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PV Associate Job Task Analysis

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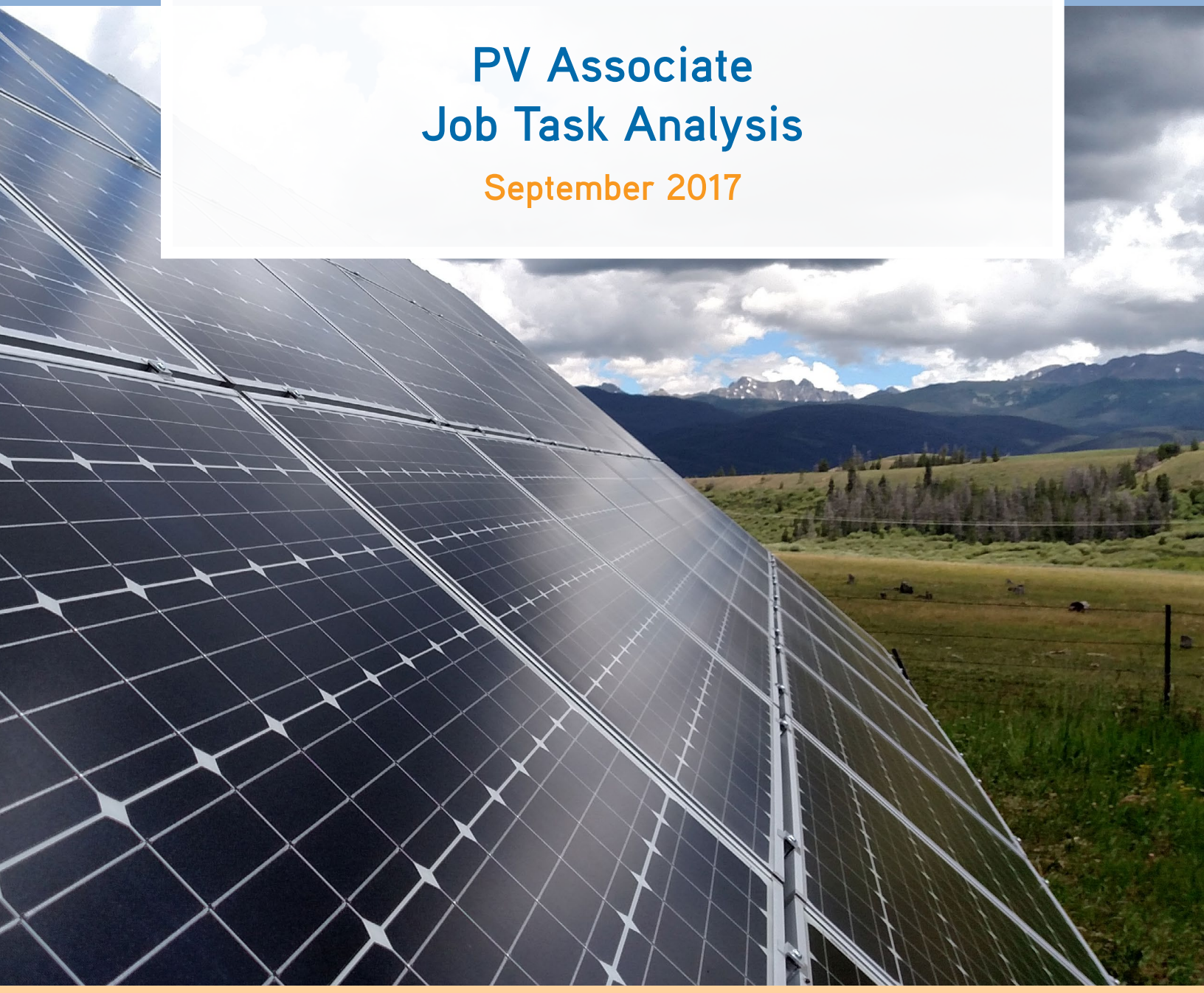

Introduction

The major function of the NABCEP Photovoltaic Associate™ (PVA™) Program is identifying individuals who have obtained the knowledge of the fundamental principles of the application, design, installation, and operation of Photovoltaic (PV) systems. This document presents a comprehensive Job Task Analysis (JTA) for individuals who are eligible for the PV Associate exam. The tasks described in this JTA are 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.

Anyone who passes the NABCEP PV Associate Exam has demonstrated a basic knowledge of photovoltaic systems. The knowledge demonstrated by passing this test does not replace the knowledge, skills or abilities of the electrical or other construction trades, or those of other professions or degree programs that require considerably more academic and practical experience. It should also be noted that individuals passing the NABCEP PV Associate Exam should not be confused with NABCEP's Certified PV Installation Professional Exam. The latter can only be achieved by highly experienced individuals who have passed a much more rigorous examination and have demonstrated the capability to supervise complete PV system installations, and who have a detailed working knowledge of the electrical codes, standards and accepted industry practice associated with PV installations. PV Associates who want to qualify for the PVIP Exam, may apply 18 hours toward the non-accredited requirements if obtained through a NABCEP Registered Associate Provider.

Task Steps and Knowledge in Each Category Level

Scope of Job Task Analysis

The scope of the NABCEP PV Associate Job Task Analysis is meant to encompass all of the knowledge of the fundamental principles of the application, design, installation, and operation & maintenance of Photovoltaic (PV) systems. NABCEP PV Associates fill a wide range of entry-level positions within the industry, and the extent of their duties may vary considerably. Due to the range of responsibilities and skills that may fall within the scope of a NABCEP PV Associate's job duties, this Job Task Analysis is broad in scope: not all PV Associates will perform all the tasks described. This JTA is used to create the PVA test specifications (i.e., test blueprint) to ensure that the knowledge and skills measured by the PVA examination reflect current practice in the field.

A panel of NABCEP Subject Matter Experts (SMEs) identified the most important information for anyone working in photovoltaics to understand. These five performance domains contain the essential tasks necessary to demonstrate that understanding: (1) Application, (2) Sales and Economics, (3) Design, (4) Installation, and (5) Operation and Maintenance.

Content Domains

Content Domain	Percentage of Examination
Application	15%
Sales and Economics	13%
Design	25%
Installation	29%
Operation and Maintenance	18%

CATEGORIZATION OF TASK STEPS USED BY NABCEP PHOTOVOLTAIC ASSOCIATES

Domain I: Application 15%

Task 1: Describe types of PV system applications

Knowledge of:

a. Grid-interactive systems with and without storage
b. Stand-alone systems for residential, commercial, and industrial applications
c. Remote industrial systems
d. Specialty applications
e. Solar-integrated products

Task 2: Identify key features and benefits of specific types of PV systems

Knowledge of:

a. Energy security
b. Predictable electricity costs
c. Simplicity of design and installation
d. Environmental impact and social benefit
e. Economic benefits
f. Portability of system
g. System cost
h. Reliability of performance

Task 3: List the key components of specific types of PV systems

Knowledge of:

a. Modules
b. Structural attachments (e.g., racking, mounting)
c. Power electronics (e.g., inverters, optimizers, charge controllers)
d. Switch gear
e. Balance of system components
f. Point of utility interconnection
g. Energy storage
h. Monitoring equipment

Task 4: Understand the safety concerns associated with the different types of PV systems

Knowledge of:

a. Fall hazards
b. DC hazards (e.g., electrical arcing, fire)
c. AC hazards (e.g., arc flash)
d. Shock hazards
e. Environmental and jobsite hazards
f. Lifting
g. Hazardous materials

Task 5: List the advantages and disadvantages of PV system compared to other electricity generation sources

Knowledge of:

a. Economics
b. Accessibility to the site
c. Reliability of the system
d. Maintenance
e. Environmental impact
f. Efficiency
g. Distributed generation

Domain II: Sales and Economics 13%

Task 1: Determine necessary customer information to collect

Knowledge of:

a. Physical location
b. Credit strength (e.g., FICO score)
c. Utility information
d. Site information (e.g., shading factors, roof type, orientation, pitch, electrical service, local jurisdictions)

Task 2: Identify the customer's motivations to install solar

Knowledge of:

a. Financial reasons
b. Environmental concerns
c. Energy independence
d. Energy security
e. Technology
f. Aesthetics
g. Health
h. Status

Task 3: Estimate system size to meet the customer's financial objective

Knowledge of:

a. Customer energy usage
b. Utility rate structure
c. Available incentives
d. Customer budget
e. General system sizing (e.g., calculations)

Task 4: Identify information from a client customer utility bill relevant to grid-interactive solar

Knowledge of:

a. Existing rate schedule and options
b. Customer usage profile (e.g., daily patterns, seasonal patterns)
c. Demand charges (e.g., peak load)

Task 5: Identify information from the client on electricity usage relevant to stand-alone solar

Knowledge of:

a. Power and energy requirements (e.g., critical load)
b. Customer usage profile (e.g., daily patterns, seasonal patterns)
c. Days of autonomy

DOMAIN II: SALES AND ECONOMICS

Task 6: List key factors that impact the economics of solar

Knowledge of:

a. Incentives
b. Net energy metering
c. Environmental conditions
d. System price (e.g., equipment, labor, soft costs)
e. Cost of electricity from utility
f. Irradiation
g. Energy storage
h. Cost to finance
i. Equipment degradation (e.g., modules)
j. Operation and maintenance

Task 7: Recognize how policies and available financial benefits affect different PV markets

Knowledge of:

a. PV markets (e.g., residential, commercial, non-profit, utility scale PV)
b. Local policies (e.g., tax credits, local benefits, utility benefits, net energy metering, zero net export)

Task 8: Identify financial risks associated with PV systems

Knowledge of:

a. Electricity rate fluctuation
b. System performance
c. Policy uncertainty
d. Warranty limitations (e.g., existing roof, PV system products, workmanship)
e. Maintenance costs

Task 9: Identify common financing options

Knowledge of:

a. Cash purchase
b. Lease
c. Power purchase agreement (PPA)
d. Loan (e.g., Property Assessed Clean Energy [PACE], line of credit, home equity)

Task 10: Identify predictable maintenance costs over the life of the system

Knowledge of:

a. Maintenance and equipment replacement costs (e.g., mechanical, batteries, inverters, service contracts)
b. Cleaning costs
c. Monitoring costs
d. Roofing replacement

Domain III: Design 25%

Task 1: Ensure equipment is appropriate for intended use

Knowledge of:

a. National recognized testing labs (e.g., Underwriters Laboratories, National Energy Testing Laboratory)
b. Product safety standards (e.g., IEEE standards, national standards)
c. Manufacturer instructions
d. Location conditions (e.g., wind, snow, seismic)
e. Electrical hazards

Task 2: Identify relevant codes and requirements that impact PV design and installation

Knowledge of:

a. Electrical codes
b. Building codes
c. Fire safety codes
d. Workplace safety codes
e. Local permitting requirements
f. Local utility requirements

Task 3: Recognize electrical concepts and terminology

Knowledge of:

a. Ohm's law
b. Power and energy
c. Electrical measurements (e.g., voltage, current, impedance, resistance)
d. Alternating current (AC) and direct current (DC)
e. Single-phase, split-phase, and three-phase circuits
f. Series and parallel circuits
g. Properties of common conductors (e.g., insulation types [PV wire, USE-2, THWN-2], sizes and ampacities, voltage ratings, color)
h. Types of common raceways (e.g., EMT, RMC, PVC, LFNC, LFMC, FMC)
i. Types of common multi-conductor cables (e.g., Romex, MC, TC)
j. Grounding and bonding terminology (e.g., equipment grounding conductor, grounding electrode conductor, grounding electrode, bonding jumper)

Task 4: Identify factors impacting solar resource on design and performance

Knowledge of:

a. Solar window
b. Local conditions (e.g., weather, soiling)
c. Peak sun hours
d. Shading analysis
e. Array orientation

DOMAIN III: DESIGN

Task 5: Identify equipment specification data

Knowledge of:

a. PV module specifications (e.g., temperature coefficient, Standard Test Conditions [STC], irradiance impact on current)
b. Inverter specifications (e.g., voltage, current, surge)
c. Voltage and current ratings
d. Battery (e.g., capacity, max current)

Task 6: Describe the function of typical components in PV systems

Knowledge of:

a. PV system configuration
b. PV modules
c. Inverters
d. Module-level electronics (e.g., microinverter, PV optimizer)
e. Overcurrent protection devices
f. PV racking systems
g. Charge controllers
h. Batteries
i. Rapid shutdown equipment
j. Electrical materials (e.g., conduits, conductors, disconnects)
k. Point of interconnection (e.g., supply side, load side)
l. Monitoring equipment
m. General balance of system (e.g., combiner boxes, disconnects)
n. Grounding and bonding elements (e.g., equipment grounding conductor, grounding electrode conductor, grounding electrode, bonding jumper)

Task 7: Explain PV system sizing considerations

Knowledge of:

a. Derating factors
b. System losses
c. Power rating
d. Energy production
e. Energy efficiency
f. Electric service infrastructure
g. Electrical codes
h. Interconnection requirements
i. Load analysis
j. Software sizing tools
k. String configuration
l. Inverter ratings

Task 8: Read an electrical diagram of a PV system

Knowledge of:

a. Electrical symbols
b. Electrical equipment (e.g., wire, conduits, raceways, disconnects)
c. PV circuit terminology
d. String configuration
e. Inverter input window
f. Equipment nameplate ratings
g. Conductor properties (e.g., temperature ratings, ampacity ratings, UV resistance, moisture rating)

Task 9: Recognize structural requirements of PV systems

Knowledge of:

a. Local building codes
b. Static and dynamic loads (e.g., wind)
c. Rooftop conditions (e.g., temperature, age, warranty)
d. Roofing systems (e.g., rafter, trusses, membranes)
e. Footing requirements
f. PV racking systems (e.g., ground mount, roof mount, pole mount)
g. Mechanical fasteners
h. Building-integrated PV options

Domain IV: Installation 29%

Task 1: Identify the elements of a complete site-specific safety plan

Knowledge of:

a. Electrical hazards and control methods (e.g., electrical shock, arc flash, de-energization plan, lockout/tagout, energized electrical work permit)
b. Use of multimeter
c. Fall hazards and protection systems (e.g., personal fall arrest systems, guardrails, scaffolding, skylight guards)
d. Safe roof access (e.g., use of ladders, equipment handling techniques, hoisting and rigging methods)
e. Proper lifting techniques
f. Vehicle safety and equipment transport (e.g., heavy equipment)
g. Equipment staging (e.g., roof load distribution)
h. Personal protective equipment (PPE) (e.g., hard hats, safety glasses, gloves, ear protection, footwear)
i. Environmental hazards (e.g., heat illness, lightning, wind)
j. Digging hazards (e.g., when trenching, when installing ground mount systems, location of underground utilities)
k. Safe use of hand and power tools
l. Battery safety (e.g., insulated tools, face guard, chemical goggles, eye wash, gloves, aprons)
m. Emergency response plan and accident reporting procedures
n. Required on-site documentation (e.g., injury and illness prevention program, safety data sheets)
o. Safety regulations (e.g., OSHA 29 CFR 1926, NFPA 70E)

Task 2: Identify the elements of the plan set

Knowledge of:

a. Site plan and array layout plan
b. Electrical diagrams (e.g., one-line or three-line diagrams, wiring or string diagrams)
c. Equipment data sheets and installation instructions
d. Structural details (e.g., rafter layout)
e. Permit documents
f. Site safety plan

Task 3: Identify the elements of racking installation

Knowledge of:

a. Manufacturer manuals and specifications (e.g., torque specifications)
b. Types of roofing materials (e.g., composition, tile, metal, shake, built-up)
c. Fire classification of roofing materials (e.g., Class A, B, C)
d. Roof and building construction vocabulary (e.g., rafter, truss, stud, decking, underlayment, low-slope, steep-slope, ridge, valley)
e. Types of racking systems (e.g., roof-mounted, flush-mounted, tilt-mounted, attachments, rail-less, ballasted, pole-mounted, building integrated, sun tracking)
f. Structural considerations (e.g., span, rail cantilever, module overhang, point load, dead load, live load, wind load, wind category, snow load, roof zones)
g. Fastener types and sizes (e.g., wood-lag bolts, GRK fasteners; metal-self-drilling screws, concrete; material-stainless steel, galvanized; grade and strength markings)
h. Components of different mounting systems (e.g., attachments, flashing, rails, splices or expansion joints, clamps)
i. Bonding methods (e.g., integrated grounding, WEEBs, star washers, jumpers)
j. Impact of standoff distance on energy performance
k. Waterproofing and weather sealing methods (e.g., flashing)
l. Common power and hand tools
m. Potential impact of installation on roof warranties

Task 4: Identify the elements of electrical component installation

Knowledge of:

a. Types of electrical components (e.g., inverters, hybrid inverters, microinverters, optimizers, charge controllers, disconnects, switchgear)
b. Manufacturer manuals and specifications (e.g., termination torque specifications, NEMA ratings, sunlight exposure, application of antioxidant)
c. Product intended use (e.g., indoor vs. outdoor fittings)
d. Working clearances
e. Common electrical fittings (e.g., connectors, couplings, grounding bushings, strain reliefs, LBs)
f. Labeling and marking requirements (e.g., durability, mounting methods)
g. Grounded vs. ungrounded system requirements
h. Spacing and materials of raceway support
i. Importance of managing wires off the roof and out of the sun
j. Wiring best practices (e.g., drip loops, service loops, minimum bend radius)
k. Corrosion of dissimilar metals and value of antioxidant
l. Documentation of module-level power electronics (e.g., serial numbers of microinverters, DC optimizers)
m. Common power and hand tools

Task 5: Identify the elements of energy storage component installation

Knowledge of:

a. Types of batteries (e.g., flooded lead acid, sealed lead acid, lithium)
b. Types of charge controllers (e.g., pulse width modulation, maximum power point tracking, load-diversion)
c. Manufacturer manuals and specifications (e.g., charging settings)
d. Battery bank location and protection (e.g., venting, insulation)
e. Labeling requirements
f. Balance of system components (e.g., disconnects, cabling)

Task 6: Identify the elements of the system commissioning procedure

Knowledge of:

a. Visual inspection
b. Measurement conditions (e.g., irradiance, temperature)
c. Relevant electrical measurements (e.g., string voltage, polarity)
d. Measured performance against expectations
e. Proper operation of all electrical equipment
f. Proper operation of monitoring equipment and performance metering
g. Documentation of testing/commissioning and inspection
h. Customer orientation (e.g., walk-through, training, monitoring, expected operations and maintenance)

Domain V: Maintenance and Operation 18%

Task 1: Identify commonly used electrical test equipment and its purpose

Knowledge of:

a. Multimeters (e.g., current, voltage, resistance, continuity)
b. Insulation testing devices (e.g., megohmmeter)
c. IV curve tracer
d. Infrared thermometer (e.g., module, breaker, connection temperature measurement)
e. Irradiance meter
f. Battery capacity testing devices (e.g., load tester)
g. Hydrometer

Task 2: Demonstrate the ability to analyze simple electrical circuits

Knowledge of:

a. Ohm's law
b. Power formulas (e.g., Watt's law)

Task 3: Describe the effects of performance parameters that are commonly monitored for PV systems

Knowledge of:

a. Temperature
b. Wind speed
c. IV curve characteristics (e.g., short circuit, open circuit)
d. Irradiance
e. Inverter AC and DC voltage
f. Utility voltage and frequency
g. Battery voltage

Task 4: Describe different types and elements of system performance monitoring equipment

Knowledge of:

a. Monitoring methods (e.g., web-based, on-site)
b. Current transformer
c. Voltage sense
d. Internet access (e.g., cellular gateways, network hub)
e. Revenue grade meter
f. Power line adapters
g. Battery temperature sensor
h. Weather monitoring systems (e.g., pyranometer, anemometer, thermometer)
i. Emerging technology trends
j. Supervisory control and data acquisition (SCADA) (e.g., data logging)

Task 5: Identify common factors that result in deviations from expected system performance

Knowledge of:

a. Test conditions (e.g., Standard Test Conditions [STC], PVUSA Test Conditions [PTC], nominal operating cell temperature [NOCT], California Energy Commission [CEC])
b. Installation practices
c. Electrical connection faults
d. Production losses and their causes (e.g., weather, pollution, shading, animals, soiling, system degradation)
e. Production enhancements and their causes (e.g., albedo, edge of cloud, low temperature, high altitude)

DOMAIN V: MAINTENANCE AND OPERATION

Task 6: Describe typical maintenance requirements for PV systems

Knowledge of:

a. Record keeping (e.g., system logging, data sheets, user manuals, return merchandise authorization [RMA] process, maintenance plan)
b. Equipment replacement (e.g., installation practices, lockout/tagout, service life)
c. Equipment upkeep requirements (e.g., installation practices, lockout/tagout, torque requirements, module cleaning)
d. Visual inspection

Task 7: Identify the safety requirements for operating and maintaining different types of PV systems

Knowledge of:

a. Electrical hazards and control methods (e.g., electrical shock, arc flash, de-energization plan, lockout/tagout, ground fault)
b. Use of multimeter
c. Fall hazards and protection systems (e.g., personal fall arrest systems, guardrails, scaffolding, skylight guards)
d. Safe roof access (e.g., use of ladders, equipment handling techniques, hoisting and rigging methods)
e. Proper lifting techniques
f. Equipment staging (e.g., roof load distribution)
g. Personal protective equipment (PPE) (e.g., hard hats, safety glasses, gloves, ear protection, footwear)
h. Environmental hazards (e.g., heat illness, lightning, wind, animal encounters)
i. Safe use of hand and power tools
j. Battery safety (e.g., insulated tools, face guard, chemical goggles, eye wash, gloves, aprons)
k. Emergency response plan and accident reporting procedures
l. Required on-site documentation (e.g., injury and illness prevention program, safety data sheets)
m. Electric shock risk associated with washing PV modules
n. Risk in working with energized and/or faulty equipment
o. Safety regulations (e.g., OSHA 29 CFR 1926, NFPA 70E)

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.

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