic components are grounded.	Critical
5.2	Ensure the grounding electrode is properly installed.	Critical
5.3	Check the inverter or power conditioning unit for ground fault error when in operation.	Critical
5.4	Ensure the equipment grounding conductor (EGC) is appropriately sized.	Important
5.5	Ensure the grounding electrode conductor (GEC) is continuous and appropriately sized.	Important

Knowledge of

a. Grounding and bonding principles
b. PV system grounding components and circuits
c. Applicable codes and standards
d. Manufacturers' specifications and technical documentation
e. Potential hazards if ground fault is indicated
f. Basic electrical safety

I. F. Visually And Physically Inspect The Point Of Pv System Interconnection With The Utility Grid For Compliance With Applicable Codes, Following Standard Electrical Safety Practices

6.1	Verify the interconnection devices are appropriate for use.	Critical
6.2	Verify the maximum current fed to the busbar does not exceed code limitations.	Critical
6.3	Verify the proper installation of the overcurrent protection device for the supply-side interconnection.	Critical
6.4	Confirm the location of interconnection devices.	Important

Knowledge of

a. PV system components and circuits
b. AC power distribution systems
c. Applicable codes and standards
d. Manufacturers' specifications and technical documentation
e. Basic electrical safety

I. G. Verify Proper Sizing And Ratings Of Overcurrent Protection Devices Per Applicable Codes And Standards To Ensure Safety

7.1	Confirm voltage limitations of the overcurrent protection devices.	Critical
7.2	Confirm circuit current calculations.	Critical
7.3	Confirm characteristics of existing electrical distribution system.	Critical
7.4	Confirm the allowable interrupting current ratings of overcurrent protection devices.	Critical
7.5	Confirm the selection of overcurrent protection enclosures.	Important
7.6	Confirm current limits of overcurrent protection devices.	Important

Knowledge of

a. PV system components and circuits
b. Applicable codes
c. PV circuit current calculations
d. Overcurrent protection device sizing calculations
e. Basic electrical safety
f. Manufacturers' specifications and technical documentation

II. INSPECTING ENERGY STORAGE COMPONENTS AND SYSTEMS

II. A. Verify PV Array Design And Control Per Applicable Codes And Standards To Ensure Safety

1.1	Verify conductor sizing is appropriate for array and charge controller ampacity.	Critical
1.2	Verify the size and rating of overcurrent protection devices (OCPD) for array and charge controller conductors.	Critical
1.3	Confirm the charge controller is suitable for the type of storage used.	Important

Knowledge of

a. String voltages and available currents
b. Series and parallel DC circuits
c. Applicable codes and standards
d. Manufacturers' specifications and technical documentation

II. B. Verify The Energy Storage System Design And Installation Adheres To Applicable Codes And Standards To Ensure Safety

2.1	Verify the mechanical enclosure is sufficient to support the weight of the battery bank.	Critical
2.2	Verify the grounding of any metal structures.	Critical
2.3	Verify proper working clearance around batteries.	Critical
2.4	Verify the battery enclosure has appropriate ventilation when required.	Critical
2.5	Confirm the battery conductors and terminals are compliant and conductor insulation is appropriate.	Critical
2.6	Verify seismic structural requirements meet applicable codes and standards.	Important
2.7	Ensure the provision for the containment of battery acid if appropriate.	Important
2.8	Verify the battery disconnect location.	Important
2.9	Verify the battery overcurrent protection device(s) (OCPD) are appropriate for inverter output.	Important
2.10	Verify code-compliant labeling.	Important

Knowledge of

a. String voltages and available currents
b. Series and parallel DC circuits
c. Different storage technologies and their theories of operation
    i. Batteries and types
    ii. Kinetic storage
d. Different battery technologies and ventilation requirements
e. Applicable codes and standards
f. Manufacturers' specifications and technical documentation

II. C. Verify The Operation Of The Multi-Mode Inverter Complies With Applicable Codes And Standards To Ensure Safety

3.1	Verify the proper installation and usage of the multimode inverter.	Important
3.2	Verify the proper interconnection of system components.	Important

Knowledge of

a. String voltages and available currents
b. Series and parallel DC circuits
c. Battery-based inverter power flow
d. Applicable codes and standards
e. Manufacturers' specifications and technical documentation

II. D. Verify The Inverter AC Connections Comply With Applicable Codes And Standards To Ensure Safety

4.1	Verify the proper AC overcurrent protection devices (OCPD) and conductors.	Critical
4.2	Verify the overcurrent protection device is sized properly for bidirectional current flow at grid connection.	Critical
4.3	Verify the installation and rating of the critical load panel.	Critical
4.4	Verify proper generator sizing and interconnection as required.	Important

Knowledge of

a. String voltages and available currents
b. Series and parallel DC circuits
c. Energy storage system inverter power flow
d. Applicable codes and standards
e. Manufacturers' specifications and technical documentation

III. INSPECTING MECHANICAL/STRUCTURAL COMPONENTS AND SYSTEMS

III. A. Inspect Roof-Mounted Components And Systems To Verify Integrity And Compliance With Applicable Codes To Ensure Longevity And Safety

1.1	Verify quantity and type of attachment points for racking.	Critical
1.2	Verify the integrity of structural members.	Critical
1.3	Verify the proper use of any dissimilar metals to avoid corrosion and deterioration.	Critical
1.4	Verify ballast weights and placement.	Critical
1.5	Inspect flashing and weather sealing.	Critical
1.6	Verify module attachments meet listing requirements.	Critical
1.7	Verify equipment is installed securely and meets listing requirements.	Critical
1.8	Verify junction boxes and disconnects are mounted securely and meet listing requirements.	Critical
1.9	Verify the racking system is properly mounted and meets listing requirements.	Critical
1.10	Inspect modules for physical damage.	Critical
1.11	Verify the rooftop array configuration meets setback requirements as defined by applicable codes and standards.	Critical
1.12	Verify the location of attachment points.	Important
1.13	Verify the integrity of attachment points into/on the structure.	Important
1.14	Verify the array structure is level and plumb.	Useful

Knowledge of

a. Manufacturers' specifications and technical documentation
b. Applicable codes and standards
c. Design documentation
d. Safety practices
e. Roofing best practices
f. Corrosive properties of metals

III. B. Inspect Ground-Mounted Components And Systems To Verify Integrity And Compliance With Applicable Codes To Ensure Longevity And Safety

2.1	Verify the proper use of any dissimilar metals to avoid corrosion and deterioration.	Critical
2.2	Verify module attachments meet listing requirements.	Critical
2.3	Verify equipment is installed securely and meets listing requirements.	Critical
2.4	Verify DC conductors are not readily accessible.	Critical
2.5	Confirm foundation inspection documentation if applicable.	Important
2.6	Verify the ground-mounted array location meets setback requirements as defined by local jurisdictional requirements.	Useful

Knowledge of

a. Manufacturers' specifications and technical documentation
b. Applicable codes and standards
c. Design documentation
d. Safety practices
e. Geotechnical reports
f. Corrosive properties of metals

IV. DOCUMENTATION FOR THE SYSTEM INSPECTION

IV. A. Review Permit Package For Accuracy, Completeness, And Compliance With Applicable Codes To Ensure A Safe And Functioning System Design

1.1	Verify a site diagram includes the location of major components.	Important
1.2	Verify the electrical diagram includes information on electrical components, wiring methods, and electrical connection to the utility service.	Important
1.3	Verify string sizing for compatibility with the inverter or other power conditioning unit.	Important
1.4	Ensure the permit package includes the specification sheets for major components.	Useful
1.5	Verify the permit plans identify an array that is mounted on a code-compliant and permitted structure.	Useful
1.6	Verify the permit plans identify a mounting system.	Useful

Knowledge of

a. Reading blueprints
   i. Architectural
   ii. Structural
   iii. Mechanical
   iv. Electrical
b. Electrical schematics and symbols
c. PV components
d. Applicable codes and standards
e. Local permit process
f. String sizing calculations
g. Manufacturers' specifications and technical documentation

IV. B. Quantify And Report Deviations Of The Installed System From Design Documentation And Applicable Codes And Standards For Various Stakeholders

2.1	Report any deviation from the manufacturer's specifications.	Critical
2.2	Report any code violations.	Critical
2.3	Report any deviation from submitted design documentation.	Important
2.4	Present supporting documentation (e.g., photographs, measurements, technical documents, code reference).	Important

Knowledge of

a. Reading blueprints
   - *i. Architectural*
   - *ii. Structural*
   - *iii. Mechanical*
   - *iv. Electrical*

b. Electrical schematics and symbols
c. PV components
d. Local and national building codes
e. National Electric Code
f. Applicable standards for component safety
g. OSHA safety requirements
h. Local permit process
i. Manufacturers' specifications and technical documentation

PRIMARY REFERENCES

- 2014 National Electrical Code® (NEC®), NFPA 70 or 2014 National Electrical Code® Handbook, National Fire Protection Association®, www.nfpa.org
- Code of Federal Regulations, Chapter 29 Part 1926 – Safety and Health Regulations for Construction, Occupational Safety and Health Administration, www.osha.gov
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- Soares Book on Grounding and Bonding, 12th Edition 2014, International Association of Electrical Inspectors, www.iaei.org
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- 2014 Understanding NEC Requirements for Solar Photovoltaic Systems, by Mike Holt, Mike Holt Enterprises, Inc, www.mikeholt.com

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North American Board of Certified Energy Practitioners
56 Clifton Country Road, Suite 202 / Clifton Park, NY 12065
800-654-0021 / info@nabcep.org

www.nabcep.org