NABCEP LEARNING OBJECTIVES

The following learning objectives have been determined by NABCEP to be a relevant knowledge base for an entry level photovoltaic industry professional. NABCEP provides an exam that can award an "*Entry Level Certificate of Knowledge of PV Systems.*" NABCEP defines a person awarded this certificate as having, "…a basic knowledge of photovoltaic systems, suitable for a supervised, entry level position with a dealer/installer or other PV industry company. The skills identified in this analysis do not replace Electrical Trades, Technician, Technologist or Engineering training

0. Conservation & Efficiency (not covered by NABCEP –SLI adds this material)

1. PV Markets and Applications

1.1. Describe history of PV technology and industry

1.2. Describe markets and applications for PV (grid-tie, remote homes, telecom, etc.)

1.3. Identify types of PV systems (direct motor, standalone with storage, grid-backup, etc.)

1.4. Associate key features and benefits of PV with applications

2. Safety Basics

2.1. Identify safety hazards of operational and non-operational PV systems

2.2. Identify safety hazards, practices and protective equipment during PV system installation and maintenance (electricity, batteries, roof work)

3. Electricity Basics

3.1. Explain difference between energy and power

3.2. Define basic electrical terms

3.3. Describe the use of digital multi-meter

3.4. Calculate simple circuit values

4. Solar Energy Fundamentals

4.1 Define basic solar terms (e.g., irradiation, Langley, azimuth)

4.2 Determine true (solar) south from magnetic (compass) south given a declination map

4.3 Describe Basic solar movement and effect of earth tilt

4.4 Predict solar position using solar path diagrams

4.5 Describe angular effects on the irradiance of array

4.6 Identify factors that reduce/enhance solar irradiation

4.7 Determine average solar irradiation on various surfaces

4.8 Convert solar irradiation into a variety of units

4.9 Determine effect of horizon on solar irradiation (shading)

4.10 Demonstrate use of Solar Pathfinder or sun charts

5. PV Module Fundamentals

5.1. Explain how a solar cell converts sunlight into electric power

5.2. Label key points on a typical IV curve

5.3. Identify key output values of solar modules using manufacturer literature

5.4. Illustrate effect of environmental conditions on IV curve

5.5. Illustrate effect of series/parallel connections on IV curve

5.6. Define measurement conditions for solar cells and modules (STC, NOCT, PTC)

5.7. Compute expected output values of solar module under variety of environmental conditions

5.8. Compare the construction of solar cells of various manufacturing technologies
5.9. Compare the performance and characteristics of various cell technologies
5.10. Describe the components and construction of a typical flat plate solar module
5.11. Calculate efficiency of solar module
5.12. Explain purpose and operation of bypass diode
5.13. Describe typical deterioration/failure modes of solar modules
5.14. Describe the major qualification tests and standards for solar modules

6. System Components

6.1. Describe most common solar module mounting techniques (ground, roof, pole)
6.2. Compare features and benefits of different solar mounting techniques
6.3. Explain the relationship between solar module cell temperature and environmental conditions, given mounting method (e.g., NOCT)
6.4. Describe purpose and operation of main electrical BOS components (inverter, charge controller, combiner, ground fault protection, battery, generator)
6.5. Identify key specifications of main electrical BOS components (inverter, charge controller, combiner, battery, generator)

7. PV System Sizing

7.1. Illustrate interaction of typical loads with IV curve (battery, MPPT, dc motor)
7.2. Analyze load demand for stand-alone and grid interactive service
7.3. Identify typical system electrical output derating factors
7.4. Calculate estimated peak power output (dc and ac)
7.5. Calculate array and inverter size for grid-connected system
7.6. Calculate estimated monthly and annual energy output of grid-connected system
7.7. Explain relationship between array and battery size for stand-alone systems
7.8. Calculate array, battery and inverter size for stand-alone system

8. PV System Electrical Design

8.1. Determine series/parallel PV array arrangement based on module and inverter specifications
8.2. Select BOS components appropriate for specific system requirements
8.3. Determine voltage drop between major components

9. PV System Mechanical Design

9.1. Describe the relationship between row spacing of tilted modules and sun angle
9.2. Describe the mechanical loads on a PV array (e.g., wind, snow, seismic)

10. Performance Analysis and Troubleshooting

10.1. Describe typical system design errors
10.2. Describe typical system performance problems
10.3. Associate performance problems with typical causes
10.4. List equipment needed for typical system performance analysis
10.5. Compare actual system power output to expected
10.6. Identify typical locations for electrical/mechanical failure