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PV Installation Professional Job Task Analysis

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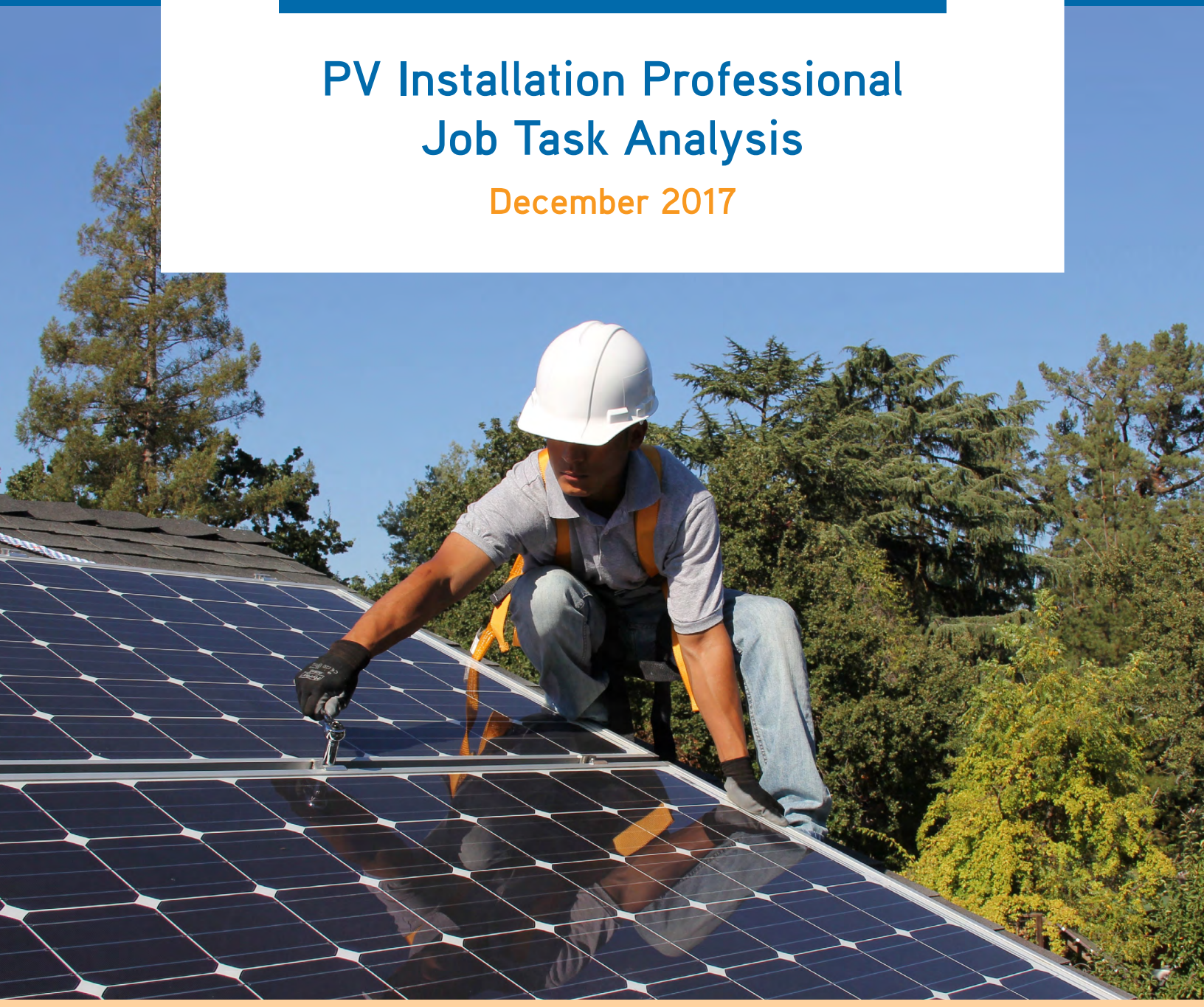

Introduction

This document presents a comprehensive Job Task Analysis (JTA) for individuals who perform responsible decision-making roles concerning the design, installation, commissioning, and operations & maintenance of Photovoltaic (PV) systems. It is important to note that the tasks outlined in this JTA apply to a range of installation personnel including but not limited to: installers; project managers; installation foreman/supervisor, and designers. The common thread among these individuals is that they will need to be fully conversant with and able to apply the knowledge areas contained in this document.

Job Description

NABCEP Certified PV Installation Professional

Given a potential site for a solar photovoltaic system installation and given basic instructions, major components, schematics, and drawings, the NABCEP Certified PV Installation Professional will: specify, adapt, implement, configure, install, inspect, and maintain any type of photovoltaic system, including grid-connected and stand-alone systems with or without battery storage, that meet the performance and reliability needs of customers in the United States and Canada, by ensuring quality craftsmanship and compliance with all applicable codes, standards, and safety requirements.

This JTA reflects the changes inherent in the growth and maturity of the solar industry over the last 5 years. It is important to note that while the range of personnel that holds responsible roles in the PV installation industry has evolved, the basic knowledge areas contained in the JTA remain fairly constant.

This task list assumes the NABCEP Certified PV Installation Professional (PVIP) starts with a system design package, complete with major components, manufacturer installation manuals, system schematics, and assembly and troubleshooting instructions. Even if the NABCEP Certified PVIP was responsible for the design of the system, this JTA begins with the step of verifying the accuracy of the design. Likewise, if the personnel did not design the system, he or she must be fully knowledgeable about systems design because they may be required to adapt the design to fit a particular application or customer need.

The tasks described in this JTA were developed based on conventional designs, equipment, and practice used in the industry today; they do not seek to limit or restrict innovative equipment, designs, or installation practice. As with any developing technology, it is fully expected that the skills required of the practitioner will develop and change over time as new materials, techniques, codes, and standards evolve.

Task Steps and Knowledge in Each Category Level

Scope of Job Task Analysis

NABCEP Certified PV Installation Professionals (PVIP) work in a variety of responsible roles on PV installation jobs. They fulfill a decision-making role that helps ensure the quality and serviceability of the PV installation. The scope of the JTA is such that Certified PVIPs fill a wide range of job positions within the industry, taking responsibility for installations of varying size and complexity. As such, the scope of their duties may vary considerably. Due to the range of responsibilities and skills that may fall within the scope of a NABCEP Certified PVIP's job duties, this Job Task Analysis is broad in scope: not all certificants will perform all the tasks described.

It is expected that all individuals who achieve NABCEP PV Installation Professional Certification will be familiar with and capable of executing all the tasks described.

Content Domains

Content Domain	Percentage of Examination
System Design	32%
Installation	38%
System Commissioning	17%
Operations & Maintenance	13%

CATEGORIZATION OF TASK STEPS USED BY PHOTOVOLTAIC INSTALLATION PROFESSIONALS

Domain I: System Design

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

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

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

DOMAIN I: SYSTEM DESIGN

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)

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)

Task 6: Configure system monitoring, control, and communications design

Knowledge of:

a. Monitoring selection criteria (e.g., PV system data, consumption data, charging/discharging data)
b. Automated shutdown (e.g., motorized switches, protection relays)
c. Low-voltage wiring methods
d. Communication methods (e.g., wired, wireless)
e. Characteristics of building automation systems
f. Tracking system controllers

DOMAIN I: SYSTEM DESIGN

Task 7: Prepare project documentation

Knowledge of:

a. Plans included in a complete project plan set
b. Characteristics of electrical diagrams and schematics (e.g., one-line, three-line)
c. Use and meaning of electrical symbols and terms
d. Engineering requirements (e.g., structural, electrical, civil, geotechnical, environmental)
e. Architectural plan requirements (e.g., elevations, street view renderings)
f. PV system labeling requirements
g. Permit application package requirements (e.g., manufacturer specification sheets)

Task 8: Secure permits and approvals

Knowledge of:

a. Authorities having jurisdiction criteria (e.g., codes, standards, covenants, regulations)
b. Types of inspections (e.g., electrical, structural, environmental)
c. Documentation criteria
d. Electric service provider and interconnection requirements (e.g., equipment locations, clearances)

Task 9: Adapt system design

Knowledge of:

a. Site condition assessment
b. Design options (e.g., value engineering, alternate materials and methods, contingency plans)
c. Effect of site conditions on design
d. Document control (e.g., revisions of plan sets from pre-construction to as-built and record drawings)
e. Change order process and documentation
f. Authorities having jurisdiction criteria (e.g., codes, standards, covenants, and regulations)
g. Equipment specifications
h. Project budget (e.g., time budget, financial budget)

Skill in:

Interpreting project scope of work
Performing gap analysis for scope of work

Domain II: Installation

Task 1: Develop safety plan

Knowledge of:

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. Site hazard assessment
e. Material safety data sheet (MSDS)
f. Emergency response resources and protocols
g. Weather event response actions
h. Specific equipment and training required for site
i. Elements of an effective safety meeting

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
g. Training requirements (e.g. education materials, security clearances, certifications, manufacturer recommendations)

Skill in:

Effectively implementing the site specific safety plan

Task 3: Install raceways

Knowledge of:

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

Skill in:

Confirming raceway routing per plans and client input

DOMAIN II: INSTALLATION

Task 4: Install electrical equipment

Knowledge of:

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

Task 5: Install DC PV 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. Appropriate conductor installation and pulling practices
d. Wire management in a neat and workmanlike manner
e. Termination and connection per NFPA 70

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 (NEC) requirements
Conducting string sizing and string configuration per plans and NFPA 70

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. Appropriate conductor installation and pulling practices
d. Wire management in a neat and workmanlike manner
e. Termination and connection per NFPA 70

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

DOMAIN II: INSTALLATION

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])

Task 8: Complete utility interconnection point

Knowledge of:

a. NFPA 70 (NEC) articles for use, installation, and construction specifications for utility interconnection
b. OSHA safety standards
c. 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
e. Effective and efficient communication regarding shutdown and inspection processes
f. Proper termination of conductors per NFPA 70
g. Local electric service provider requirements for interconnection
h. Methods of interconnection

Skill in:

Effectively implementing the site-specific safety plan
Interpreting design and construction documents

Task 9: Install system monitoring, control, and communication hardware

Knowledge of:

a. NFPA 70 (NEC) articles for use, installation, and construction specifications
b. Neat and workmanlike installation of monitoring equipment
c. Types and methods of data communication hardware
d. Termination and connection per NFPA 70

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 NFPA 70 and approved plan sets
Preparing monitoring system for commissioning

DOMAIN II: INSTALLATION

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 NFPA 70
Conducting field verification of proper conductor identification, size, color, type, and rating

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. Foundation and structural elements (e.g., geotechnical requirements)
e. Construction and assembly of PV structure and racking
f. Neat and workmanlike manner of installation
g. Location of underground utilities (e.g., call ahead, underground locator services)
h. Environmental impact (e.g., protected species, water management)
i. Site protection and restoration (e.g., straw and seed)
j. Equipment requirement and availabilities

Skill in:

Managing excavation to design specifications (e.g., trenching, piers, foundations)
Interpreting design and construction documents (e.g. site plan, system design plan)

DOMAIN II: INSTALLATION

Task 12: Install building-mounted system

Knowledge of:

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

Skill in:

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

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. Proper module handling and preparation
e. Proper wire management methods and materials
f. Termination and connection per NFPA 70
g. Grounding and bonding (e.g., integrated grounding, bonding washers, lugs)
h. 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)
Interpreting design and construction documents

Domain III: System Commissioning

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. Project-specific requirements
d. Test equipment

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

Task 3: Conduct mechanical tests

Knowledge of:

a. Installation per torque specifications
b. Field testing (e.g., pile load tests, soil test, concrete slump test)
c. Witness testing (e.g., module wind or snow loading)

Task 4: Conduct electrical tests

Knowledge of:

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

DOMAIN III: SYSTEM COMMISSIONING

Task 5: Verify system operation

Knowledge of:

a. 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

Task 6: Confirm project completion

Knowledge of:

a. Finalized documentation (e.g., commission report, signed permits, permission to operate [PTO], photographs)
b. Visual documentation (e.g. photograph, thermal image, screen shot)
c. Close-out procedures (e.g., punch lists, contract reconciliation, demobilization)
d. Owner-signoff requirements (e.g., appropriate site addition, customer satisfaction)
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 owner
h. Warranty terms and coverage
i. System design, operation, and performance metrics (e.g., performance ratio)

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

Domain IV: Operations & Maintenance (O&M)

Task 1: Verify system operation and 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)

Task 2: Perform preventive maintenance

Knowledge of:

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

Task 3: Perform corrective maintenance

Knowledge of:

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

Skill in:

Verifying effectiveness of corrective measures

NABCEP's mission is to establish and operate high quality credentialing programs for renewable energy professionals. NABCEP credentials promote worker safety, provide value to practitioners and consumers, and set the standard for measurable cognitive skill levels.

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.

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NABCEP
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