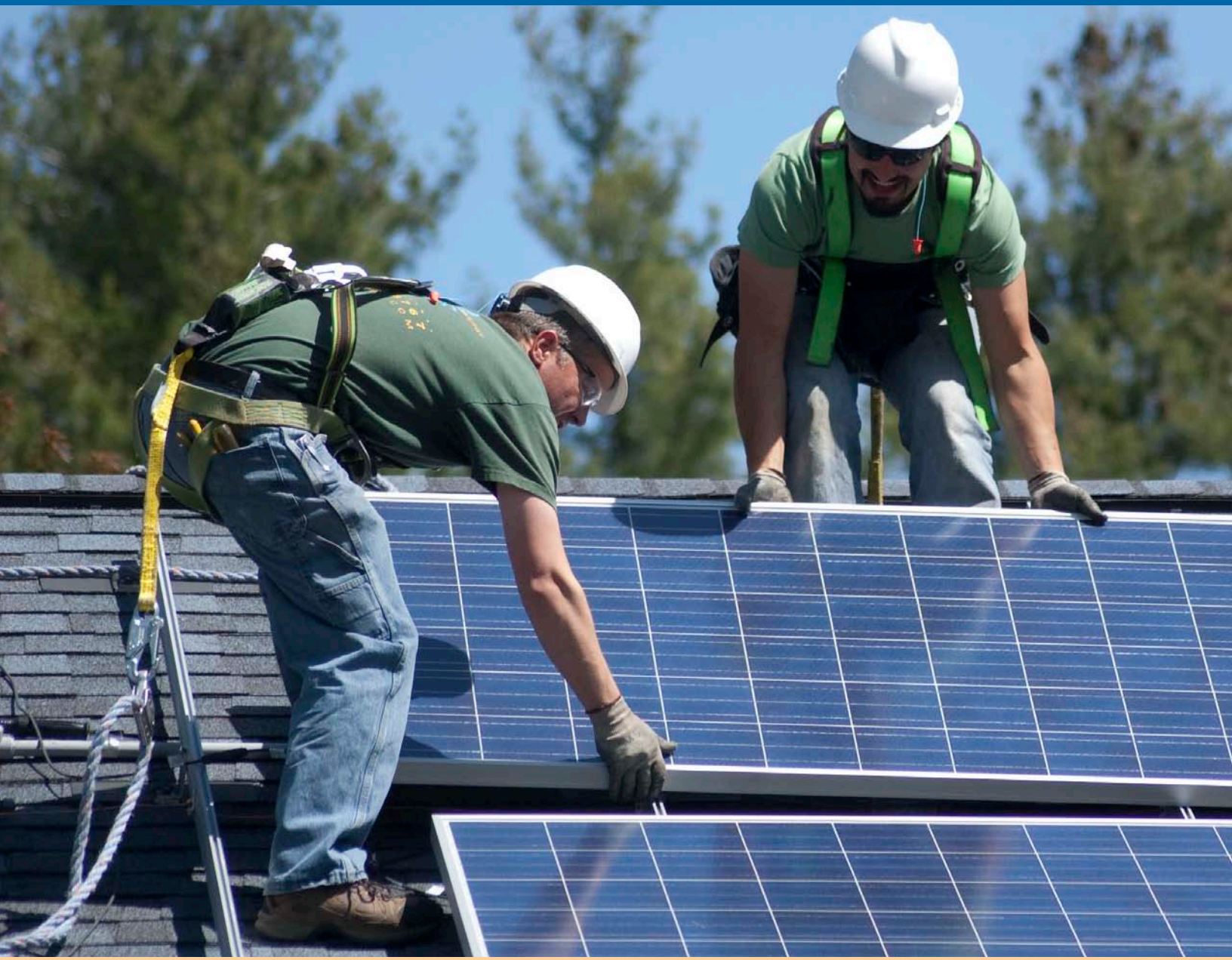
NABCEP

PV Installation Professional Job Task Analysis



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NABCEP PV Installation Professional Job Task Analysis

Introduction

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

This JTA introduces a broadening of the scope and definition of the previously used term "PV Installer" and is reflective of the evolution of job roles and responsibilities in the Photovoltaic Installation industry. The industry has grown and matured over the past decade and this document reflects these changes in job roles. It is important to note that while the range of personnel that hold 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 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 PV Installation Professional 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, as he or she may be required to adapt the design to fit a particular application or customer need.

While these tasks described in this JTA have been 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 in any manner. 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.

Job Description

for 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.

Task Steps and Knowledge in each Category Level

CATEGORY / LEVEL	DESCRIPTION
● Critical	Absolutely essential for a PV installer. Installers do these tasks most frequently.
● Important	Very important, but not of the highest level of criticality. These tasks are done with less frequency by installers yet have been identified as important to the knowledge base of installers.
● Useful	Might be useful; can inform education and training to add richness and depth. Installers do these tasks infrequently.

Scope of Job Task Analysis

NABCEP Certified PV Installation Professionals work in a variety of responsible roles on PV installation jobs. He or she fulfills a decision-making role that helps ensure the quality and serviceability of the PV installation. The scope of the JTA is such that Certified PV Installation professionals 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 PV Installation Professional's job duties, this Job Task Analysis is very broad in scope: not all certificants will perform all the tasks described herein.

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 as "critical" and that these tasks will be common to most if not all PV installations. It is further expected that all individuals who achieve NABCEP PV Installation Professional Certification 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 certified installer's body of knowledge. Those tasks that are described as "useful" are performed more infrequently by the certified installer 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 Installations.

Candidates preparing for examination and educators developing curriculum should be aware that those questions regarding tasks described as "critical" are most likely to be included in examinations; tasks described as "important" may be on the examination; and those described as "useful" are least likely to be included as examination questions.

Content Domains and Examination Specifications

Content Domain	Percentage of Examination
Verify System Design	30%
Managing the Project	17%
Installing Electrical Components	22%
Installing Mechanical Components	8%
Completing System Installation	12%
Conducting Maintenance and Troubleshooting Activities	11%

Categorization/Prioritization of Task Steps Used by Photovoltaic Installation Professionals

A: Verify System Design

1. Verify Client Needs

TASK STEP	CATEGORY
Confirm desired location of equipment	Critical
Address aesthetic concerns	Critical
Address legal concerns	Important
Confirm loads assessment	Useful *
Confirm critical loads	Useful *
Confirm system matches client expectation	Useful

2. Review Site Survey

TASK STEP	CATEGORY
Evaluate roof conditions	Critical
Evaluate desired array and equipment locations	Critical
Locate solar equipment	Critical
Locate conduit paths	Critical
Evaluate roof structure	Critical
Determine obstructions	Critical
Conduct site hazard assessment (existing hazards)	Critical
Identify staging/lifting/access locations	Critical
Confirm accuracy of shading analysis	Important
Evaluate existing electrical equipment	Important
Determine true south	Important
Evaluate wall structure	Important
Confirm existing roof tilt and orientation (pitch and azimuth)	Important
Confirm accuracy of site drawings	Important
Evaluate wind exposure	Useful
Evaluate soil conditions	Useful
Confirm solar resource	Useful

3. Confirm System Sizing

TASK STEP	CATEGORY
Arrange modules in mounting area	Critical
Determine topography of mounting area	Important
Confirm utility/authority having jurisdiction (AHJ) restrictions	Important

** The items noted were deemed to be useful or important primarily because most installations do not involve batteries and as such installers do not frequently perform the tasks. Each of these tasks becomes critical when installing battery systems and should be so noted.*

TASK STEP	CATEGORY
4. Review Design of Energy Storage Systems	
Verify appropriate energy storage system location	Important
Verify ventilation requirements	Important *
Verify circuit design for critical loads	Important
Verify access requirements	Important
Verify load analysis	Useful
Inspect existing wiring	Useful
Identify multi-wire branch circuits	Useful *
Confirm that battery bank is appropriate to inverter requirements	Useful
Confirm that battery bank is appropriate to other charging sources	Useful
Confirm that battery technology is appropriate to usage	Useful
5. Confirm String Size Calculations	
Confirm highest and lowest design temperature	Important
Confirm module Voc at lowest design temperature	Important
Confirm temperature corrected voltage	Important
Confirm voltage limits of system	Important
Confirm appropriate string diagram	Important
Confirm Vpmax at highest design temperature	Important
6. Review System Component Selection	
Confirm component compatibility	Critical
Confirm the selected module mounting system is appropriate for the application	Important
Confirm the selected grounding method is appropriate for the application	Important
Confirm the selected combiner boxes are appropriate for the application	Useful
Confirm the number and type of inverters are appropriate for the application	Useful
Confirm the number and type of charge controllers are appropriate for the application	Useful
Confirm that all overcurrent protection devices are appropriate for the application	Useful
Confirm the DC disconnect(s) are appropriate for the application	Useful
Confirm the AC disconnect(s) are appropriate for the application	Useful
Confirm maximum allowable number of unprotected parallel strings	Useful
Confirm GFP devices are appropriate for the application	Useful
7. Review Wiring and Conduit Size Calculations	
Confirm conductor ampacity calculations	Critical
Confirm conduit fill calculations	Critical

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TASK STEP	CATEGORY
Confirm conductor run distance	Critical
Confirm appropriate conduit type(s)	Critical
Confirm appropriate conductor insulation type(s)	Critical
Confirm continuous current calculations	Important
Confirm continuous load calculations	Important
Confirm conditions of use calculations	Important
Confirm temperature de-rate calculations	Important
Confirm conductor de-rate calculations	Important
Confirm voltage drop calculations	Important
Confirm power loss calculations	Important
Confirm appropriate grounding conductor type(s)	Important
Confirm circuit current calculations	Important
Confirm conduit size calculations	Important
Confirm grounding conductor sizing calculations	Important
Confirm thermal expansion calculations	Useful

8. Review Overcurrent Protection Selection

Confirm voltage specifications	Important
Confirm compatibility with conductor size and type	Important
Confirm circuit current calculations	Useful
Confirm characteristics of existing electrical distribution system	Useful
Confirm selection of overcurrent protection device enclosures	Useful
Confirm equipment limits of overcurrent protection	Useful
Confirm available fault currents	Useful
Confirm voltage compatibility	Useful
Confirm disconnecting means type	Useful
Confirm disconnecting means amperage rating	Useful
Confirm temperature rating of device	Useful
Confirm terminal temperature limits of device	Useful
Confirm enclosure rating of device	Useful
Confirm wire size limitations of device	Useful

9. Review Fastener Selection

Confirm fastener sizes	Critical
Confirm environmental conditions assessment	Critical
Confirm compatibility of fasteners to system	Critical
Confirm fastener types	Critical
Confirm pilot hole specifications	Critical
Confirm fastener assembly	Critical
Confirm structural characteristics of substrate	Important
Confirm fastener pull-out strengths	Important
Confirm fastener removal	Important

TASK STEP	CATEGORY
Confirm mounting method	Important
Confirm torque values	Important
Confirm usage of appropriate auxiliary materials	Important
Confirm weatherproofing materials for building penetrations	Important
Confirm pull-out loads	Useful
Confirm wind loading	Useful
Confirm shear loads	Useful
Confirm shear strengths	Useful
Confirm types of loads	Useful
Confirm accuracy of bill of materials	Useful

10. Review Plan Sets

Confirm AHJ requirements	Important
Confirm accuracy of electrical one- or three-line diagram	Useful
Confirm accuracy of site plan	Useful
Confirm accuracy of system design	Useful
Generate a safety plan	Useful
Assemble manufacturer's data sheets	Useful
Create labeling schedule	Useful
Assemble manufacturer's instructions	Useful
Note and address structural concerns	Useful
Complete commissioning forms	Useful
Generate string diagram	Useful

B: Managing the Project

1. Conduct Pre-Construction Meetings

Plan weather contingencies	Critical
Verify site conditions match design	Critical
Assemble workforce, including other trades as appropriate	Important
Determine daily construction goals	Important
Communicate construction strategy to customer	Important
Provide customer orientation	Important
Communicate target pull-off time for crew	Important
Document safety plan	Important
Resolve scheduling conflicts	Important
Ensure pre-construction commitments by customer are complete	Important
Determine community issues	Important
Determine customer requirements	Important

TASK STEP	CATEGORY
2. Secure Permits and Approvals	
Coordinate inspections	Important
Schedule inspections	Important
Confirm job permits	Important
Resolve AHJ conflicts	Important
Submit plans to utilities	Useful
Resolve utility conflicts	Useful
Obtain sign-off on final building permit	Useful
Determine additional agency permits (e.g. zoning, solar access, Homeowners' Association, historic district)	Useful
3. Manage Project Labor	
Coordinate with subcontractors	Critical
Determine order of tasks	Critical
Allocate resources	Critical
Supervise project crews	Critical
Communicate aspects of safety plan	Critical
Coordinate with other trades	Important
Orient contractors to job site conditions	Important
Track man hours	Important
Conduct toolbox talks	Important
Resolve disputes	Useful
4. Adapt System Design	
Identify potential conflicts in design	Critical
Document changes to proposed design	Critical
Maintain as-built documentation	Critical
Submit modification proposals	Important
Acquire approvals to change design	Important
Submit any change orders	Important
5. Manage Project Equipment	
Take delivery of components	Important
Schedule deliveries	Important
Identify lifting and handling areas	Important
Perform equipment inspection	Important
Perform equipment maintenance	Important
State site equipment	Useful
Schedule machinery	Useful
Ensure equipment operator certification	Useful
Install pedestrian barriers	Useful

TASK STEP	CATEGORY
6. Implement a Site-Specific Safety Plan	
Perform hazard analysis	Critical
Identify job site hazards	Critical
Implement ladder safety	Critical
Implement fall protection plan	Critical
Execute electrical safety	Critical
Select personal protective equipment (PPE)	Critical
Develop site-specific safety plan	Important
Implement vehicle safety	Important
Install site safety barriers	Important
Identify access points to site	Important
Identify site evacuation points	Important
Post hospital map routes	Important
Post emergency contact numbers	Important
Ensure material safety data sheets (MSDS) are on-site	Important
Post contingency plan	Useful

C: Installing Electrical Components

1. Mitigate Electrical Hazards	
Implement the site safety plan	Critical
Implement the lock-out, tag-out procedures	Critical
Determine voltage levels of interconnections	Critical
Maintain clear work area	Critical
Clarify the maximum working voltage	Critical
Select required PPE based on system design (arc flash, shock, burn, voltage, etc.)	Critical
Disconnect all unnecessary live circuits	Critical
Determine working clearances	Critical
Demonstrate situational awareness	Critical
Measure voltage on equipment before proceeding with work	Critical
Inspect safety equipment	Critical
Inspect test equipment	Critical
Maintain safety equipment	Important
Inspect hand and power tools	Important
Measure current on equipment before proceeding with work	Useful
Maintain hand and power tools	Useful

TASK STEP	CATEGORY
2. Install Grounding Systems	
Install module grounding	Critical
Install inverter grounding	Critical
Install mounting system grounding	Critical
Ground all noncurrent-carrying metal parts	Critical
Bond metallic raceways	Critical
Install grounding electrode conductor	Critical
Bond all electrical equipment	Critical
Apply antioxidant material	Critical
Prepare surfaces for electrical connections	Critical
Make grounding electrode connection	Important
Install grounding electrode(s)	Important
Install supplementary ground electrode	Important
Install system grounds	Important
Determine grounding conductor size	Important
Install DC ground-fault protection	Important
Locate underground hazards	Useful
3. Install Conduit and Raceways	
Plan conduit routing	Critical
Penetrate building envelope	Critical
Support and secure conduit	Critical
Tighten all fittings	Critical
Select fittings according to application	Critical
Install above ground electrical raceways	Critical
Install conduit bushings	Critical
Make knockouts in electrical raceways	Critical
Install underground electrical raceways	Important
Remove sharp edges (deburr)	Important
Install service entry mast	Useful
Locate underground utilities	Useful
Create underground trenches	Useful
Backfill underground trenches	Useful
Mark underground cables	Useful
Mark underground trenches	Useful
4. Install Electrical Components	
Select location of DC disconnect	Critical
Mount electrical enclosures	Critical
Install DC combiner	Critical
Label equipment	Critical

TASK STEP	CATEGORY
Install PV system disconnects	Critical
Install inverter disconnects	Critical
Install utility required disconnects	Critical
Install array wiring transition box	Critical
Install inverter	Critical
Install underground electrical components	Important
Install AC combiner	Important
Install meter bases	Important
Select label materials	Important
Install junction boxes in the attic	Important
5. Install Circuit Conductors	
Pull conductors	Critical
Label conductors	Critical
Terminate conductors	Critical
Wire the inverter	Critical
Wire modules	Critical
Select the correct wire type, color, and gauge	Critical
Secure conductors	Critical
Measure wires	Critical
Set up the wire installation (tugger, fish tape, rope)	Critical
Test conductor installation	Critical
Test DC source circuits	Critical
Test DC currents	Critical
Set up pull stations	Important
Clear the electrical raceway	Important
Splice electrical conductors	Important
6. Install Utility Interconnection	
Install overcurrent protection device (OCPD)	Critical
Install disconnects	Critical
Test utility voltage	Critical
Coordinate AHJ inspection	Critical
Verify fill rates	Critical
Terminate conductors	Critical
Implement lock-out, tag-out procedures	Critical
Evaluate existing service entrance equipment	Critical
Install generation metering	Important
Test conductor insulation	Important
Select connection location	Important
Coordinate utility shutdowns	Important

TASK STEP	CATEGORY
Coordinate with customers and other regarding shutdowns	Important
Move existing circuits	Important

7. Install System Instrumentation

Test system	Critical
Install power and energy metering	Important
Install data communication cables	Useful
Install communication systems	Useful
Install environmental sensors	Useful
Install controllers	Useful
Install electrical sensors	Useful
Install inverter interface	Useful
Install power supply	Useful
Install battery temperature sensors	Useful
Install outlet for monitoring system	Useful

8. Install Battery Components

Test each unit before placement (voltage, specific gravity, polarity)	Important
Terminate fine stranded cables	Important
Install maintenance disconnect	Important
Confirm battery bank location	Important
Install battery enclosure	Important
Install battery enclosure venting	Important
Install battery spill containment	Important
Install batteries	Important
Prepare battery terminals (e.g. clean)	Useful
Install battery interconnection conductors	Useful
Install battery units	Useful
Apply antioxidant compounds	Useful
Calculate ampacity	Useful
Install charge controller	Useful *
Seal conduit entry to battery box	Useful
Label battery units	Useful
Label battery enclosure	Useful
Label battery room	Useful *
Establish maintenance schedule	Useful
Test final assembled battery polarity and voltage	Useful *
Install safety station	Useful

** The items noted were deemed to be useful or important primarily because most installations do not involve batteries and as such installers do not frequently perform the tasks. Each of these tasks becomes critical when installing battery systems and should be so noted.*

TASK STEP	CATEGORY

D: Installing Mechanical Components

1. Install Equipment Foundation

Locate center points of holes	Important
Place anchor hardware	Important
Install grounding equipment conductor (GEC)	Important
Excavate to design specifications	Useful
Build concrete forms	Useful
Coordinate foundation inspections	Useful
Identify location of underground utilities	Useful
Add structural reinforcement	Useful
Install wire raceways	Useful
Place concrete to design specifications	Useful
Install driven posts	Useful
Strip concrete forms	Useful
Backfill excavation	Useful
Place mounting posts	Useful

2. Install Mounting System

Install roof attachments	Critical
Weatherproof penetrations	Critical
Locate structural roof members	Critical
Determine array attachment locations	Critical
Install structural attachments	Critical
Install module support frame	Critical
Install rack components	Critical
Locate array footprint	Critical
Confirm compatibility with existing roofing system	Critical
Plumb array structure	Critical
Level array structure	Critical
Apply corrosion protection to cut surfaces	Critical
Install tracking apparatus	Important
Install actuator motors	Important
Install supplementary structural supports	Important
Confirm row spacing	Important
Confirm structural analysis has been performed	Important
Install structural members	Important
Locate ballast for mounting system	Useful
Install seismic and wind loading	Useful

TASK STEP	CATEGORY
3. Install PV Modules	
Unpack PV modules	Critical
Stage PV modules	Critical
Secure module wiring	Critical
Inspect module for physical damage	Critical
Fasten modules to structure	Critical
Torque module fasteners	Critical
Confirm module frame grounding	Critical
Align modules aesthetically	Critical
Determine project workflow	Critical
Test PV modules	Important
Prep PV modules	Important

E: Complete System Installation

1. Test the System	
Verify mechanical connection integrity	Critical
Verify system grounding	Critical
Verify electrical connection torque	Critical
Verify polarity	Critical
Measure DC voltages (string, output)	Critical
Verify inverter operation	Critical
Measure DC currents	Critical
Compare measured values with expected values	Critical
Measure AC system values	Critical
Perform physical inspection	Critical
Verify conduit fitting tightness	Critical
Verify conduit and wiring supports	Critical
Verify workmanship	Critical
Measure irradiance levels	Important
Calculate expected electrical parameters	Important
Verify anti-islanding system	Important
Test for ground fault	Important
Measure insulation resistance	Useful
Measure environmental levels	Useful
Confirm phase rotation	Useful

TASK STEP	CATEGORY
2. Commission the System	
Turn on system	Critical
Initiate start-up procedures per manufacturer instructions	Critical
Program variable set points	Critical
Measure all electrical parameters	Critical
Compare measured values to expected values	Critical
Monitor start-up process	Critical
Record anomalous conditions	Critical
Document design changes	Critical
Verify as-built documentation	Critical
Verify labeling accuracy	Critical
Note data and time of system start-up	Important
Repair anomalous conditions	Important
Record environmental conditions	Important
Record prior values on inverter	Important
Measure voltage of energy storage system	Important
Verify calculation of Total Solar Resource Fraction	Important
Verify polarity of energy storage system	Useful
Verify anti-islanding performance	Useful
Record voltage of energy storage system	Useful
3. Complete System Documentation	
File project photographs	Critical
Record component serial numbers	Important
Deliver as-built documents	Important
File permits	Important
Record certificates of inspection	Important
File inspection forms	Important
File commissioning forms	Important
File data sheets	Important
File proof of system test results	Important
Complete equipment warranty registration	Useful
Complete installation warranty registration	Useful

TASK STEP	CATEGORY
4. Orient Customer to System	
Explain start-up and shutdown procedures	Critical
Answer customer questions	Critical
Explain safety procedures to customer	Critical
Explain maintenance procedures	Critical
Address customer concerns	Important
Train customer on maintenance and operation procedures	Important
Explain equipment clearance requirements	Important
Perform customer walk-through	Important
Provide contact information to customer	Important
Explain normal operational performance	Important

F: Conducting Maintenance and Troubleshooting Activities

1. Perform Visual Inspection	
Verify equipment grounding	Critical
Inspect module mounting system	Critical
Identify hazards	Critical
Inspect weatherproofing systems	Critical
Inspect for wiring damage	Critical
Inspect module integrity	Critical
Check inverter status	Critical
Inspect electrical equipment	Critical
Identify damage due to corrosion	Critical
Identify array shading	Critical
Identify array soiling	Critical
Inspect cells for discoloration	Critical
Verify grounding system integrity	Critical
Look for unsupported wiring	Critical
Identify damage to module glazing	Critical
Document findings	Critical
Identify mismatched equipment	Critical
Inspect for working clearances	Important
Identify electrical connections damage due to overheating	Important
Confirm equipment serial numbers	Important
Inspect module back skin	Important
Check conduit fitting tightness	Important
Inspect for evidence of animals	Important
Identify vegetation growth	Important
Identify water ponding	Important
Identify ice damage	Important

TASK STEP	CATEGORY
2. Verify System Operation	
Measure system electrical parameters	Critical
Document found electrical parameters	Critical
Calculate expected electrical parameters	Critical
Compare expected parameters with found parameters	Critical
Note anomalous conditions	Critical
Test system electrical equipment operations	Critical
Recommend corrective actions	Critical
Verify source circuits are connected	Critical
Interview customer	Important
Document customer's concerns	Important
Compare historical kWh performance against expected kWh performance	Important
Measure equipment temperatures	Important
Note interannual weather variability	Important
Measure terminal temperatures	Important
Verify operation of battery venting systems	Important
Verify battery auxiliary systems	Important
3. Perform Corrective Actions	
Replace defective modules	Important
Check equipment variable set points	Important
Perform scheduled maintenance	Important
Replace frayed wires	Important
Replace blown fuses	Important
Replace faulty components	Important
Locate ground faults	Important
Repair ground faults	Important
Mitigate negative local conditions	Important
Locate line to line faults	Important
Repair line to line faults	Important
Document corrective actions	Important
Clean arrays	Useful
Service ventilation systems	Useful
Clean batteries	Useful
Recalibrate equipment at variable set points	Useful
Wipe down power conditioning equipment	Useful
Clean heat sinks	Useful
Schedule manufacturer on-site service call	Useful
Seal compromised weatherproofing systems	Useful
Perform battery maintenance	Useful

TASK STEP	CATEGORY
Perform controlled overcharge	Useful
Clean system labeling	Useful
Replace system labeling	Useful

4. Verify Effectiveness of Corrective Actions

Retest system operations	Critical
Retest electrical parameters	Important
Retest environmental conditions	Important
Compare pre-maintenance values to post-maintenance values	Important
Retest weatherproofing system	Useful
Reorient customer to system	Useful

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

NABCEP's PV Installation Professional Certification is North America's only renewable energy personnel certification that has been ANSI accredited to the internationally recognized ISO/IEC 17024 standard.

ANSI Accredited Program
PERSONNEL CERTIFICATION

#0702

Knowledge Groups for NABCEP Job Task Analysis

The topic list below provides the broad content areas from which the JTA was developed. The test items for the certification examination will be based upon the stated competencies in the JTA and not from general content in this topic list. Successful candidates will need to have knowledge in the topics listed below.

A detailed version of this list that includes subtopics is available on the NABCEP website (www.nabcep.org). This list is included as valuable information to help candidates evaluate their readiness for examination.

- Basic Electricity
- Building Codes
- Blueprint Reading
- Customer Relations
- Construction Processes
- Instrumentation and Measurements
- Mathematics
- National Electrical Code
- Occupational Safety and Health
- PV System Design
- PV System Installation
- Residential and Commercial Wiring
- Solar and PV Fundamentals

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