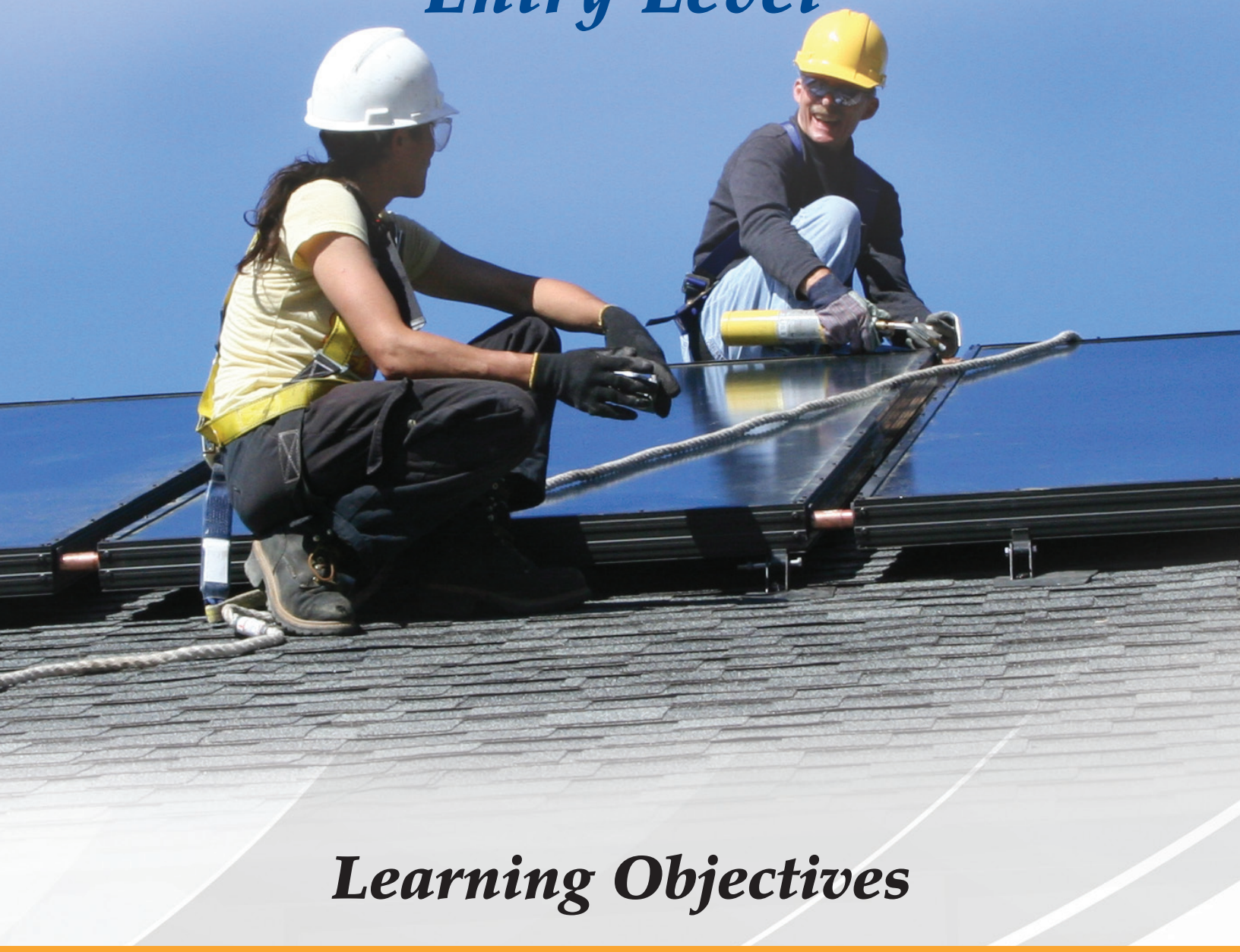
NABCEP

Solar Heating
Entry Level



Learning Objectives

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North American Board of
NABCEP
Certified Energy Practitioners®

Solar Heating Entry Level Learning Objectives

Introduction

The following document outlines the Learning Objectives that NABCEP's subject matter experts (SME) have identified as appropriate and relevant for Entry Level Solar Heating educational and knowledge assessment programs. The Learning Objectives were developed and validated through broad consultation with the Solar Heating community with representatives from manufacturers, distributors, installers, and educators all taking a strong and active role.

It is intended that this document will enable educators to develop curriculum that will prepare students for careers in the Solar Heating industry, which is experiencing record growth. NABCEP has developed an Entry Level Solar Heating Exam that is offered to students who complete programs based on these Learning Objectives offered by registered Providers. Achieving a passing score on this exam will indicate that the candidate has demonstrated basic knowledge of the fundamental principals of the application, installation, design and operation of solar heating systems in North America.

The NABCEP Board and staff wish to thank all the volunteers who aided in developing this document with special note to Bill Guiney, John Harrison and Dell Jones.

Major Content Domains

Entry level candidates will solve generic, basic problems applicable to commonly installed Solar Heating (SH) systems in North America using schematics, pictures and graphics to demonstrate fundamental SH knowledge by:

1. ***Conducting a site analysis, including load analysis***
2. ***Identifying SH safety practices, standards, codes, and certification***
3. ***Identifying systems for specific climates and applications***
4. ***Identifying proper operation and installation methods***
5. ***Identifying proper use of balance-of-system components and materials (e.g., controllers, tanks, pumps, valves, piping, etc.)***
6. ***Identifying common SH maintenance items***

Given common North American applications of SH systems and schematics, pictures, and graphics (as needed), each entry level candidate will solve generic, basic problems using solar fundamentals by:

1. Conducting a site analysis, including load analysis

1.1	Describe the fundamentals of solar radiation
1.2	Explain how the sun's annual path affects seasonal performance variation based on orientation and tilt of collectors
1.3	Demonstrate the use of shading analysis tools
1.4	Explain the effects of compass declination for various geographical locations in the U.S.
1.5	Explain the physical principles (conduction, convection, radiation, absorptance, reflection, thermal mass, etc.) that affect solar thermal technologies
1.6	Explain the various roof types, materials (shingle, tile, built-up, metal, synthetic surface), structures (rafters/trusses) and how they impact the installation of solar collectors
1.7	Describe the structural roof and wind loads that affect solar collector installations
1.8	Evaluate the required installation area, orientation, and tilt for proposed collector installation
1.9	Determine the extent of existing and future shading for proposed collector location using typical sun path calculators or similar devices
1.10	Evaluate the structural integrity and suitability of roof and ground-mount collector installation sites
1.11	Determine soil conditions and integrity for footing design and pipe path. (Local codes or site conditions may require additional engineering expertise)

2. Identifying ST safety practices, standards, codes, and certification

2.1	Identify the major government, certification, research, training, and information organizations that impact solar thermal and heating in the U.S. (i.e., DOE, SRCC, IAPMO, SANDIA, NREL, DOE, FSEC, SEI, NABCEP, IREC, DSIRE,USH2O, etc.)
2.2	Demonstrate safe and accepted practices and safety equipment for personnel protection
2.3	Identify appropriate codes and standards concerning installation, operation and maintenance of solar thermal systems and equipment
2.4	Identify physical personnel safety hazards associated with solar heating installations (roof work, attic temperature, electrical, etc.)
2.5	Identify environmental hazards associated with solar heating installations through demonstrated awareness of pertinent Material Safety Data Sheets and other appropriate documents
2.6	Determine components that require identification tag and/or label (per system certification guidelines)

3. Identifying systems for specific climates and applications

3.1	Describe components specific to active direct solar systems
3.2	Describe components specific to active indirect solar systems
3.3	Describe components specific to passive direct solar systems
3.4	Describe components specific to passive indirect solar systems
3.5	Describe components specific to combination water and space heating (combi) systems
3.6	Describe components specific to swimming pool heating solar systems
3.7	Determine the appropriate system types for specific applications, environmental conditions, and geographical locations
3.8	Describe the various thermal system sizing programs and demonstrate a basic understanding of their use, applications, restrictions, and capabilities
3.9	Size a system for specific loads to avoid over-sizing and resultant over-heating
3.10	Identify freeze protection, over-heating protection, and other mechanisms/ procedures to address low and high temperatures and water quality issues
3.11	Describe national certification programs for collectors and systems
3.12	Apply national collector and system ratings to determine collector and system selection and sizing

4. Identifying proper operation and installation methods

4.1	Determine active direct system layout and components location and configuration
4.2	Determine active indirect system layout and components location and configuration
4.3	Determine passive direct system layout and components location and configuration
4.4	Determine passive indirect system layout and components location and configuration
4.5	Determine solar pool system layout and components location and configuration
4.6	Describe the various roof mounting strategies (stand-off, rack, lag-bolt, j-bolt mounting methods)
4.7	Describe the method of attaching mounting hardware to a collector
4.8	Describe collector mounting methods suitable for various roof and racking types
4.9	Understand specific manufacturers' mounting design, materials and installation methods and requirements.
4.10	Identify collector and roof-mounted storage tank dead load requirements
4.11	Identify locations for roof/ wall, foundation penetrations, and structural attachments
4.12	Determine multi-collector piping strategy (configuration and balancing)
4.13	Explain the method of weather sealing roof penetrations and other structural devices with code and industry-acceptable flashings and sealants
4.14	Determine water heater ports to be used for solar and plumbing lines
4.15	Determine water heater dip tube strategy (purpose, location, and internal configuration)
4.16	Determine plumbing retrofit method to be used if conventional water heater tank (electric or gas) is used
4.17	Determine that water heater and storage tanks are installed per manufacturers' installation recommendations and local codes
4.18	Determine expansion of pipe and its effect on hangers and the integrity of the pipe
4.19	Determine type, length, and diameter of copper piping required
4.20	Determine type, length, and diameter of plastic piping required
4.21	Determine type, length, and diameter of insulation required
4.22	Describe ultraviolet radiation protective methods and materials for exposed insulation
4.23	Determine type of pipe flashing to use for specific roof types
4.24	Determine the area where pipe flashing will be installed
4.25	Describe pipe flashing and sealant installation
4.26	Determine slope strategy of piping to avoid traps on horizontal runs
4.27	Describe pipe hangers and supports
4.28	Determine underground piping methods
4.29	Identify plumbing, valves and other mechanical/plumbing components required for particular systems
4.30	Determine location of plumbing valves and other components
4.31	Describe the installation of valves and monitoring system components as specified in component manufacturer or system manufacturer installation manual and schematic
4.32	Determine the heat exchanger location

Continued

4. Identifying proper operation and installation methods Continued

4.33	Determine pump location
4.34	Describe the operation and installation of differential controller and sensors
4.35	Describe the operation and installation of photovoltaic module controller and DC pump
4.36	Select ultraviolet radiation protective method(s) for external wiring
4.37	Determine that the system mechanical installation has structural integrity and is weather sealed
4.38	Determine that the system plumbing installation is correctly installed
4.39	Determine that the electrical installation is correctly installed
4.40	Describe system start up and shut down functionality
4.41	Describe overall system operation and functionality

5. Identifying proper use of system components and materials (e.g., collectors, controllers, tanks, pumps, valves, piping, etc).

5.1	Describe the various types and designs of solar collectors used in thermal systems.
5.2	Compare and contrast the types of solar collectors used in thermal systems.
5.3	Identify and explain the operational function and installation requirements of differential controllers and associated sensors
5.4	Identify and explain the operational function and installation requirements of solar water heating system energy monitoring/metering equipment and sensor placement
5.5	Identify and explain the operational function and installation requirements of circulators and pumps used in various solar water heating systems (types, materials, uses, restrictions, AC and DC, low and high head, multi-speed, matching DC pumps with PV modules, pump curves, sizing, etc.)
5.6	Identify and explain the operational function and installation requirements of the various valves that are used in all manners of solar water heating systems (including, but not limited to: air vents, air-separators, anti-scald, tempering, boiler drain, mechanical and electric check, freeze, isolation, pressure gauge, pressure relief, temperature-pressure relief, vacuum breaker, solenoid, diverter, balancing, etc.)
5.7	Identify and explain the operational function and installation requirements of system monitoring components (flow meter, temperature gauge, BTU meter, controller integrated BTU meter, etc.)
5.8	Identify and explain the operational function and installation requirements of solar water heating system piping, (including, but not limited to, copper piping and fittings [types and sizes], solder types [including brazing], pipe hangers, plastic piping [commonly-used types, sizing, temperature and support restrictions], flow rates, sizing, etc.)
5.9	Identify and explain the operational function and installation requirements of insulation used in solar water heating systems. (This includes UV protection materials and methods, rubber versus plastic, residential versus commercial, use on piping, use on water heaters, use on heat exchangers, etc.)

Continued

5. Identifying proper use of system components and materials Continued

5.10	Identify and explain the types and operational function and installation requirements of solar storage tanks (This includes solar only, solar with electric element, existing retrofits, tanks with heat-exchangers, solar with gas back up, conventional tanks, multiple tank systems, etc.)
5.11	Identify and explain the types and operational function and installation requirements of heat exchangers. (Single and double wall classifications, tube in tube, tube in shell, plate, materials used, efficiency, sizing, service, etc.)
5.12	Identify and explain the operational function and installation procedures of heat transfer fluids. (Types, uses, maintenance, restrictions, MSD sheets [Material Safety Data], GRAS designation [Generally Recognized As Safe].)
5.13	Identify and explain the operational function and installation requirements of expansion tanks. (Types, sizing, pressure setting, installation.)
5.14	Identify and explain the operational function and installation requirements of water supply. (Water conditions as they relate to system type, pH and TDS [Total Dissolved Solids] checks and what the resulting values signify.)

6. Identifying common SH Maintenance Items

6.1	Demonstrate proficiency in using tools and materials required for maintenance and troubleshooting
6.2	Demonstrate the ability to use a multi-meter and how it is used to troubleshoot control and electrical malfunctions
6.3	Interpret installation manual, plumbing diagrams, drawings, and other specifications to plan maintenance or repair work
6.4	Explain maintenance requirements and maintenance tasks for specific system types
6.5	Determine evaluation points for system monitoring, maintenance and troubleshooting (i.e., sensor calibration, heat exchange fluid integrity, pump operation)
6.6	Define how to evaluate the acidity and freeze protection levels in antifreeze solutions.
6.7	Identify cause of problems based on evaluation results and troubleshooting checklists
6.8	Determine what repairs or system modifications are needed to restore the system to its baseline operating conditions

Exam Blueprint

	Content Domains	# items for a 60 item exam	% of exam
1	Conducting a site analysis, including load analysis	9	15%
2	Identifying SH safety practices, standards, codes, and certification	4	7%
3	Identifying systems for specific climates and applications	7	12%
4	Identifying proper operation and installation methods	26	43%
5	Identifying proper configuration of balance-of-system components and materials (e.g., controllers, tanks, pumps, valves, piping, etc.)	9	15%
6	Identifying common SH Maintenance Items	5	8%
	Total	**60**	**100%**

Note: The objectives listed below are not included in the Exam or the above Learning Objectives but should be taught in the course as background information.

- Describe the history of solar heating technology in the US
- Describe the solar heating market structure (manufacturers, distributors, installers, energy service companies, utilities, etc.)
- Describe the specific markets and applications for solar heating systems (residential, commercial, high temperature, power, etc.)

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