



NABCEP[®]

Photovoltaic Specialists: Job Task Analysis Photovoltaic Design, Photovoltaic Installer, Photovoltaic Commissioning & Maintenance

September 2017

Introduction

This document presents a comprehensive Job Task Analysis (JTA) for PV Specialists who perform decision making roles with respect to the design, installation and commissioning & maintenance of Photovoltaic (PV) systems. NABCEP Specialist Credentials all relate to PV installation. The PV Design Specialist, PV Installer Specialist and the PV Commissioning and Maintenance Specialist Certifications each focus on one domain from the NABCEP PV Installation Professional classification system. The Exams were formulated by Subject Matter Experts with input from a wide range of individuals working in the industry.

Who Are NABCEP PV Specialists?



PV Design Specialist (PVDS)

Experts at configuring the electrical design of a project. In assessing the project site, PVDS will be able to design both the mechanical and electrical design components with confidence, accuracy and safety.



PV Installer Specialist (PVIS)

Highly competent with all aspects of PV installation including DC and AC PV system conductors and grounding and bonding systems. As with all NABCEP credentials, safety standards and plans are of critical importance.



PV Commissioning and Maintenance Specialist (PVCMS)

NABCEP PVCMS Specialists combine the skill sets of operations, maintenance and commissioning tasks into one job specialty. Exceptional application of verification protocols and preventive and corrective maintenance operations are key to this Certification.

Scope of the JTAs

NABCEP Certified PV Specialists work in a variety of responsible roles on PV installation jobs. Varying sizes and complexities of installations calls for a wide range of duties required of any PV Installation Professional.

The NABCEP Specialist Exams are designed to narrow the scope of duties while elevating the competency of the specified technology.

Task Steps & Knowledge

Individuals who achieve a NABCEP Specialist Certification will be familiar with and capable of executing all the tasks listed in the specific examination content outline below. These tasks may not be performed on every project but they are an important part of a body of knowledge.

Content Domains and Examination Specifications

PV Design Specialist

Description	Percent of Test
Review customer expectations.....	12%
Review project criteria.....	12%
Assess project site	15%
Configure mechanical design.....	13%
Configure electrical design.....	17%
Configure system monitoring, control, and communications design	7%
Prepare project documentation	8%
Secure permits and approvals	8%
Adapt system design	8%

PV Installer Specialist

Description	Percent of Test
Develop safety plan.....	8%
Safeguard against hazards.....	10%
Install raceways.....	7%
Install electrical equipment	8%
Install DC PV system conductors	8%
Install AC PV system conductors	8%
Install grounding & bonding.....	10%
Complete utility interconnection point.....	8%
Install system monitoring, control, and communication hardware	3%
Install battery equipment	7%
Install ground-mounted structure	5%
Install building-mounted system.....	8%
Install PV modules	8%

PV Commissioning & Maintenance Specialist

Description	Percent of Test
Review or develop commissioning protocol.....	10%
Complete visual and mechanical inspection.....	12%
Conduct mechanical tests.....	8%
Conduct electrical tests	15%
Verify system operation	10%
Confirm project completion.....	8%
Orient end user to system	8%
Verify system operation and performance.....	8%
Perform preventive maintenance	10%
Perform corrective maintenance.....	10%



CATEGORIES PER PV SPECIALTY EXAM

PV Design Specialist (PVDS)

PVDS Task 1: Review Customer Expectations

Knowledge of:

- a. Equipment location
- b. Aesthetic concerns
- c. Electric loads assessment (e.g., new construction, multi-modal and stand-alone systems)
- d. System functionality and performance requirements
- e. Value engineering

PVDS Task 2: Review Project Criteria

Knowledge of:

- a. Authorities having jurisdiction criteria (e.g., codes, standards, covenants, and regulations)
- b. Electric service provider criteria (e.g., utilities, co-ops, third-party providers)
- c. Construction plan sets and project specification documents

PVDS Task 3: Assess Project Site

Knowledge of:

- a. Characteristics of appropriate array locations
- b. Characteristics of viable roof surfaces
- c. Live and dead load characteristics of PV arrays
- d. Common roof structural design
- e. Drilling and trenching equipment capabilities
- f. Characteristics of appropriate equipment locations
- g. Types of electrical services
- h. Point of interconnection
- i. Raceway installation parameters
- j. Effect of obstructions
- k. Construction site hazards
- l. Characteristics of appropriate staging/lifting/access locations
- m. Shading analysis tools and techniques
- n. Azimuth measurement tools
- o. Magnetic declination
- p. Slope tools and techniques
- q. Building use and dimensions
- r. Effects of wind exposure
- s. Required site information documentation

PVDS Task 4: Configure Mechanical Design

Knowledge of:

- a. PV system performance simulation software
- b. Basic algebra, geometry, and trigonometry calculations (e.g., area, slope, inter-row shading, withdrawal loads)
- c. Characteristics of racking systems
- d. Fastener selection criteria (e.g., types, sizes)
- e. Structure attachment criteria (e.g., spacing, quantity, type)
- f. Waterproofing and flashing methods and materials
- g. Existing and allowable loads (e.g., snow load, seismic)
- h. Design principles of ground mount foundations
- i. Effect of PV module tilt and orientation
- j. Characteristics of PV module technologies
- k. Methods for equipment racking and/or installation
- l. Criteria for placement of energy storage systems
- m. Pathways and setbacks (e.g., walkways, clearances, accessibility)

PV DESIGN SPECIALIST (PVDS)

PVDS Task 5: Configure Electrical Design

Knowledge of:

- a. Inverter selection criteria (e.g., types of inverters, DC to AC ratio)
- b. String size calculations and layout
- c. DC circuit sizing formulas (e.g., PV source and output circuits, battery cables)
- d. AC circuit sizing formulas (e.g., inverter output circuit, feeders)
- e. Module level power electronics (MLPE)
- f. Voltage drop calculations
- g. Methods of interconnection (e.g., supply-side connection, load-side connection)
- h. Conductor properties and types
- i. Raceway selection criteria and calculations
- j. Raceway installation methods
- k. Source circuit combining methods (e.g., combiner boxes, wire harnesses)
- l. Overcurrent protection selection criteria
- m. Electrical enclosure selection criteria
- n. Panelboard selection criteria
- o. Disconnect selection criteria
- p. Grounding system criteria and components
- q. Rapid shutdown equipment and methods
- r. Arc-fault protection equipment and methods
- s. Characteristics of battery technologies
- t. Characteristics of charge controllers
- u. Characteristics and components of AC coupled systems
- v. Energy storage system sizing and performance calculations
- w. Power requirements of auxiliary systems (including backup power)

PV Installer Specialist Examination (PVIS)

PVIS Task 1: Develop Safety Plan

- a. OSHA requirements (e.g., fall protection, competent/qualified person, reporting of incidents)
- b. NFPA 70E (National Fire Protection Association—Standard for Electrical Safety in the Workplace)
- c. Personal protective equipment (PPE) (e.g., specific equipment required for project, maintenance of PPE)
- d. Material safety data sheet (MSDS)
- e. Emergency response resources and protocols
- f. Weather event response actions
- g. Specific equipment and training required for site
- h. Elements of an effective safety meeting

PVIS Task 2: Safeguard Against Hazards

Knowledge of:

- a. NFPA 70E (National Fire Protection Association—Standard for Electrical Safety in the Workplace)
- b. OSHA CFR 29 1926 safety standards
- c. Proper care and use of safety equipment (e.g., life cycle, defects, storage)
- d. Proper care and use of test equipment (e.g., life cycle, defects, storage)
- e. Proper care and use of power tools (e.g., life cycle, defects, storage)
- f. Safe work practices

Skill in:

** Effectively implementing the site specific safety plan*

PVIS Task 3: Install Raceways

Knowledge of:

- a. NFPA 70 (NEC) articles for use, installation, and construction specifications for raceways and associated fittings
- b. Raceway manufacturer specifications and installation requirements
- c. Proper raceway selection and sizing
- d. Proper installation and labeling of raceways per NFPA 70/AHJ requirements (e.g., expansion joints, physical protection)
- e. Neat and workmanlike manner of installation of raceways
- f. Plan sets and schematics

Skill in:

** Confirming raceway routing per plans and client input*

PV INSTALLER SPECIALIST (PVIS)

PVIS Task 4: Install Electrical Equipment

Knowledge of:

- a. NFPA 70 (NEC) articles for use, installation, and construction specifications for equipment and associated fittings
- b. Equipment manufacturer specifications and installation requirements
- c. Neat and workmanlike manner of installation of electrical equipment
- d. Proper installation and labeling of equipment per NFPA 70 requirements
- e. Plan sets and schematics

Skill in:

- * *Confirming equipment suitability and placement per plans and client input*
- * *Providing and maintaining access and working space around all electrical equipment*
- * *Interpreting construction plans (e.g., electrical plans, schematics, line diagrams)*

PVIS Task 5: Install DC P System Conductors

Knowledge of:

- a. NFPA 70 (NEC) articles for use, installation, and construction specifications for DC conductors
- b. NFPA 70E (National Fire Protection Association—Standard for Electrical Safety in the Workplace)
- c. Equipment manufacturer specifications and installation requirements
- d. Appropriate conductor installation and pulling practices
- e. Wire management in a neat and workmanlike manner
- f. Termination and connection per manufacturer specifications

Skill in:

- * *Conducting field verification of proper conductor identification, size, color, type, and rating*
- * *Properly identifying and labeling DC conductors per plan set and NFPA 70 requirements*
- * *Conducting string sizing and string configuration per plans and manufacturer specifications*

PVIS Task 6: Install AC PV System Conductors

Knowledge of:

- a. NFPA 70 (NEC) articles for use, installation, and construction specifications for AC conductors
- b. NFPA 70E (National Fire Protection Association—Standard for Electrical Safety in the Workplace)
- c. Conductor manufacturer specifications and installation requirements
- d. Appropriate conductor installation and pulling practices
- e. Wire management in a neat and workmanlike manner
- f. Termination and connection per manufacturer specifications

Skill in:

- * *Conducting field verification of proper conductor identification, size, color, type, and rating*
- * *Properly identifying and labeling AC conductors per plan set and NFPA 70 requirements*

PV INSTALLER SPECIALIST (PVIS)

PVIS Task 7: Install Grounding and Bonding Systems

Knowledge of:

- a. NFPA 70 (NEC) articles for use, installation, and construction specifications for grounding and bonding
- b. Proper installation of bonding and bonding jumpers
- c. Grounding systems and certifications (e.g., UL 2703, integrated bonding)

Skill in:

- * *Conducting field verification of existing grounding electrode systems*
- * *Installing proper system grounding per NFPA 70 and manufacturer specifications (grounding electrode conductor [GEC])*
- * *Installing proper equipment grounding per NFPA 70 and manufacturer specifications (equipment grounding conductor [EGC])*

PVIS Task 8: Complete Utility Interconnection Point

Knowledge of:

- | | |
|---|--|
| <ol style="list-style-type: none">a. NFPA 70 (NEC) articles for use, installation, and construction specifications for utility interconnectionb. OSHA safety standardsc. NFPA 70E (National Fire Protection Association—Standard for Electrical Safety in the Workplace)d. Calculation and verification of OCPD overcurrent protection device (OCPD) and disconnecting means | <ol style="list-style-type: none">e. Effective and efficient communication regarding shutdown and inspection processesf. Proper termination of conductors per manufacturer specificationsg. Local electric service provider requirements for interconnectionh. Methods of interconnection |
|---|--|

Skill in:

- * *Effectively implementing the site-specific safety plan*

PVIS Task 9: Install System Monitoring, Control, and Communication Hardware

Knowledge of:

- | | |
|---|--|
| <ol style="list-style-type: none">a. NFPA 70 (NEC) articles for use, installation, and construction specificationsb. Cable manufacturer specifications and installation requirementsc. Monitoring equipment manufacturer specifications and installation requirements | <ol style="list-style-type: none">d. Neat and workmanlike installation of monitoring equipmente. Types and methods of data communication hardwaref. Manufacturer specifications and approved plan setsg. Termination and connection per manufacturer specifications |
|---|--|

Skill in:

- * *Confirming monitoring equipment placement per plans and with client*
- * *Conducting field verification of final system configuration*
- * *Conducting field verification of proper cable identification, size, type, and rating*
- * *Installing equipment per manufacturer specifications and approved plan sets*
- * *Preparing monitoring system for commissioning*

PV INSTALLER SPECIALIST (PVIS)

PVIS Task 10: Install Battery Equipment

Knowledge of:

- a. NFPA 70 (NEC) articles for use, installation, and construction specifications for batteries
- b. OSHA safety standards
- c. NFPA 70E (National Fire Protection Association—Standard for Electrical Safety in the Workplace)
- d. Proper installation of batteries and battery equipment (e.g., labeling, spill kits, enclosure, ventilation)
- e. Neat and workmanlike manner of installation of battery equipment
- f. Proper conductor installation, routing, identification, size, color, type, and rating
- g. Proper battery handling, storage, future maintenance, and installation techniques

Skill in:

- * *Implementing the site-specific safety plan*
- * *Confirming battery equipment placement per plans and client input*
- * *Installing batteries and battery-related equipment per manufacturer specifications*
- * *Conducting field verification of proper conductor identification, size, color, type, and rating*

PVIS Task 11: Install Ground-Mounted Structure

Knowledge of:

- a. NFPA 70 (NEC)
- b. Authorities having jurisdiction criteria (e.g., codes, standards, zoning, covenants, regulations)
- c. OSHA safety standards
- d. Ground-mounted structure manufacturer specifications and installation requirements
- e. Module manufacturer mounting specifications and installation requirements
- f. Foundation and structural elements (e.g., geotechnical requirements)
- g. Construction and assembly of PV structure and racking
- h. Neat and workmanlike manner of installation
- i. Coordination of foundation, trench, and pad inspections
- j. Location of underground utilities (e.g., call ahead, underground locator services)
- k. Environmental impact (e.g., protected species, water management)
- l. Site protection and restoration (e.g., straw and seed)
- m. Earth moving equipment

Skill in:

- * *Managing excavation to design specifications (e.g., trenching, piers, foundations)*

PV INSTALLER SPECIALIST (PVIS)

PVIS Task 12: Install Ground-Mounted Structure

Knowledge of:

- a. Authorities having jurisdiction criteria (e.g., codes, standards, zoning, covenants, regulations)
- b. OSHA safety standards (fall protection, hoisting, scaffolding)
- c. Racking manufacturer specifications and installation requirements
- d. Roofing systems manufacturer specifications, warranty, and installation requirements
- e. Mounting surface compositions (e.g., tile, composite, membrane, metal)
- f. Mounting surface and structure protection and restoration
- g. Array layouts per location (e.g., inter-row shading, electrical efficiency)
- h. Neat and workmanlike manner of installation
- i. Types of roofing system construction
- j. Lightning protection systems
- k. Staging materials and equipment (e.g., roof or other structure loading, security)
- l. Waterproofing building penetrations

Skill in:

- * *Effectively implement the site-specific safety plan*
- * *Interpreting and applying approved design (e.g., engineered drawings, manufacturer specifications)*
- * *Installing points of attachment to roof manufacturer requirements*

PVIS Task 13: Install PV Modules

Knowledge of:

- a. NFPA 70E (National Fire Protection Association—Standard for Electrical Safety in the Workplace)
- b. OSHA safety standards (e.g., fall protection, ladder use, lifting)
- c. Neat and workmanlike manner of installation (e.g., coplanar, square)
- d. Manufacturer specifications for installation of modules
- e. Proper module handling and preparation
- f. Proper wire management methods and materials
- g. Termination and connection per manufacturer specifications
- h. Grounding and bonding (e.g., integrated grounding, bonding washers, lugs)
- i. Regional considerations (e.g., animal guarding, ice and snow, wind)

Skill in:

- * *Effectively implementing the site-specific safety plan*
- * *Conducting field verification of equipment selection (e.g., nameplate, racking compatibility)*

NABCEP PV Commissioning & Maintenance Specialist (PVCMS)

PVCMS Task 1: Review or Develop Commissioning Protocol

Knowledge of:

- a. Applicable standards (e.g., manufacturer recommendations, building system, IEC 62446-1, performance testing)
- b. NFPA 70E (National Fire Protection Association—Standard for Electrical Safety in the Workplace)
- c. Contract requirements and intent of design
- d. Project-specific requirements
- e. Test equipment

PVCMS Task 2: Complete Visual and Mechanical Inspection

Knowledge of:

- a. Project design
- b. Manufacturer requirements
- c. NEC and local AHJ requirements
- d. Electric service provider requirements (e.g., disconnecting means, interconnection method, equipment location, labeling requirements)

Skill in:

* *Verifying installation per project design and requirements*

PVCMS Task 3: Conduct Mechanical Tests

Knowledge of:

- a. Installation per torque specifications
- b. Field testing (e.g., pull on driven piles, soil test, concrete slump test)
- c. Witness testing (e.g., module wind or snow loading)

PVCMS Task 4: Conduct Electrical Tests

Knowledge of:

- | | |
|--|---|
| a. Proper use of diagnostic tools (e.g., multimeter, insulation resistance tester) | g. Continuity testing |
| b. Insulation resistance testing | h. Ground resistance test |
| c. Polarity testing | i. Wire termination torque verification |
| d. DC string open circuit voltage (Voc) testing | j. AC voltage testing |
| e. DC string maximum power current (Imp) testing | k. Witness testing (e.g., functionality of relay, communication to utility, anti-islanding) |
| f. DC string short circuit (Isc) testing | |

PV COMMISSIONING & MAINTENANCE SPECIALIST (PVCMS)

PVCMS Task 5: Verify System Operation

Knowledge of:

- a. Manufacturer startup procedure
- b. Acceptance test and/or performance verification test
- c. Impact of site conditions on testing (e.g., cell temperature readings, plane of array irradiance, power output)
- d. Proper use and calibration requirements of testing equipment

Skill in:

- * *Programming system electronics (e.g., charge controller set points, firmware updates, monitoring system connection, inverter)*
- * *Calculating expected electrical parameters and comparing to measured values*

PVCMS Task 6: Confirm Project Completion

Knowledge of:

- | | |
|--|--|
| <ol style="list-style-type: none">a. Finalized documentation (e.g., commission report, signed permits, permission to operate [PTO], photographs)b. Close-out procedures (e.g., punch lists, contract reconciliation, demobilization)c. Owner sign-off requirements (e.g., appropriate site condition, customer satisfaction)d. Accounting requirements (e.g., payment approval, billing, cost coding) | <ol style="list-style-type: none">e. Warranty and owner's documents (e.g., manuals, specification sheets, signed permits)f. Equipment identification requirements (e.g., labeling, tags, signage)g. Operation instructions and/or training for ownerh. Lien releasei. Warranty terms and coveragej. System design, operation, and performance metrics (e.g., performance ratio) |
|--|--|

PVCMS Task 7: Orient End User to System

Knowledge of:

- a. Safe startup, operation, and shutdown procedures
- b. Emergency procedures
- c. Location of components
- d. Monitoring access

Skill in:

- * *Explaining system operation and limitations (e.g., training, operational indicators)*
- * *Reviewing system and project documentation with end user*

PV COMMISSIONING & MAINTENANCE SPECIALIST (PVCMS)

PVCMS Task 8: Verify System Operation Performance

Knowledge of:

- a. Access to system monitoring, control, and communications platform(s)
- b. Platform settings and alert mechanisms
- c. Indicators of failure, underperformance, or false alarms
- d. Interpretation of performance data
- e. Seasonal impacts on system performance
- f. Site weather data source
- g. Climate data and impact on performance
- h. Data monitoring system capabilities and instrumentation quality
- i. Performance analytics (e.g., trends)
- j. Remote diagnostics solutions (if available)

PVCMS Task 9: Perform Preventative Maintenance

Knowledge of:

- a. Site access protocol
- b. NFPA 70E (e.g., lock-out/tag-out)
- c. Site-specific safety requirements
- d. Site specific O&M procedure
- e. Periodic visual and mechanical inspection
- f. Instrumentation calibration
- g. Mounting system degradation, failure points and causes (e.g., loose connections, corrosion, displacement)
- h. Module failure points and causes (e.g., signs of overheating, damage to J-Box, discoloration)
- i. Electrical equipment failure points and causes (e.g., vermin, debris, ventilation, water intrusion)
- j. Wiring system degradation, failure points, and causes (e.g., unsupported conductors, connector failure, loose terminations, physical damage to raceway)
- k. Battery system degradation, failure points, and causes (e.g., cable terminations, corrosion, capacity testing, deformation of battery)
- l. Site factors affecting performance (e.g., module soiling, vegetation impacts, shading)
- m. Array testing (e.g., Voc, Isc, Imp, fuse continuity testing)
- n. Comparison of whole system performance to predicted values

PVCMS Task 10: Perform Corrective Maintenance

Knowledge of:

- a. Site access protocol
- b. NFPA 70E (e.g., lock-out/tag-out, personal protective equipment [PPE])
- c. Site-specific safety requirements
- d. Methods for diagnosing failure or low performance (e.g., multimeter, monitoring system, thermal imager)
- e. Methods of repair or replacement
- f. Field modification and equipment substitution
- g. System cleaning (e.g., snow removal, dust/pollen removal)

Skill in:

* *Verifying effectiveness of corrective measures*



NABCEP's mission is to support, and work with, the renewable energy and energy efficiency industries, professionals, and stakeholders to develop and implement quality credentialing and certification programs for practitioners.



NABCEP's PVIP and SHI Certifications are North America's only renewable energy personnel certification that has been ANSI accredited to the internationally recognized ISO/IEC 17024 standard.

NABCEP wishes to acknowledge and thank the following individuals for their contribution in developing these JTAs:

<i>Beth Copanas</i>	<i>James Hasslebeck</i>	<i>Doug Sabetti</i>
<i>Greg Demarse</i>	<i>Bob Hattier</i>	<i>Phil Schneider</i>
<i>Kevin Flaws</i>	<i>Dell Jones</i>	<i>Rob Smith</i>
<i>Chris Giannoumis</i>	<i>Jeff Laukhart</i>	<i>Bob Solger</i>
<i>Jeff Gilbert</i>	<i>Ernie Pritchard</i>	<i>Andy Walker</i>
<i>Mark Gillespie</i>	<i>Cathy Redson</i>	



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