SEIA Solar Energy Industries Association®

SEIA 251

Solar and Energy Storage Installation Requirements Standard: Large Commercial & Industrial Systems

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Foreword

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1.0 Purpose & Scope

1.1 Purpose

The purpose of this standard is to establish the design, installation and quality requirements of renewable resources to be installed in large commercial and industrial applications, to ensure their adequate integration with electrical distribution systems, and to promote their performance and longevity.

Note: This standard may require compliance with installation specifications and other requirements that may exceed AHJ, manufacturer, or Code requirements in keeping with its purpose. In jurisdictions where installations specifications or other requirements from AHJs or Code conflict with those established in this document, the most stringent requirement shall prevail for compliance with this standard.

1.2 Scope

This standard sets forth criteria for the design and installation of 250kW to 5MW utility-interactive solar photovoltaic systems, energy storage systems, and energy storage systems connected with solar photovoltaic systems installed on commercial, and industrial properties. The scope includes all parts of the PV array, balance of system, microgrids, and energy storage. This standard also includes contractor and finance provider qualifications, quality control and management, and inspection processes.

This standard does not cover:

- Solar thermal energy systems.
- Utility scale power generation, storage or loads.
- Non-utility interactive systems.
- Systems intended to operate under concentrated sunlight.
- The AC premises and service electrical system.

Note: This standard is intended to provide the requirements for systems to be installed with the qualities detailed in this section. Some information included in standards UL 62446-1 and UL 62446-2 may be helpful but is not required under this standard.

2.0 Normative References

The codes and standards referenced in this document shall be considered to be part of the requirements of this standard to the prescribed extent of each such reference.

Appendix A contains a complete list of all referenced documents.

3.0 Definitions & Abbreviations

3.1 General

For the purposes of this standard the terms and definitions of section 3 apply.

3.1.1 Authority Having Jurisdiction (AHJ)

"An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure" (NFPA 70). This is typically a local (e.g., town, city, or county) authority responsible for the permitting and approval of solar PV installations. E.g., electrical and/or building inspectors, fire marshals, and/or local utility representatives.

3.1.2 Balance of System

The Balance of System (BOS) encompasses all components of a photovoltaic system other than the photovoltaic array e.g., wiring, switches, solar inverters and equipment not attached to array, and ESS.

3.1.3 Contractor/Installer

The Contractor/Installer will typically have the physical resources (e.g., staff, equipment, licensing) to complete installations. These installations may be completed by Contractor staff and/or using subcontractors (including electricians, laborers, roofers, and other tradespeople) and the Contractor will bear responsibility for the installations, which may include holding relevant warranties, and agreements with the Finance Providers to install and maintain the systems.

3.1.4 Contractor QM Inspector/Verifier

A Contractor QM inspector or verifier is part of the installation company (e.g., part of the O&M division).

3.1.5 Developer

A developer is a person, association, or company which identifies locations for solar and/or energy storage installations, secures the land or roof space, and assures the feasibility of a solar and/or energy storage project. They are responsible for the design, planning, and contracting of a project, may be the legal or beneficial owner, and may be responsible for the operation and maintenance of the finished project.

3.1.6 Finance Provider

The Finance Provider will take funds and originate loans, leases, or other financing products that are executed with host customers (i.e., homeowners). While the Finance Provider may have a role in managing PV installations, they more typically will work with contractors who handle day-to-day customer interaction and installation activities until the PV system is operating.

3.1.7 Inspection

An official examination of an installation by persons representing an AHJ or municipality to ascertain compliance with codes, standards, and plan review requirements.

3.1.8 Interconnection

Single or multiple connections between electricity generators, energy storage, and utility systems enabling electric power and energy to be exchanged between these networks by means of electric circuits and/or transformers (IEC Glossary, modified).

3.1.9 Investor

The investor originates funds to underwrite portfolios of large commercial and industrial PV installations. They generally have little day-to-day involvement in managing the portfolio but may have due diligence requirements that would apply during transactions, such as purchasing a portfolio of solar loans or leases.

3.1.10 Microgrids

A group of interconnected loads and distributed energy resources with defined electrical boundaries forming a local electric power system at service voltage levels, that acts as a single controllable entity and is able to operate in either grid-connected or island mode (IEC Glossary, modified).

3.1.11 Program Administrator
A board, committee, individual, or group responsible for the operation of a program that provides public funds to contractors, finance providers, or owners to support the sales, design, installation, and maintenance of solar PV and energy storage systems.

3.1.12 PV Array
A mechanically and electrically integrated grouping of PV modules with mounting structure, including any attached system components e.g., inverter(s), dc-to-dc converter(s), and attached associated wiring (NFPA 70).

3.1.13 Real Property
Property identified by a permanent street address and the buildings thereon, including any improvements thereon and all fixtures that are not temporary or mobile.

3.1.14 Third-party Verifiers
A third-party inspector or verifier can be part of the installation company (e.g., part of the O&M division), a representative from a Finance Provider or incentive program, or an entirely separate entity.

3.1.15 Verification
An examination of on-site conditions or a review of supplied evidence to confirm or substantiate quantity and type of equipment installed, operation of systems, and compliance with this standard by persons representing installers, finance providers, incentive programs, or third-party inspection companies.

3.1.16 Utility Scale
Systems interconnected at transmission voltage levels.

3.2 Abbreviations

AC	Alternating Current	LFMC	Liquid-tight Flexible Metal Conduit
AHJ	Authorities Having Jurisdiction	MPPT	Maximum Power Point Tracking
BOS	Balance Of System	NEC	National Electrical Code
CFR	Code of Federal Regulations	OCPD	Overcurrent Protective Device
DC	Direct Current	OSHA	Occupational Safety and Health Administration
EOR	Engineer of Record	PV	Photovoltaic
EGC	Equipment Grounding Conductor	PVRSE	PV Rapid Shutdown Equipment
ESS	Energy Storage System	RSD	Rapid Shutdown Devices
ETL	Electrical Testing Laboratories	TSRF	Total Solar Resource Fraction
GEC	Grounding Electrode Conductor	UL	Underwriters Laboratories
IEEE	Institute of Electrical and Electronics Engineers	WEEB	Washer, Electrical Equipment Bond
JHA	Job Hazard Analysis		

4.0 Contractor Qualifications

4.1 Contractor Work Performance

The Contractor shall have work performance experience that demonstrates its ability to install safe and reliable solar PV systems. The Contractor shall meet minimum general requirements and minimum personnel qualifications as set forth below.

4.1.1 The Contractor shall have a successful track record of design and construction of similar type and scale projects, completed on time and on budget. The Contractor shall demonstrate this experience through:

- At least 3 years company work experience in design, engineering and installation of commercial scale solar PV systems.
- Project experience in relevant project types and installation regions.
- References from similar projects.

4.2 Financial Transparency

The Contractor shall be in compliance with SEIA 401, Solar and Energy Storage Consumer Protection Standard or equivalent.

4.3 Customer Acquisition, Sales and Contracting

The Contractor shall be in compliance with SEIA 401, Solar and Energy Storage Consumer Protection Standard or equivalent.

4.4 Contractor Health and Safety

The Contractor shall create and maintain a health and safety program and manual which establishes appropriate rules and procedures concerning workplace safety, including rules related to the reporting of health and safety problems, injuries, and unsafe conditions; risk assessment; and first aid and emergency response.

The program requirements shall include:

- Site Supervisors, or equivalent positions, shall complete the Occupational Safety and Health Administration (OSHA) 30-hour Construction and General Industry training.
- All site personnel shall complete the OSHA 10-hour Construction Industry training and the OSHA Ladder Safety course.
- Provide guidance for site personnel to identify hazards, provide corrective actions, and prevent recurrence specific to solar PV systems.
- All site personnel shall be equipped with all necessary Personal Protective Equipment (PPE) and trained on any specific hazards associated with their jobs.
- Contractor Site Supervisor shall complete a Job Hazard Analysis (JHA).
- Contractor Site Supervisor shall complete a jobsite orientation with all workers onsite.
- The Contractor shall maintain an Injury and Illness Prevention Program (IIPP) and manual and conduct regularly scheduled training on all operations impacting employees.

4.5 Contractor Insurance and Bonding

4.5.1 The Contractor shall maintain current and appropriate minimum business insurances, including liability insurance, workers' compensation insurance, and commercial vehicle insurance.

- General liability - $1,000,000 per occurrence, $2,000,000 aggregate.
- Workers' compensation, if required - $1,000,000 for each accident, each employee, policy limit.
- Automobile Liability: bodily injury, death, and property damage combined single limits of at least $1,000,000 per occurrence covering vehicles owned, hired, or non-owned.
- Professional Liability at appropriate levels if the Contractor is also designing systems.
- Cyber Liability insurance at appropriate levels if the contractor is storing confidential customer data.
- Notice of cancellation to additional insured shall be required.

4.5.2 The Contractor shall provide Surety Bonds, Payment Bonds, Warranty Bonds, and Supply Bonds, as required.

4.6 Contractor Personnel Qualifications

4.6.1 The Site Supervisor or designated responsible party shall have the professional qualifications required by state or local authorities.

4.6.2 Personnel engaged in "electrical installations" as defined by the local authority having jurisdiction shall meet the definition of "Qualified Person" indicated in NFPA 70E and shall hold any credential required by the AHJ for performing such work.

4.6.3 A Site Supervisor shall have completed 40 hours of solar PV technical course training.

Note: Some Contractors may have proprietary training and education programs that are more specific to the job duties performed by their personnel, which may meet or exceed training and experience requirements for the certifications above.

4.6.4 The Engineer of Record shall be licensed as a Professional Engineer (PE) in the state where the project is located. The PE shall be qualified and experienced in the relevant specific discipline (e.g., electrical power, electrical controls, structural, environmental, mechanical).

4.6.5 The Project Manager shall meet minimum general requirements and qualifications as set forth below.

- Commercial or utility construction experience.
- Solar PV experience on commercial, industrial, or utility-scale projects.

4.6.6 The Quality Manager shall meet minimum general requirements and qualifications as set forth below.

- Commercial or utility construction experience.
- Demonstrated experience with design and construction practices for solar PV projects.

4.7 Contractor Trade License

The Contractor shall have all professional and trade licenses required by the state and local AHJ.

4.8 Contractor Business License

The Contractor shall have all applicable business licenses required to sell and install commercial, industrial solar and storage PV systems in each state of current operation.

4.9 Program Requirements

The Contractor shall maintain all applicable requirements for program participation in good standing to assure eligibility in states where the Contractor will need to be registered with, or pre-approved by, an organization or agency so that consumers can participate in incentive programs or other renewable energy programs.

4.10 O&M Provider Qualifications

4.10.1 The O&M Provider shall have work performance experience that demonstrates its ability to maintain safe and reliable solar PV systems.

4.10.2 O&M Provider Personnel shall have the professional qualifications and licenses required by state or local authorities. In instances where the project is registered with the Regional Transmission Operator (RTO), the site O&M lead shall also be certified by the North American Energy Reliability Corporation (NERC).

4.10.3 O&M personnel and on-site operations shall comply with the provisions of SEIA 301, Solar and Energy Storage Operations and Maintenance Standard Technician Training.

4.11 Developer Qualifications

4.11.1 The Developer shall have work performance experience, qualified personnel and financial capacity that demonstrates its ability to complete safe and reliable solar PV systems.

4.11.2 The Developer shall maintain current and appropriate business insurances, including liability insurance, workers' compensation insurance, and commercial vehicle insurance commensurate with investor requirements and the type and scale of development.

5.0 Design and Equipment

***Source*:** Standard SEIA 201, section 5.

5.1 Site Assessment

The Contractor shall gather and document relevant site-specific information such that the system designer can design a system appropriate for the application and compliant with this standard.

***Note*:** Where applicable, a site assessment involves a survey that includes:

- A possible suitable location for the array.
- The impact of shade on the array location.
- The mounting method for the array.
- Where the Balance Of System (BOS) components will be located.
- Where the Energy Storage System (ESS) components will be located.
- Which loads will be served by the ESS.
- How the PV system will interface with the existing electrical system.

5.2 Solar Resource

The solar resource shall be measured and documented with an industry standard handheld tool on site, or a remote shade analysis tool verified by an objective third party.

***Note*:** Incentive programs and Finance Providers may require a minimum TSRF. The most common requirement is an average 80% TSRF across each array. Some programs use 70% for full funding, others a graduating scale reducing funds for projects below 70% or 80%.

5.2.1 For handheld measurement tools, the shade measurement locations for each proposed array section shall include at least the approximate corner locations of the proposed array(s) and along long edges of the proposed array(s), as needed, such that there is no more than 20 ft in between measurements along the edge.

Problem areas, such as the north side of tall obstructions (e.g., chimneys), shall also be measured. Problem areas shall be measured at the approximate point on the proposed array that is nearest the obstruction.

5.2.2 For remote shade analysis tools, each person using the tool must complete the manufacturers' official training. In completing the report, the complete roof structure will be drawn, all shade objects shown clearly, and available radar or other available measurement data applied.

5.3 Production and Savings Estimates

The Contractor shall be in compliance with SEIA 401, Solar and Energy Storage Consumer Protection Standard or equivalent.

5.4 System Design

5.4.1 System shall be installed on real property.

5.4.2 System shall meet the interconnection requirements of the utility serving the site.

5.4.3 The installation shall be able to be completed to industry standard with professional and skillful quality.

5.4.4 System shall be designed for optimal annual performance. 'Optimal' will primarily be judged by customer benefit and bill savings, not just energy production. For example, a south facing array may provide more total production, while a more west facing array may produce more energy later in the day when electrical rates are higher providing better customer benefit.

Note: Trade-offs in system performance due to sub-optimal tilt and orientation when installing systems in a manner that blends in with the building architecture can greatly enhance the aesthetics of the installation and thereby increase long term public support for solar., which keeps with the purpose of this standard.

5.4.5 A rooftop system shall not be installed unless the roof covering on the roof section that will be located under the array has sufficient useful life remaining such that re-roofing or recovering will not be needed within 10 years of system installation unless a written disclosure is provided to the purchaser. The roof life should be evaluated by following the methods indicated in Appendix C.

5.4.6 A site-specific informational-only estimate to remove and replace the existing system at the time of reroofing or recovering shall be provided.

5.4.7 Energy Storage Systems (ESS) shall be designed so the system maximizes the owner's economic and/or operational benefit. The programming of an Energy Storage System (ESS) shall maintain an output and capacity to optimize time of use, resilience, and/or backup loads as appropriate. Setup information shall be part of the design documents.

5.4.8 System design shall be documented with a site plan (as-built diagram) that accurately describes locations of major system components. Documentation shall be shared with the purchaser. The diagram shall include, if applicable:

5.4.8.1 Layout of roof or installation location, including existing obstructions.

5.4.8.2 Tilt and orientation for each solar array.

5.4.8.3 Locations of documented TSRF measurement(s).

5.4.8.4 Locations of installed modules, inverter(s), and Energy Storage Systems.

5.4.8.5 Locations of all other generation and energy storage equipment on site (e.g., photovoltaic, backup generator, hydropower and wind components).

5.4.8.6 Locations of all applicable electrical panels, subpanels, meters, rapid shutdown devices, rapid shutdown initiation devices, emergency shutdown initiation devices and disconnects.

5.4.9 System design shall be documented with a one-line diagram that accurately shows all electrical components to be installed (e.g., modules, inverters, Energy Storage Systems (ESS), disconnects, and meters) and the wiring design. The diagram shall include, if applicable:

5.4.9.1 Manufacturer and model number of all system components (e.g., module, inverter, Battery Energy Storage System (BESS), battery, controls and rapid shutdown devices).

5.4.9.2 Module series/parallel wiring.

5.4.9.3 Wire run from array to point of utility interconnection, including applicable sub-panels, with pre-existing wiring or sub-panels used in the AC run clearly described and labeled.

5.4.9.4 Conductor and ground wire types and sizes.

5.4.9.5 Conduit types and sizes.

5.4.9.6 Voltage drop calculations.

5.4.9.7 AC and DC Overcurrent Protective Device (OCPD) sizing.

5.4.9.8 All other generation and energy storage equipment on site.

5.4.9.9 System size (rated inverter power, PV array DC watts) and BESS capacity.

5.4.10 System design documents shall include:

5.4.10.1 Equipment data sheets.

5.4.10.2 A data sheet for the PV array mounting system and installation details for the roof attachments or ballasts if roof-mounted or support structure if ground mounted.

5.4.10.3 ESS design and programing documentation, if applicable.

5.4.10.4 Available structural drawings.

5.4.11 PV systems shall be sized to ensure that operating voltage remains 10% greater than the minimum DC input MPPT voltage of the connected power electronics. The operating voltage shall be calculated using the ASHRAE 2% local design temperature as the cell temperature.

5.4.12 DC PV Conductors shall be sized to keep voltage drop within the operating requirements of section

5.4.11. Voltage drop shall be calculated using temperature-adjusted Vmp (max power voltage) of the array for the location's average high temperature adjusted with the temperature adders.

5.4.13 AC Inverter output conductors shall be sized to keep voltage drop within limits required by the manufacturers listed instructions from the inverter to the point of interconnection. In the absence of manufacturer guidance, conductors shall be sized to keep voltage drop at or below 2%.

Example points of interconnection include the distribution panel that contains the main service disconnect(s), a supply-side tap, a pre-existing sub-panel with other loads, a generator transfer switch, or a switchgear.

5.4.14 Array mounting systems and modules shall be designed to meet local wind, snow and seismic load requirements. Thermal break requirements for both the attachments and racking shall be designed according to the manufacturer's recommendations.

Note: Roof attachments may have different thermal break requirements than the mounting system. Ensure the lesser of the two are included in the array design. PV modules shall not be installed over a thermal break.

5.5 Equipment Requirements

5.5.1 All installed system components shall be new or certified reconditioned.

5.5.2 All electrical equipment shall meet appropriate standards and shall be tested and listed by a nationally recognized testing laboratory (e.g., UL, ETL, or equivalent).

5.5.2.1 **Photovoltaic modules** shall be listed to UL 61730-1 or their successor standards. BIPV shall meet the requirements indicated in document UL 7103.

5.5.2.2 **Inverters** shall meet IEEE 1547 (listed to UL 1741 SA or 1741 SB) or their successor standards as applicable.

5.5.2.3 **Photovoltaic mounting systems** and clamping devices used as part of a grounding system shall be listed to UL 2703 or successor standard. PV mounting systems shall be listed and installed to meet the PV Hazard Control System requirements indicated in the NEC, and UL 3741 when applicable.

5.5.2.4 **Photovoltaic mounting systems** for solar trackers and clamping devices used as part of a grounding system shall be listed to UL 3703 or successor standard.

5.5.2.5 **Energy Storage Systems** shall be listed to UL 9540 or successor standards.

5.5.2.6 **Batteries** shall be listed to UL 1973 or successor standards.

5.5.2.7 **Labeling** shall be in compliance with OSHA 29 CFR 1910.145.

5.5.3 Each system shall have the ability to measure total AC system production in kilowatt-hours with at least +/- 0.5% accuracy using one of the following methods:

5.5.3.1 A production meter built-in to the inverter. It shall appear on the List of Eligible Inverters provided by the California Energy Commission as having an approved built-in meter.

Note: Refer to the following URL for details: https://solarequipment.energy.ca.gov/Home/MeterList

5.5.3.2 A system performance meter (i.e. a microinverter monitor). It shall appear on the List of Eligible System Performance Meters provided by the California Energy Commission.

Note: Refer to the following URL for details: https://solarequipment.energy.ca.gov/Home/MeterList

5.5.3.3 A hard wired production meter compliant with NEMA C12.1-2022.

5.5.3.4 Multiple-inverter systems may either combine output through a dedicated sub-panel from which the output is metered or use one electric meter/monitor for each inverter.

5.5.3.5 When a hard-wired production meter is installed, the solar system meter shall have a UV-resistant label identifying it as the Customer Owned Solar Generator Output.

5.5.3.6 All hard-wired meters shall be set at 000000 or 999999 at time of shipment to the installer to ensure accurate and consistent "start" readings for every system.

5.5.4 Equipment shall be installed with the minimum expected productive and mechanical service life specified in the chart below.

Equipment	Minimum Expected Service Life
Inverters	10 years
PV Modules	25 years
Energy Storage	10 years

Note: Acceptable evidence of meeting this requirement shall be determined by the Program Administrator or AHJ. Such evidence may include statements of warranty or production processes, e.g., for modules: tested to UL 61730-1 in an ISO 9001 system.

5.5.5 All electrical equipment shall be listed for the voltage and current ratings necessary for the application.

5.5.6 Equipment shall not be modified such that it voids the listing beyond the manufacture's specifications and intended use.

5.5.7 All required Over-Current Protective Devices (OCPD) shall be included in the system and accessible for maintenance. The inspection or maintenance of OCPD shall not require the removal or displacement of modules or other obstructions.

5.5.8 Junction boxes and combiner boxes shall be listed and suitable for their environment and conditions of use. Boxes used in damp or wet locations shall have water-tight or properly flashed covers, screw holes and conduit connections meeting a minimum NEMA 3R type of enclosure as indicated in standard NEMA 250.

5.5.9 Inverters, AC Modules, MLPE and ESS shall include the installation of manufacturer-provided equipment that allows local monitoring of system performance and identification of errors if available, e.g., on site readout, cloud-based app or remote readout.

5.5.10 For hybrid systems with power production sources installed in addition to PV, battery overcharge protection and/or diversion controller and diversion loads shall be installed.

5.5.11 Materials used outdoors shall be sunlight/UV-resistant and listed for outdoor locations.

5.5.12 Materials used shall withstand the temperatures to which they are exposed.

5.5.13 Dissimilar metals that have galvanic action (such as aluminum and copper) shall be isolated from one another using industry standard practices. For conductors, only connectors identified for the material of the conductor shall be used.

5.5.14 Aluminum shall not be placed in direct contact with concrete materials.

5.5.15 Fasteners used to secure modules and racking equipment shall be stainless steel or specified by the manufacturer. For substructural components, only corrosion resistant fasteners shall be used. Stainless steel bolts shall be designed to prevent galling and allow for removal during system maintenance or repair.

5.5.16 Mounting systems shall be corrosion resistant and designed to last the expected useful life of the modules.

6.0 Installation

Source: Standard SEIA 201, section 6.

6.1 General Requirements

The Systems shall be properly permitted, inspected, and in compliance with all applicable building and electrical codes as well as this standard.

6.1.1 All components shall be mounted securely and attached according to the manufacturer's installation instructions when applicable.

6.1.2 The roofing system shall be protected from damage during system installation using industry-standard methods e.g., protective mats and appropriate clean footwear. Any damage created during installation that may impact the warranty or expected useful life of the roofing system shall be repaired and disclosed in writing to the owner.

6.1.3 All building penetrations shall be sealed and fire resistance maintained.

6.1.3.1 To prevent intrusion by insects, vermin, or weather, all penetrations to the building shell (e.g., walls) resulting from the installation of the solar system shall be permanently sealed with appropriate water and pest-proof materials.

6.1.3.2 Any penetrations through fire-rated assemblies shall be sealed and shall not reduce the fire resistance required by local codes and standards.

6.1.4 All listed and/or labeled electrical equipment shall be installed and used as shown in the manufacturer's instructions and this standard.

6.1.5 All electrical terminations shall be torqued to specification, secured, and have strain relief as appropriate.

6.1.6 All cables, conduit, exposed conductors, and electrical boxes shall be secured and supported according to code requirements and in accordance with their performance ratings.

6.1.7 Conduit used for DC conductors shall be metallic raceways or raceways required by listed installation manuals. Where allowed by state or local codes PVC conduit may be used below grade, and above grade in marine climates.

6.1.8 Readily accessible disconnect switch covers (not switch handles) which when opened exposes live parts shall be secured closed for safety. Because this may interfere with access during an inspection, the means to secure the cover may be left with the customer or system owner with instructions for use.

6.1.9 Non-current carrying metallic equipment (both DC and AC) shall be grounded per the requirements of the NEC, and equipment manufacturer, e.g., metal raceways, enclosures, mounting systems, (when applicable) module frames and conduit fittings.

6.1.10 Interconnection shall not be made into the existing customer panel if the safety of the panel has been obviously compromised, or if the make and model of the panel has been subject to recall, or the manufacture of that panel has been discontinued because of documented failures.

6.2 Mounting/Racking Systems

6.2.1 All mounting hardware shall be installed according to manufacturer installation instructions and this standard.

6.2.2 All penetrations through the roof plane shall be flashed and sealed according to local codes, standards, and roofing manufacturer's requirements. Sealant compounds used shall be appropriate for the roofing material and application and shall not be the sole method of waterproofing. Flashing systems third-party certified to the UL 2703A shall meet the requirements of this section when installed according to their listed installation instructions.

6.2.3 Array placement shall comply with access setbacks and distance from vent penetrations and rooftop equipment as required by local codes and standards.

6.2.4 System components shall all be from the same listed system or approved by the manufacturer.

6.2.5 If there is a Lightning Protection System (LPS) existing on the building, the Engineer of Record for the PV system shall make a determination as to whether to bond the array and racking system equipment ground to the LPS grounding system and the method to accomplish that purpose.

6.2.6 Engineered and tested snow retention devices shall be installed where required by degree of hazard in specific areas where individuals are at risk of snow/ice shedding (e.g., over building entries, driveways and decks). System designs shall incorporate the additional loads added by the snow retention devices in the load calculations.

6.2.7 Photovoltaic rooftop mounting systems shall be listed to UL 2703 or successor standard for mechanical loading and system fire classification as applicable.

6.3 Ground Based Mounting/Racking Systems

6.3.1 Array racking placement shall comply with property line setbacks and physical size required by local codes and standards.

6.3.2 Soil testing shall be done in areas known to have corrosive or acidic soils.

6.3.3 Where used, foundations shall be installed below the freeze/thaw depth.

6.3.4 Where PV source and output circuits are installed in readily accessible locations, circuit conductors shall be guarded or installed in a raceway.

Note: Guards typically include close fencing of the entire array of sufficient height to render the area inaccessible or installation of materials to the mounting structure intended to screen and protect the conductors. If close fencing is installed the fence shall be minimum 5 ft high with a secured gate.

6.4 PV Modules

6.4.1 Wire management shall be completed in a professional and skillful manner using long-lasting materials, such as clips, to prevent conductors from contacting sharp edges or abrasive surfaces. Products utilized shall be listed for securement and support per NEC requirements.

6.4.2 Modules shall be installed maintaining adequate clearance between the module back sheet and protrusions such as bolts, screws, grounding lugs, or other hardware that could compromise the module back sheet integrity under wind or snow loads.

6.4.3 Modules shall be installed following manufacturer's requirements for handling and installation, applicable clamping zones for the specified module design load rating for the project, and minimum spacing between modules and module rows.

6.4.4 Electrical mismatch caused by partial shading of the array, different orientations of strings within the array and by variations in module voltages shall be minimized, allowing the inverter to operate within its maximum power point window. Modules in a single string shall be installed at the same tilt and orientation or with no more than 10° variation unless connected to DC-to-DC converters or microinverters.

6.5 MLE, MLPE & PVRSE

6.5.1 MLE, MLPE & PVRSE or similar devices shall be installed according to manufacturer specifications and this standard.

6.5.2 The serial numbers of MLPE shall be mapped and documented during installation using the manufacturer's protocol.

6.6 Inverters

6.6.1 Means of disconnection shall be provided for the inverter(s) such that the inverter(s) can be safely isolated from all sources of power (DC input and AC output circuits) for service or in an emergency.

6.6.2 The array shall be sized to operate within the current, voltage and power limits approved and warranted by the inverter manufacturer. The temperature-adjusted array voltage shall remain within the inverter limits at the extreme high and low temperatures expected at the installation site as documented in ASHRAE's extreme minimum and 0.4% maximum databases.

6.6.3 The AC voltage at the inverter shall be within the inverter's operating limits. At locations where the utility service is higher than the typical voltage, this may require a larger AC wire size or a shorter AC run than otherwise allowed to minimize voltage rise between the point of utility interconnection and the inverter.

6.6.4 The serial numbers of microinverters and AC modules shall be mapped and documented during installation using the manufacturer's protocol.

6.6.5 Inverters shall be programmed to meet local IEEE 1547 smart inverter requirements as outlined in utility interconnection standards.

6.7 Energy Storage Systems

6.7.1 Batteries shall be installed in a secure enclosure that meets seismic requirements and is weatherproof as needed.

6.7.2 Access to live battery terminals shall be limited as required by the NEC.

6.7.3 Battery and inverter cables shall be properly sized, and secured. Where used, lugs and terminals shall be listed for the wire type used.

6.7.4 Charge controller, ESS settings, and inverter settings shall be appropriate for the installation's batteries and set for optimum performance based on the application. The ESS shall be installed in compliance with the design requirements indicated in section 5.4.7.

6.7.5 For DC coupled systems the array configuration shall operate within the current and voltage limits of the charge controller and ESS, accounting for temperature-adjusted array voltage under record high and low temperatures for the installation site as documented in ASHRAE's extreme minimum and 0.4% maximum databases.

6.7.6 Ground fault protection shall be added to the system if required by code and not included in the inverter.

6.7.7 The customer manual shall include instructions for operation, maintenance and safety procedures for batteries, charge controller and inverter.

6.7.8 ESS shall not be installed in an unconditioned space where the ASHRAE extreme minimum temperature database exceeds the minimum temperature specified in the equipment documentation or warranty.

6.8 Energy Storage Systems Utilizing a Hazardous Electrolyte

6.8.1 Batteries shall be listed to UL 1973.

6.8.2 Flooded batteries shall be housed in an enclosure with adequate spill containment and vented to the outdoors, with a nearby clearly marked OSHA 29 approved safety kit.

6.8.3 Temperature compensation probes for inverter and/or charge controller shall be installed to control battery charge properly to ensure that charge current is adjusted for temperature.

6.9 Labeling

6.9.1 Materials and Construction

Labeling used outdoors shall be of durable construction and intended to withstand conditions including high temperatures, UV exposure, and moisture as required by NEC field-applied hazard markings. The labeling shall never be removed or covered.

Note: Heavy duty UV resistant vinyl, metal, or plastic may all be suitable materials, depending on the specific product ratings. Installers should also consider the label attachment method (e.g., adhesive) when considering longevity and are encouraged to review NEMA Z535.4 for guidance on selecting the appropriate labeling and adhesive materials.

6.9.2 Placement

Installation of specific labels shall not cover any existing manufacturer applied labels.

6.9.3 Installer Identification
The installer shall attach a permanent label with the company name, address, telephone number, and e-mail address at the inverter or interconnection point for easy reference.

6.9.4 Colors
Label colors shall be chosen per OSHA 29 CFR 1910.145 direction that the requirements of NEMA Z535.4 be used.

Exception 1: NFPA 70 (NEC) and other code and utility requirements provide specific colors and characteristics for certain labels. These requirements shall be followed in those cases.

6.9.5 Marking
Field applied markings on labels for system specific values, such as short circuit current, shall not be hand-written and must be legible.

Note: Marking may be achieved by means of engraving, or use of indelible ink or paint, as part of the printing process.

6.10 System Owner Documentation Requirements

6.10.1 Upon completion of the installation, the Contractor shall instruct the customer on proper system operation and maintenance and shall provide the customer with a manual (the "Customer Manual") that includes, at a minimum, the items listed in section 6.10.2-6 below.

6.10.2 A System Overview Page shall be provided. This information would typically be presented as the first page of the system documentation. The Overview Page may include but is not limited to the following items.

- Customer name.
- Site address.
- Project identification reference (where applicable).
- Rated (STC nameplate) system power and available ESS capacity.
- PV modules, inverters, and batteries – manufacturer, model and quantity.
- Installation date.
- Commissioning date.
- Emergency shutdown/isolation procedures.

6.10.3 System designer information, if different than the installer, shall be provided. The information shall include the company name, address, telephone number, and e-mail address.

6.10.4 Installation Contractor information shall be provided. The information shall include the company name, address, telephone number, and e-mail address. Where more than one company has responsibility for the installation of the system, the same information shall be provided for all companies along with a description of their role in the project.

6.10.5 Updated as-built system design drawings required in sections 5.4.8, 5.4.9, and 5.4.10 shall be included in the Customer Manual.

6.10.6 Operation and maintenance information in the Customer Manual shall include the following items:

- Instructions for verifying system operation and system production.
- A checklist of what to do in case of a system failure.
- Maintenance and cleaning recommendations, if any.
- Warranty documentation for equipment.
- Documentation on any applicable maintenance requirements or weather-tightness warranties.

7.0 Quality Management & O&M

7.1 Quality Management Plan

Contractors shall have a written quality management plan that includes all elements of the company's customer service policy and other quality assurance practices. Documents shall be available for review by the Program Administrator. A Quality Management Plan, at a minimum, shall include:

7.1.1 Roles, responsibilities, and quality management workflow (e.g., how issues found during inspections are addressed, who is in charge of internal quality assurance).

7.1.2 Defined approved equipment list and inspection checklist.

7.1.3 Materials handling and receiving checklist.

7.1.4 Defined inspection schedule.

7.1.5 Defined O&M activities post weather related incidents.

7.1.7 Defined sub-Contractor qualification requirements.

7.1.8 Defined inspection protocol/inspector qualification.

7.1.9 Clear process for quality-related employee incentives, noting specific Finance Provider requirements (e.g., maintaining a certain "pass rate" on inspections or a minimum inspection score).

7.1.10 Defined design requirements or best practices.

7.1.11 Finance Providers' installation guidelines with explicit quality standards (this document may be used).

7.1.12 Safety Policies.

7.1.13 O&M Plan Requirements.

7.1.14 Standardized equipment recall protocol.

7.1.15 Review and reporting process for QA inspection photos and data.

7.1.16 Defined protocol for integration with external parties, e.g., municipalities and first responders.

7.2 System Records

Contractors shall store basic building owner EPC and system information for the term of the initial customer agreement. The information shall include:

7.2.1 The Contractor shall maintain a photo inventory of all active systems. Photos shall be stored throughout the life of the service contract and retrievable through customer/address query.

7.2.2 Warranty documentation for all installed equipment. Warranties by the Contractor shall contain clear terms of the warranty and/or O&M services included, and the record of the initial purchase transaction. The documentation shall be site specific, listing the address and system owner name, and kept on file by the Contractor and Finance Provider during either the lifespan of the system or term of the financing.

7.2.3 Contractors shall not collect, share or retain nonpublic building owner information, unless they meet federal and state consumer protection requirements.

7.3 Fleet Monitoring

7.3.1 Monitoring systems such as DAS shall be set up in such a manner that the production data for each system is authorized to be accessed via a dedicated login by the Contractor and system owner. Finance Providers may also have direct access to systems financed but shall, at minimum, have the contractual rights to access the monitoring at the Finance Providers' request.

7.3.2 Data access shall be granted to owners and parties with a financial interest upon request.

7.4 Operations and Maintenance (O&M)

7.4.1 System owners shall ensure ongoing and as-needed O&M activities are conducted on all facilities as shown in the table below, if applicable. O&M activities may be conducted by the owner, installer, or an O&M Contractor in compliance with this standard.

O&M Task	Preventive/ Corrective	Frequency
Perform cleaning and vegetation management	Preventive	Quarterly
Roof inspection	Preventive	Every other year
Inspect modules for damage	Preventive	Semi-annually
Corrosion inspection	Preventive	Every five years
Mechanical and electrical torque check	Preventive	Every five years
Inspect array mounting system	Preventive	Semi-annually
Verify tracker operation and perform tracker manufacturer required and recommended maintenance	Preventive	As needed or required
Test damaged and degraded modules	Preventive	As needed
Inspect cabling and electrical boxes	Preventive	Semi-annually
Inspect and test grounding system	Preventive	Annually
Ensure functionality of disconnects and shutdown system	Preventive	Annually
Check fuses and electrical connections	Preventive	Annually
Test circuits	Preventive	Annually
Inverter inspection	Preventive	Monthly
Conduct system performance tests	Preventive	Annually
Install software updates	Preventive	Every five years
Transformer/switchgear inspection	Preventive	Annually
Inspect and clean battery and battery enclosure, performing all manufacture required and recommended maintenance	Preventive	Quarterly

Load and capacity test batteries	Preventive	Semi-annually
Monitor system production and alerts	Preventive	Monthly
Inspect and calibrate sensors and monitoring equipment	Preventive	Semi-annually
Roof repairs	Corrective	As needed
Address array shading issues	Corrective	As needed or required
Racking and corrosion repair and replacement	Corrective	As needed
Replace or repair damaged or degraded modules	Corrective	Every five years
Test equipment suspected of damage, degradation, corrosion	Corrective	As needed
Address electrical faults	Corrective	As needed
Replace or repair damaged electrical components	Corrective	As needed
Replace fuses and other OCPDs	Corrective	As needed
Replace inverter or inverter components	Corrective	As needed
Check and clear alerts and error codes	Corrective	As needed
Ensure communication connectivity and update software	Corrective	As needed
Replace or re-tap transformer	Corrective	As needed
Replace battery cells, strings, and other components	Corrective	As needed
Perform testing on replacement parts	Corrective	As needed

7.4.2 O&M system documentation shall comply with section 7.5 of standard SEIA 251.

7.4.3 Periodic inspections shall take place in accordance with section 7.4.1 of this standard.

Note: The extent of remote equipment and site monitoring capabilities may alter some of these requirements.

7.4.3.1 Monthly system checks, and reporting shall include, if applicable:

- Remote review and analysis of system monitoring.
- On-site verification of Inverter and ESS programing, operation, and performance.

7.4.3.2 Semi-annual system inspections and reporting shall include, if applicable:

- On-site inspection of module conditions, tracking equipment and controls, and wire management.
- For rooftop systems – inspect roof penetrations for signs of leaks, and wire management for contact with structure and compliance with UL 3741 standard for safety for Photovoltaic (PV) Hazard Control, if applicable.
- On-site inspection of environmental conditions including shading, debris, rodent intrusion, module soiling and vegetation management.
- On-site inspection of mounting system and equipment pads/supports.
- On-site inspection of combiner boxes and random enclosure which contain connectors for connector corrosion and torque.

- On-site infrared (IR) inspection of modules, field equipment, and wire management when site conditions provide stable irradiance of more than 500 W/m^2.
- Equipment temperatures as measured by IR should be relatively uniform. Investigate and make repairs as required.
- If bypass diodes are hot with no cause from site conditions, replace module.
- If PV connectors are hotter than surrounding conductors, repair or replace.
- Remote review and analysis of system monitoring, along with on-site inspection of monitoring equipment.
- On-site verification of Inverter and ESS programing, operation, and performance.

7.4.4 O&M personnel and on-site operations shall comply with the provisions of SEIA 301, Solar and Energy Storage Operations and Maintenance Standard Technician Training.

7.5 System Commissioning

System documentation shall be provided to the owner and O&M Contractor (if applicable) in accordance with section 6.10 of this standard. In addition, the following documentation shall be completed and provided:

7.5.1 A Commissioning report shall be completed by a qualified and responsible party and shall include:

- A certification that the report has been completed in accordance with this standard.
- An initial inspection report that shall include, if applicable:
  - Compliance with local codes and standards.
  - A visual inspection of mounting system, electrical equipment, roof attachments or ground support, wire management, equipment and mounting system grounding, ESS, and labeling and signage.
  - Verification against as-built plans and site conditions.
  - Evaluation of array shading conditions.
  - A review of environmental conditions including storm water management, site security, and emergency access.
  - Verification against approved plans.
  - A review of lightning protection systems.
  - An inspection of fuses in combiner boxes and inverter.
  - Verification of zero ohms across removed fuse.
  - Verification of polarity of PV strings.
  - Open circuit voltage.
  - At inverter, combiner boxes, module strings.
  - Verification against expected value calculated from temperature.
  - Short circuit current.
  - Verify against the expected value calculated from solar radiation.
  - Continuity of grounding system.
  - Verification of zero ohms to ground.
  - Integrity of electrical insulation on source and output circuits.
  - Complete mega-ohm testing.
  - Verification of infinite ohms to ground.
  - System operating voltage.
  - System operating current.
  - I-V curve trace.
  - Trace of entire current /voltage curve.
  - Verification of inverter programming and performance.
  - Verification of ESS programing and performance.

- Verification of operation of system monitoring, and alert setpoints.
- System Performance Test.
- Verification of acceptable performance ratio: actual/predicted.

8.0 Inspection and Verification

8.1 Inspection and Verification

Contractors shall measure and verify installed system quality through inspection/verification of newly installed systems and a continuous process of third-party inspections/verifications and/or Contractor QM inspections/verifications of a percentage of completed systems over time. The inspections/verifications are completed to verify the systems are operational have been installed in accordance with this standard, specifications, codes, and installation best practices. Inspections/verifications also serve to verify O&M activities are being completed as required by this standard.

8.2 Inspector or Verifier Qualifications

Third-party and Contractor QM inspectors or verifiers shall have one of the following professional credentials and have specific knowledge of solar PV design and installation.

- NABCEP PV Installation Professional Certification.
- NABCEP PV Installation Specialist Certification.
- NABCEP System Inspector Certification.
- UL Certified PV System Installer.
- Licensed Professional Engineer.
- Licensed Electrician.
- ICC Certified Electrical Inspector and/or Plans Examiner.
- Equivalent training and/or documented experience.

8.3 Sampling Protocols

Contractors shall collect specific photos and data to be available for program or jurisdictional review for each new system they install. In addition:

8.3.1 On-site verifications shall be completed for ___% of systems installed from the start of the program at three, six and nine years intervals.

8.3.2.1 The minimum sampling rate shall be 5%.

Note: Sampling rates for completed systems vary by Contractor size (number of installs) and generally range from 5-30%. The rate can change with a certain number of passing systems.

8.3.3 The random sampling of systems shall represent a balanced cross section of system types installed by the Contractor and the areas served by the Contractor.

Note: Other factors, like providing a check of specific installation crews and personnel, Finance Provider requirements, and program requirements, may change the sampling rate.

8.4 Inspection Checklist and Results

8.4.1 Data and photos collected during an inspection/verification shall include the system operation data, system production data, photos and counts of the PV modules, inverters and ESS. They shall also include photos of the MLPE, mounting system, raceway, junction boxes, combiners, disconnects, electrical equipment labeling, system labeling, grounding/bonding, wire management, ballast conditions, roof conditions, roof repairs, flashing, roof attachments, clamping zones, thermal breaks, shading, interconnection, and system layout. A sample checklist is contained in Appendix B of this standard.

8.4.2 For each inspection, a report shall be issued that summarizes the non-compliant items identified and provides the Contractor with a list of the items requiring corrective action.

APPENDIX A – References

A.1 Normative References

A.1.1 ASHRAE Design Temperatures. https://weather.ashrae.org.

A.1.2 California Energy Commission List of Eligible System Performance Meters. https://solarequipment.energy.ca.gov/Home/MeterList.

A.1.3 IEEE 1547, Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces.

A.1.4 ISO 9001, Quality Management Systems.

A.1.5 NEMA 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).

A.1.6 NEMA C12.1, Electric Meters - Code for Electricity Metering.

A.1.7 NEMA Z535.4, Product Safety Signs And Labels.

A.1.8 NFPA 70, National Electrical Code.

A.1.9 NFPA 70E, Standard for Electrical Safety in the Workplace.

A.1.10 OSHA 29 CFR 1910.145, Specifications for Accident Prevention Signs and Tags.

A.1.11 SEIA 201, Solar and Energy Storage Installation Requirements Standard: Residential and Small Commercial Systems.

A.1.12 SEIA 301, Solar and Energy Storage Operations and Maintenance Standard – Technician Training.

A.1.13 SEIA 401, Solar and Energy Storage Consumer Protection Standard.

A.1.14 UL 1741 (Supplement SA, Supplement SB), Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources.

A.1.15 UL 1973, Batteries for Use in Stationary and Motive Auxiliary Power Applications.

A.1.16 UL 2703, Standard for Mounting Systems, Mounting Devices, Clamping/Retention Devices, and Ground Lugs for Use with Flat-Plate Photovoltaic Modules and Panels.

A.1.17 UL 2703A, Outline of Investigation for Flashing Devices and Systems for Rooftop-Mounted Photovoltaics.

A.1.18 UL 3703, Solar Trackers.

A.1.19 UL 3741, Photovoltaic Hazard Control.

A.1.20 UL 7103, Outline of Investigation for Building-Integrated Photovoltaic Roof Coverings.

A.1.21 UL 9540, Energy Storage Systems and Equipment.

A.1.22 UL 61730-1, Photovoltaic (PV) Module Safety Qualification - Part 1: Requirements for Construction.

A.2 Informative References

A.2.1 UL 62446-1, Photovoltaic (PV) systems – Requirements for testing, documentation and maintenance – Part 1: Grid connected systems – Documentation, commissioning tests and inspection.

A.2.2 UL 62446-2, Photovoltaic (PV) Systems - Requirements for Testing, Documentation and Maintenance - Part 2: Grid Connected Systems - Maintenance of PV Systems.

Appendix B. Sample Inspection Checklist *(Informative)*

The sample inspection checklist below is intended to provide useful information and background but is not considered essential. The information in this appendix is not considered part of the standard.

B.1 Inspection Checklist

The Inspection Checklist in this Appendix can be used directly by the AHJ or provided to a third-party inspection agency, where applicable. The checklist is intended to highlight key system characteristics and common installation errors. Completing the checklist should take approximately 20 minutes per field inspection. Not all sections may apply to a given installation.

A "rough inspection" (which occurs when all boxes and wires are installed to the point when walls or trenches are ready to be closed) is not necessary on most large commercial and industrial installations with existing construction.

When a field inspection is necessary, inspectors should consider bringing the following items:

- Ladder with non-conductive sides.
- Binoculars for surveying inaccessible roof-mounted equipment.
- Screwdriver for opening enclosures.
- A copy of the Contractor's submitted design.

Code enforcement officers should consider asking solar PV Contractors for a set of construction photos. Contractors typically document their installation progress with photos, which are sometimes required by their internal quality assurance team or financing partners. Code enforcement officers can use such photos to review hard-to-access parts of the installation (such as roof-mounted racking).

B1.1 AC Installation

Circle the correct response as appropriate. Select "Y" for Yes, "N" for No and "N/A" for Not Applicable.

Calibrated torque wrench is being used on all terminations.	N	Y	N/A
Expansion fittings are being installed per plan, or electrical specifications.	N	Y	N/A
All conduit/conductor sizes were installed per plan.	N	Y	N/A
All cables and conductors have been tested per electrical specifications outlined by EOR.	N	Y	N/A
Spot check torque specification on AC terminations torque marks are present.	N	Y	N/A
All conduit and fittings exposed are raintight.	N	Y	N/A
All conduit entry holes through walls are sealed or flashed.	N	Y	N/A
All equipment is permanently labeled, marks are not handwritten.	N	Y	N/A
Any changes to construction drawings were recorded (as-built redlines).	N	Y	N/A

B.1.2 DC Installation

Circle the correct response as appropriate. Select "Y" for Yes, "N" for No and "N/A" for Not Applicable.

Installer has received training from the manufacturer on how to assemble field-made DC connectors.	N	Y	N/A
Installer has procured DC connectors that match submittals and module/RSD equipment.	N	Y	N/A
Installer demonstrates an understanding on RSD manufacturer installation procedures (cable tray & conduit routing best practices).	N	Y	N/A
DC wire harness and loops are secure, meet specification.	N	Y	N/A
All cables and conductors have been tested per electrical specifications outlined by EOR.	N	Y	N/A
DC wires clear of racking, avoiding sharp edges, rough surfaces and moving parts of racking systems.	N	Y	N/A
Free-air DC conductors protected from UV exposure, sagging wires (where possible).	N	Y	N/A
DC conductors routed to avoid overly tight bending radii.	N	Y	N/A
Connectors on modules and RSD are sealed with dust caps until ready for use.	N	Y	N/A
All wires are installed in a professional and skillful fashion and are in good physical condition.	N	Y	N/A
Connectors (e.g., MC4 and QC4) are matching and installed per manufacturer's specifications. Photos of installed connectors are provided by the installer.	N	Y	N/A
Drip loop is present per specification, where applicable.	N	Y	N/A
Expansion fittings or LFMC are installed per plan.	N	Y	N/A
PV source circuits are labeled per specification.	N	Y	N/A
PV labels are synthetic and appropriate to withstand the installation environment. Use of tape or markers is not acceptable.	N	Y	N/A
DC junction box terminations are clean and sealed from water.	N	Y	N/A
Electrical metallic tubing fittings exposed are raintight.	N	Y	N/A

B.1.3 Inverters

Circle the correct response as appropriate. Select "Y" for Yes, "N" for No and "N/A" for Not Applicable.

Installer has removed DC fuses until ready for startup procedures.	N	Y	N/A
Installer has read the inverter installation manual and is familiar with torque specifications (both DC and AC).	N	Y	N/A
Installer has been trained and/or certified by PV inverter manufacturer on installation best practices.	N	Y	N/A
Inverter wire boxes have appropriate fuse size per plan.	N	Y	N/A
MPPT is installed per plan and specification.	N	Y	N/A
All cables and conductors have been tested per electrical specifications outlined by EOR.	N	Y	N/A
Spot check torque of DC and AC inverter terminations. Torque marks are present.	N	Y	N/A

Inverters are labeled per plan.	N	Y	N/A
Inverter nameplate labels (including safety labels) are per specification.	N	Y	N/A
Inverter mounted correctly and securely.	N	Y	N/A
Inverter conduit punchouts sealed appropriately.	N	Y	N/A
Inverter wirebox is free of debris.	N	Y	N/A

B.1.4 Modules

Circle the correct response as appropriate. Select "Y" for Yes, "N" for No and "N/A" for Not Applicable.

Installer demonstrates an understanding on how to handle the modules with care (no standing on, or placing objects on the modules).	N	Y	N/A
Installer demonstrates an understanding on how to properly ground each module (e.g., WEEB and lay-in-lug).	N	Y	N/A
Connectors on modules are sealed with dust caps until ready for use.	N	Y	N/A
Installer demonstrates an understanding on mounting method and torque specification for module installation to racking.	N	Y	N/A
Installer is using torque wrench (or torque limiter) to torque module connections to specification.	N	Y	N/A
Modules are being grounded to racking per plan.	N	Y	N/A

B.1.5 Racking

Circle the correct response as appropriate. Select "Y" for Yes, "N" for No and "N/A" for Not Applicable.

Module ground washer or other module grounding solution is installed per plan.	N	Y	N/A
Racking is bonded per plan. Photos are provided by the racking installer.	N	Y	N/A
EGC is installed correctly throughout electrical system as designed by EOR.	N	Y	N/A
Ground lug, tap and ground rod are installed per plan (if applicable).	N	Y	N/A
All cables and conductors have been tested per electrical specifications outlined by EOR.	N	Y	N/A
Any exposed non-current carrying metal parts are grounded in accordance with NEC Art. 250.134 and 250.136.	N	Y	N/A
Grounding electrode system (where shown on approved drawings) has been installed per plan.	N	Y	N/A
Racking assembly, mechanical attachments, supports, ballast or foundations are installed per approved drawings and manufacturer's requirements.	N	Y	N/A

B.1.6 Grounding

Circle the correct response as appropriate. Select "Y" for Yes, "N" for No and "N/A" for Not Applicable.

Module ground washer or other module grounding solution is installed per plan.	N	Y	N/A
Racking is bonded per plan. Grounding photos were provided by installer.	N	Y	N/A
EGC is installed correctly throughout the electrical system as designed by EOR.	N	Y	N/A
Ground lug, tap and ground rod are installed per plan (if applicable).	N	Y	N/A

All cables and conductors have been tested per electrical specifications outlined by EOR.	N	Y	N/A
Any exposed non-current carrying metal parts are grounded in accordance with NEC Art. 250.134 and 250.136.	N	Y	N/A
Grounding electrode system (where shown on approved drawings) has been installed per plan.	N	Y	N/A

B.1.6 Data Acquisition System (DAS)

Circle the correct response as appropriate. Select "Y" for Yes, "N" for No and "N/A" for Not Applicable.

CTs are properly sized and seated in the panelboards or other location per the construction drawings (if applicable).	N	Y	N/A
CT orientation is correct with the high side (e.g., X1 or H1) facing the source (i.e. the inverters).	N	Y	N/A
CT lead ends (within DAS cabinet) are labeled per phase.	N	Y	N/A
Gel filled connectors are used to ensure a good connection is made on communication cable splices.	N	Y	N/A
Plane of Array (POA) pyranometer is installed at the same angle as the panels in an area that will not be shaded.	N	Y	N/A
Module temperature sensor is mounted on the back of the module, along with the strain relief tab.	N	Y	N/A
Ambient temperature sensor is mounted out of the direct sunlight.	N	Y	N/A
Global Horizontal Irradiance (GHI) pyranometer is installed horizontal to the ground in an area that will not be shaded.	N	Y	N/A
All weather sensors have been connected to the DAS.	N	Y	N/A
Inverters are daisy chained per manufacturer's installation manual.	N	Y	N/A
RS485 wire colors have consistent polarity (+, -, gnd) across the entire inverter/weather station communication loop.	N	Y	N/A
Voltage taps are referenced to the correct phase.	N	Y	N/A
Inverter communication settings configured (baud rate and unique modbus id). Settings match the DAS specifications and single line diagram.	N	Y	N/A

Appendix C. Assessments of Roof Remaining Life *(Informative)*

The assessments below are intended to provide useful information and background but are not considered essential. The information in this appendix is not considered part of the standard.

C.1 Roof Assessments

The Contractor should follow the steps indicated below for evaluating roof life.

C.1.1 Request or search for evidence of installation date.

- Ask the owner.
- Ask the builder or Contractor.
- Search out warranty notices. These are sometimes found near the main electrical panel.
- Search for permits of associated construction.
- Ask the neighbors.

C.1.2 Evaluation by licensed roofing Contractor.

C.1.3 Self-evaluation by solar installer.

C.1.3.1 For all roof types.

- Cracks or holes through roofing system.
- Evidence of leaks inside structure.
- Displaced panels or shingles.
- Compromised roof sheathing.
- Compromised flashings.

C.1.3.2 For composition shingle.

- Exposed or compromised fiberglass mat layer.
- Curled or cupped shingles.
- Brittle shingles.
- Rotten shingles.
- Excessive amounts of moss or algae.
- Excessive loss of top granular layer.

C.1.3.3 For metal roofing.

- Rust or corrosion.
- Loss of protective layer.
- Thinning.
- Missing or displaced fasteners.
- Excessive chalking or fading.

C.1.3.3 Concrete or clay tile roof system.

- Underlayment condition.
- Broken, damaged and missing tiles.
- Environmental problems, such as biological growth.
- Manufacturing problems, such as spalling, voids and shrinkage cracks.

About SEIA

The Solar Energy Industries Association® (SEIA) is leading the transformation to a clean energy economy. SEIA works with its 1,200 member companies and other strategic partners to fight for policies that create jobs in every community and shape fair market rules that promote competition and the growth of reliable, low-cost solar power.

Founded in 1974, SEIA is the national trade association for the solar and solar + storage industries, building a comprehensive vision for the Solar+ Decade through research, education and advocacy.

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