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## SOLAR PHOTOVOLTAIC AND THERMAL SYSTEMS REVIEW AND APPROVAL REQUIREMENTS

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# IR 16-8

References:	Revised 10-16-12
California Education Code	Revised 07-20-12
Section 17282.5	Revised 01-06-12
California Code of Regulations (CCR), Title 24	Revised 11-03-10
Part 2, California Building Code, Sections 1609A, 1609*, 1613A and 1613*	Revised 06-25-10
Part 3, California Electrical Code, Articles 250, 310, and 690	Revised 04-03-09
California State Fire Marshal Photovoltaic Installation Guideline dated April 22, 2008	Issued 08-15-08

Discipline: All

This Interpretation of Regulations (IR) is intended for use by the Division of the State Architect (DSA) staff, and as a resource for design professionals, to promote more uniform statewide criteria for plan review and construction inspection of projects within the jurisdiction of DSA which includes State of California public elementary and secondary schools (grades K-12, community colleges), and state-owned or state-leased essential services buildings. This IR indicates an acceptable method for achieving compliance with applicable codes and regulations, although other methods proposed by design professionals may be considered by DSA.

This IR is reviewed on a regular basis and is subject to revision at any time. Please check the DSA web site for currently effective IRs. Only IRs listed in the document at <http://www.dgs.ca.gov/dsa/Resources/IRManual.aspx> at the time of plan submittal to DSA are considered applicable.

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**Purpose:** This Interpretation of Regulations (IR) describes the Division of the State Architect (DSA) requirements for review and approval of solar photovoltaic (PV) and solar thermal systems used in construction projects under the jurisdiction of DSA. This IR also describes and clarifies the requirements for projects not subject to DSA review.

**Scope:** This IR clarifies the requirements for structural support, and anchorage of panels and balance-of-system (BOS) equipment. It also addresses the basic requirements of the California Building Code (CBC) for Fire-Life Safety, Access Compliance, certain electrical requirements, excluded solar projects, and projects exempt from DSA review.

Photovoltaic roofing systems (such as tiles) that incorporate photovoltaic technology physically integrated into the roof covering materials are outside the scope of this IR, except those addressed in Section 2.5 of this IR.

**Background:** Typical photovoltaic (PV) or solar thermal systems consist of solar panels and BOS equipment. The BOS equipment includes factory assembled foundations or support structures, DC-to-AC inverters, electrical wiring, electrical protection, monitoring, and safety equipment.

Photovoltaic panels are anchored to building structures, or ground mounted. Anchoring relies on various attachment systems such as support frames (Section 2.2, below), ballast (Section 2.4, below), or adhered systems (Section 2.5, below).

Solar thermal panels are typically anchored by support structures.

**1. SOLAR PROJECT COMPONENTS SUBJECT TO DSA REVIEW:** DSA Structural Safety reviews the anchorage of solar panels and their BOS equipment to the building structure or foundation. The anchorage design for solar panels and their BOS equipment must meet the wind force requirements of the CBC, Section 1609A (1609\*) and the seismic requirements of the CBC, Section 1613A.

Manufacturer's support frames will also be reviewed by DSA. The building's vertical and lateral load resisting systems will also be evaluated for the additional loads from the solar panels and BOS equipment.

See Sections 3.1, 3.2 and 3.3 below for design and/or submittal requirements for Access Compliance, Fire-Life Safety, and Electrical, respectively.

DSA does not review the design and construction of the panels and the BOS equipment. However, the panels and BOS equipment must be designed and constructed to meet the requirements of Title 24.

## **2. BASIC STRUCTURAL SAFETY DESIGN REQUIREMENTS FOR SOLAR PROJECTS:**

### **2.1 General Design Requirements:**

**2.1.1 Requirements for Dead Load.** The dead load of solar panels shall be considered in the design of the structure. For installations on existing roofs, the additional dead load may be offset by the roof live load per Section 2.1.2, provided the roof design is adequate for the concentrated loads from solar panel support frames. The increase in effective seismic weight of the structure shall be evaluated per Title 24, Part 1, California Administrative Code (CAC), Section 4-309.

**2.1.2 Requirements for Live Load.** It is not necessary to include roof live load (20 psf, 300 lb point load) in the area(s) covered by the panels when these area(s) are inaccessible, or signs are posted prohibiting storage under the panels. Areas where the clear space between the panels and the rooftop is 24 inches or less are considered inaccessible. Where the solar panels do not cover the entire area of the roof, the remaining area shall have the roof live load applied.

The exclusion of the roof live load in the area(s) covered by the panels does not preclude the design of building roofs from being designed for the roof live load requirements in CBC 1607A.11 for the loading condition where the solar panels system may be removed or not installed.

For solar panels that are mounted on carports and shade structures with open grid framing and no roof deck, the following two separate live loading conditions shall be applied in combination with other applicable loads.

- 1) 10 psf uniform roof live load per CBC 1607A.11.5 with no solar panel dead load
- 2) 300 lbs. concentrated roof live load per CBC Table 1607A.1 with solar panel dead load

As a condition for use of this reduced loading condition, the following note shall be shown on the construction plans: "No future roof decking or sheathing may be applied on the open grid framing."

**2.1.3 Requirements for Snow Load.** When applicable, include snow loads and loads from snow drift.

**2.1.4 Requirements for Wind Design:** The wind design requirements are given in CBC Section 1609A (1609\*). The CBC and ASCE 7-05 do not contain specific wind design provisions for solar panel systems. The following summarizes when the "Method 1 – Simplified Procedure" or "Method 2 – Analytical Procedure" in ASCE 7-05 Sections 6.4 and 6.5, respectively, may be used for the wind design of solar panel systems. "Method 3 – Wind Tunnel Procedure" in ASCE 7-05 Section 6.6 may be used for any solar panel system.

- **Flush-mounted systems on enclosed and partially enclosed building roofs:** Solar panel systems installed parallel to and less than 10 inches above

the roof surface shall be designed as roof components and cladding per ASCE 7-05 Section 6.5.12.4 (Method 2) with  $GC_{pi}$  (internal pressure coefficient) set equal to zero or per ASCE 7-05 Section 6.4.2.2 (Method 1). There shall be a minimum air gap around the perimeter of each solar module of 0.5 inches or between rows of panels of 1 inch to allow pressure equalization above and below panels. If the panels are installed less than 2 inches above the roof surface or the minimum air gap is not provided, or it is a BIPV system per Section 2.5 below, then  $GC_{pi}$  may not be set equal to zero as indicated above.

- **Low-profile tilted systems on enclosed and partially enclosed flat roof buildings:** Low-profile (<4 ft above roof surface) tilted solar panel systems installed on flat roof ( $\theta < 7^\circ$ ) buildings shall be designed using the analytical method outlined in SEAOC PV2-2012 "Wind Design for Low-Profile Solar Photovoltaic Arrays on Flat Roofs" Section 3, provided the geometric limitations contained therein are satisfied.
- **Freestanding ground supported systems:** Freestanding ground supported systems (e.g. solar carports, ground mounted arrays, etc.) shall be designed using the open building provisions in ASCE 7-05 Section 6.5.13.
- **Other systems:** Solar panel systems not meeting the limitations in the above methods shall use the Wind Tunnel Procedure in ASCE 7-05 Section 6.6.

**2.1.4.1 Wind Tunnel Procedure:** When utilizing Method 3 (wind tunnel procedure) in ASCE 7-05 Chapter 6 to develop wind loads for solar photovoltaic arrays, the wind tunnel model shall properly model the wind flow environment in accordance with ASCE 7-05 Section 6.6.2, and in accordance with the requirements in ASCE 49, "Wind Tunnel Testing for Buildings and Other Structures."

- **Modeling:** When developing generalizable wind loads for rooftop solar photovoltaic arrays, the wind tunnel model shall include to scale the array configuration and layouts placed on the roof of a building that properly models the rooftop wind flow environment. The model shall include various building features that affect the wind flow environment on the roof. The testing and instrumentation shall be designed to determine the wind load effects in different roof zones (corner, edge, center, etc.). Modeling site-specific buildings is not necessary; rather, generic models with buildings large enough in plan area to capture the wind flow environment over different roof zones may be used.
- **Instrumentation:** Wind tunnel testing shall use an arrangement of pressure taps or other instrumentation methodology that is sufficient to establish design wind forces on solar panels and the variation of such forces as a function of effective wind area.
- **Results:** Wind tunnel results shall not be extrapolated to other panel geometry, panel inclination angle, panel row spacing, panel elevation above roof surface, or other roof shape types (e.g. gable, hip, barrel, flat, etc.) that were not part of the wind tunnel study. For moderate changes in panel angle, row spacing, or other parameters, reasonable interpolation between two or more tests is permitted. The limitations of any wind tunnel study, such as the range of array and building geometry parameters that were tested, shall be clearly reported along with the results. The wind tunnel results shall provide wind loads for the design of each structural element of the PV support system, such as by providing design wind pressures as a function of effective

wind area. The wind tunnel results shall be provided in a format that is compatible with ASCE 7 (e.g. GC factors) that can be adjusted for site and buildings characteristics (exposure, building height, wind speed, etc.).

**a) Minimum Wind Pressure for Wind Tunnel Procedure:** The minimum design wind loads based on a wind tunnel study for solar panel systems shall comply with this section.

- **Flush-mounted systems on enclosed and partially enclosed building roofs and freestanding ground supported systems:** These systems, as described in Section 2.1.4 above, shall comply with the following minimum design wind loads when based on a wind tunnel study, except for closely spaced ground mounted arrays that rely on shielding from adjacent rows where an independent peer review, as indicated in Section 2.1.4.1 (b) below, is performed to allow wind loads to be less than these minimums.
  - **Minimum net pressure** of 10 psf per ASCE 7-05 Section 6.1.4.
  - **Loads for the main wind force resisting system** shall be limited in accordance with CBC Section 1609A.1.1.2.1, except when the limiting value of 80 percent is being reduced further with specific testing indicated therein; then the limiting value of 80 percent may not be reduced to lower than 50 percent.
  - **Pressures for components and cladding** determined shall be limited in accordance with CBC Section 1609A.1.1.2.2, except when the limiting value of 80 percent is being reduced further with specific testing indicated therein, then the limiting value of 80 percent may not be reduced to lower than 65 percent.
- **Low-profile tilted systems on enclosed and partially enclosed flat roof buildings:** For low-profile tilted solar panel systems installed on flat roof buildings, as described in Section 2.1.4 above, shall comply with the following minimum design wind loads when based on a wind tunnel study, except values lower than these minimums are permitted where an independent peer review, as indicated in Section 2.1.4.1 (b) below, is performed.
  - **Minimum design wind load:** For systems that meet the limitations and geometry requirements in SEAOC PV2-2012 Section 3, the minimum design wind load based on a wind tunnel study shall be 50 percent of the values resulting from SEAOC PV2-2012 Section 3.
- **Other systems:** These systems, as described in Section 2.1.4 above, shall comply with the minimum design wind loads as indicated above for flush-mounted systems and free standing systems when based on a wind tunnel study. Limits lower than these minimums are subject to approval of DSA and an independent peer review.

**b) Wind Tunnel Study Peer Review:** The independent peer review is an objective, technical review by knowledgeable reviewer(s) experienced in performing wind tunnel studies on buildings and similar systems, in properly simulated atmospheric boundary layers.

DSA may require an independent peer review of a wind tunnel study in accordance with this section, depending on complexity and suitability of the study and qualifications of the wind tunnel laboratory. DSA will require an independent peer review of a wind tunnel study where wind load values lower than the minimums are being used, only where specifically allowed in Section 2.1.4.1(a),

or when utilizing an unattached system per Section 2.4 below. Once a particular wind tunnel study has been peer reviewed and found acceptable, it need not be peer reviewed for subsequent projects provided the applicability and findings are appropriate for such projects.

The peer review shall be completed before substantial portions of the design and/or analysis work will be reviewed by DSA.

- **Peer Reviewer Qualifications:** minimum qualifications and terms of employment for the peer reviewer shall be as follows:
  - The peer reviewer shall be independent from the wind tunnel laboratory that performed the study and prepared the report and shall bear no conflict of interest.
  - The peer reviewer shall be acceptable to DSA.
  - The peer reviewer shall have technical expertise in the application of wind tunnel studies on buildings similar to that being reviewed.
  - The peer reviewer shall have experience in performing or evaluating boundary layer wind tunnel studies and shall be familiar with the technical issues and regulations governing the wind tunnel procedure in ASCE 7 as it is applied to systems similar to solar photovoltaic arrays that use generalized wind tunnel data for design.
- **Peer Reviewer Responsibilities:** The peer reviewer shall review the wind tunnel report, including, but not limited to, data collection methods, data analysis, boundary layer modeling, array and building modeling, resulting wind loads and their relationship to effective wind area, conversion of data into GC values, and conditions of applicability of results to different buildings types, array geometry, etc. The peer reviewer shall prepare a written report to the client. Such a report should include, at a minimum, statements regarding the following:
  - Scope of peer review with limitations defined.
  - The status of the wind tunnel study at time of review.
  - Conformance of the wind tunnel study with the requirements of ASCE 7-05 Section 6.6.2 and ASCE 49.
  - Presentation of the conclusions of the reviewer identifying any areas that need further review, investigation and/or clarification.
  - Recommendations.
  - Whether, in the reviewer's opinion, the wind loads derived from the wind tunnel study are in conformance with ASCE 7 for the intended use(s).

#### **2.1.4.2 Other Wind Design Considerations:**

- a) **Shielding:** No reduction of wind load shall be taken for shielding or shadowing for interior rows of solar panel arrays provided by edge panels when utilizing using Method 1 (Simplified Procedure) or Method 2 (Analytical Procedure) in ASCE 7-05 Chapter 6. Shielding or shadowing effects shall be derived utilizing Method 3 (wind tunnel procedure) in ASCE 7-05 Chapter 6. Shielding or shadowing effects implicitly included within the analytical prescriptive procedure in SEAOC PV2-2012 Section 3 may be used.

- b) **Computational Fluid Dynamics (CFD)** is not recognized by ASCE 7 as an acceptable method to develop wind loads, and therefore is not acceptable to DSA.
- c) **Solar PV Wind Load Applied to Main Wind Force Resisting System (MWFRS):** For solar PV systems installed on buildings, the MWFRS shall be designed to include the wind load from the solar PV panels, except solar PV systems flush mounted to the roof. When calculating the contributing wind load from the solar PV panels, the effective wind area may be assumed to be the total area of solar arrays on the building. The increase of wind load on the MWFRS of existing buildings shall be evaluated per Title 24, Part 1, CAC Section 4-309.

**2.1.5 Requirements for Seismic Design:** The seismic anchorage design of solar panels and racking systems attached to buildings shall be based on the requirements in CBC Section 1613A, and ASCE 7-05, Chapter 13.

**Friction** due to gravity cannot be used to resist seismic loads in combination with attachments as allowed in SEAOC PV1-2012 "*Structural Seismic Requirements and Commentary for Rooftop Solar Photovoltaic Arrays*" Section 4, unless shake table testing or nonlinear response history analysis is performed. Testing or analysis must be similar to that described in SEAOC PV1-2012 Section 9, demonstrating satisfactory load sharing between friction and attachments, subject to the peer review requirements in Section 2.4.2 below.

**Unattached solar panel systems** that resist seismic forces by friction alone shall be designed in accordance with Section 2.4 below.

**Solar carports, walkways, and other freestanding ground supported systems:** The seismic design of the seismic force resisting system of solar carports, walkways, and other freestanding ground supported systems sheltering any use or occupancy shall be based on ASCE 7-05, Chapter 12. The seismic design of freestanding ground supported systems not sheltering any use or occupancy, including fenced off systems, shall be based on ASCE 7-05, Chapter 15, except systems similar to buildings may be designed in accordance with Chapter 12 per ASCE 7-05 Section 15.4.

**2.1.6 Requirements for Load Combinations:** The applicable load combinations in CBC 1605A shall be applied to all loading conditions, including evaluating the effects of dead load to counteract wind uplift for ballasted and anchored systems.

**2.2 Solar Panels Supported on Framing Systems and Foundations:** DSA will review support frames or racking systems either supplied by manufacturers or designed by the architects or structural engineers in general responsible charge (see Section 4 below), foundations, primary structure, the connection details of panels to support frames and connection details of support frames to primary structures or foundations. The design of support frames and racking systems shall be based on calculations or testing in accordance with ICC AC 428 "*Acceptance Criteria for Modular Framing Systems used to Support Photovoltaic (PV) Modules.*"

**2.3 Solar Panels supported on Standing Seam Metal Roofs (SSMR):** When solar panels are attached directly to SSMR, the attachment of SSMR panels to the roof structure shall be verified per Section 2.3.1 to demonstrate that the SSMR panel-to-structure attachment is capable of resisting the imposed loads from the solar panel system. The attachment of the solar panel to the SSMR shall be verified per Section 2.3.2. Testing on the final installed connections shall be performed per Section 2.3.3.

### 2.3.1 Standing Seam Metal Roof Panels:

- a) **Attachment of New Metal Roof Panels:** The attachment of standing seam metal roof (SSMR) panels to the roof structure shall be detailed on the plans, including special detailing for areas of discontinuities (edges, ridge, corners, etc.).
- b) **Structural Calculations for New Metal Roof Panels:** Provide structural calculations to demonstrate that the SSMR panel-to-structure attachment is capable of resisting the imposed loads from the solar panel system. Panel clip values shall be based on a valid evaluation report per IR A-5 or testing per ASTM E1592 as specified in CBC Section 1504.3.2.
- c) **Existing Metal Roofs:** The sliding capacity of the existing SSMR panel attachments shall be determined by existing construction documents, roof panel removal, or by other acceptable means (removal of ridge cap, etc.). For verification by panel removal, one panel for every 3000 square feet of roof area and not less than a minimum of 3 locations per building shall be removed to verify the attachment method and shall be shown on the submitted plans. Except when the roof is subject to snow load, the sliding capacity need not be evaluated if the new sliding load (seismic, wind, etc.) is less than the displaced design live load sliding component. The uplift capacity of existing SSMR panels will be verified through the field testing indicated below in Section 2.3.3 b). This testing may be performed after plan approval if each solar PV racking beam is connected to every crossing seam; otherwise, the testing shall be conducted prior to plan approval.

**2.3.2 Solar Panel Attachment to Metal Roof Panels:** The components of the solar panel array (rails, clips, fasteners, etc.) and its attachment to the SSMR panels shall be detailed on the plans and structural calculation shall be provided. Product information (model number, manufacturer, etc.) and installation procedure (torque, retightening of set screws, etc.) of the seam connecting devices (e.g. S-5 clips, AceClamp, etc.) shall be specified.

**Seam Connecting Device Testing:** The design values of the connecting devices (e.g. S-5 clips, AceClamp, etc.) between the panel array and the SSMR shall be based on testing on the same metal panel system (profile, manufacturer, and gauge) used for the project.

- The connecting device shall be tested for uplift and lateral load parallel to the seam; see Photograph #1 in Appendix D for uplift test.
- The failure criteria shall be the disengagement of the connecting device from the standing seam or the cracking of the standing seam, whichever occurs first.
- A minimum of five tests is required for each direction for each metal panel system, and the design value shall be the average of the five tests with a safety factor of 3 or higher.
- Manufacturer may submit results from previous tests performed by an accredited third party testing agency or may submit a valid evaluation report per IR A-5.
- The design values must be verified and submitted to DSA plan check prior to plan approval. Where previous test data is not available for installations on the existing metal panel system, the testing shall be fully detailed on the

approved plans and the test results shall be submitted and approved by DSA prior to commencement of the installation.

**2.3.3 Field Testing:** All testing shall be performed by personnel approved by the Architect or Structural Engineer of Record and DSA. The project inspector or designated special inspector shall observe the installation of all connecting devices to the seams. The approved plans shall clearly indicate the following testing requirements. The load rate shall be per Section 3.2.5 of ICC AC 428.

- a) **On New Roof:** After all the connecting devices have been installed, test a minimum of 20 consecutive connections to twice the maximum ASD wind uplift load tributary to the connecting device based on the wind pressure at areas of discontinuity such as roof edges and ridges. If there is no failure in the 20 consecutive testing, test 10% of the remaining installed anchors. See Photograph #1 in Appendix D which illustrates this testing.
- b) **On Existing Roof:** Field tests are required to verify the adequacy of the connection of the standing seam roof to the substrate and the seam connection device.
  - 5 group tests of 3 (minimum) adjacent connecting devices on the same seam shall be performed. These devices shall be pull tested simultaneously to 1.67 times the maximum design wind load (ASD) on each device based on the pressure coefficients for the roof zones (1,2 or 3) in which the connection is located.
  - The reaction from the pull test shall bridge over at least one seam on each side of the tested seam. See Photograph #2 in Appendix D which illustrates this testing.
  - After the initial 5 group tests, continue at a rate of 10% on the remaining connections.
  - If failure occurs on any of the setups, additional tests shall be performed until 10 consecutive successful tests of the similar configuration are performed.
  - The tests shall be distributed over the roof area to capture the various roof pressure zones (1,2 and 3).

**2.4 Unattached Solar PV Systems:** Unattached solar PV arrays are ballast systems that are not attached to the roof. They rely on their weight and ballast to resist the wind uplift forces, while friction between the array supports and the roof surface resist seismic forces. The wind load design requirements are indicated in Section 2.1.4 above. Unattached arrays are only permitted when all of the following conditions are met:

- The maximum roof slope at the location of the array is less than or equal to 1:12 slope (4.8 degrees).
- The height above the roof surface to the center of mass of the solar array is less than the smaller of 36 inches and half the least plan dimension of the supporting base of the array.
- The array is designed to accommodate the seismic displacement determined by nonlinear response history analysis or shake table testing requirements in the SEAOC PV1-2012 "*Structural Seismic Requirements and Commentary for Rooftop Solar Photovoltaic Arrays*" Section 9. The seismic displacements may also be determined by the prescriptive design seismic displacements indicated in Section

7 of SEAOC PV1-2012 provided the additional limitations therein are complied with.

- The roof shall not be subject to significant ice, snow or frost considering the seismicity at the site. For the purposes of determining this, it will be acceptable to consider it as not significant if the lowest average monthly low temperature (LAMLTL) for any month in the city the building is located and the seismicity at the site comply with any of the following limits.
  - Any roof where  $S_{DS} < 0.5$ .
  - Any roof where the  $LAMLTL \geq 32^{\circ}F$  and  $S_1 < 0.75$
  - Any roof where  $LAMLTL \geq 35^{\circ}F$

Appendix E lists major California cities and the LAMLTL.

**2.4.1 Requirements to Accommodate Seismic Displacements:** The accommodation of seismic displacement shall be afforded by providing the minimum separations indicated in SEAOC PV1-2012 Section 6 to allow sliding.

- **Qualifying parapet:** Where SEAOC PV1-2012 Section 6 allows a smaller roof edge separation when there is a “qualifying” parapet, that parapet and its connection to the roof needs also to have the strength to resist the seismic impact load of the array striking the wall concurrently with the out-of-plane seismic inertial load of the wall and parapet. If the smaller roof edge separation is not used, then the parapet need not comply with this strength requirement.
- **Minimum clearance** around solar arrays shall be the larger of the seismic separation defined herein and minimum separation clearances required for firefighting access in Section 3.2.1 (f) below.
- **Repositioning array:** In the event that the array is displaced, due to seismic shaking, wind loads, or other reasons, the array shall be repositioned into its original design location so as to ensure that the proper seismic and firefighting access clearances and separations are maintained, in addition to electrical wiring seismic slack as required in Section 2.4.3 below.
- **Interconnection:** Each separate array shall be interconnected as an integral unit and have the strength as indicated in SEAOC PV1-2012 Section 6. Elements of the array that are not interconnected as specified shall be considered structurally separate and shall be provided with the required minimum separation.
- **Friction testing** per SEAOC PV1-2012 Section 8 shall be conducted where required in other sections of SEAOC PV1-2012 to be used to determine the seismic displacements.

**2.4.2 Peer Review Requirements:** DSA may require an independent peer review when the seismic displacements are determined by nonlinear response history analysis or shake table testing depending on complexity of the analysis and availability of staff qualified to perform such review. If seismic displacements are less than 50% of the values indicated in the prescriptive design seismic displacements indicated in Section 7 of SEAOC PV1-2012, then an independent peer review must be performed. The peer reviewer shall be approved by DSA and the peer review shall comply with CBC Section 3422.

**2.4.3 Other Considerations:** Unattached solar PV systems shall not cause excessive sagging of the roof resulting in water ponding. They shall also not block or impede drainage flows to any overflow drains and scuppers as a result of the movement of the array imposed by the seismic displacements.

The Electrical systems and other items attached to arrays shall be flexible and designed to accommodate the required minimum separation in a manner that meets code life-safety performance requirements. Details of providing slackness or movement capability to electrical wiring shall be included on the approved drawings for the solar installation.

**2.5 Building-Integrated Photovoltaic (BIPV) Roof Covering Systems:** BIPV roof cover systems include modules, shingles and panels that are attached to the roof by adhesive. Adhered photovoltaic panels may be accepted if test and analysis data, and quality control and assurance program are submitted to demonstrate compliance with ICC AC 365 "Acceptance Criteria for Building-Integrated Photovoltaic (BIPV) Roof Covering Systems." Tests shall be performed by an accredited third party testing agency or a valid evaluation report per DSA [IR A-5](#) may be submitted.

The local DSA Regional Office should be contacted early in the design phase if a BIPV system is anticipated.

**3. ACCESS COMPLIANCE, FIRE AND LIFE SAFETY AND ELECTRICAL REQUIREMENTS:** In addition to the above structural design requirements, the following requirements apply:

**3.1 Access Compliance:** Projects which consist only of solar alteration work installed on existing buildings and which are accessed only by ladders, catwalks or narrow passages and frequented only by maintenance personnel do not trigger accessibility code requirements or DSA accessibility review. See Section 1103B.1, Exception 1, Part 2, Title 24, CCR, for detailed requirements. Also see DSA IR 11B-6: Mechanical Only Projects Exempt from Accessibility Review.

New shade structures, lunch shelters, canopies, and carports incorporating solar panels will require access compliance review. For example, a new shade structure over an existing parking lot will trigger access compliance review to determine if upgrades are required to the parking area and the path of travel to conform with current access compliance code requirements.

**3.2 Fire-Life Safety Requirements:** DSA Fire and Life Safety (FLS) has added the following for clarification and to address issues that have arisen during plan review. The State Fire Marshal has reviewed and concurred with the following provisions.

**3.2.1 General Requirements:** A PV System shall be typically considered equipment. There is typically not an occupancy group classification, building area limitation, or type of construction assignment to a PV system.

a) PV equipment supported by non-combustible framing installed in locations dedicated for building frontage used for area increases per California Building Code (CBC), Chapter 5, Section 506, shall be limited in size and may be allowed on a case by case basis. Maximum area that may be allowed for such systems shall not exceed 1/3 of the horizontal projected area of each frontage.

b) Open sided PV systems and framing that are non-combustible and without use underneath may be considered equipment and may be placed next to

property lines. Signs may be required on or near the system prohibiting any use or storage underneath the equipment.

- c) Combustible PV systems and framing and those with use underneath such as for assembly or parking, may need to comply with 2010 CBC, Table 602. These structures may include those that do and that do not have a roof underneath the PV system.
- d) PV systems (both the frame and the array) shall not be placed in fire department access roads. (Per Title 24 CCR, Division 1, Chapter 1, Section 3.05 and 2010 CFC Chapter 5, Section 503.)
- e) Access to a public way or safe dispersal area shall not be obstructed by the system or system framing. (CBC 1027.6 and 442.3)
- f) PV systems that cover a lunch area or similar (occupant load less than 50), that are not used for assembly purposes shall be considered equipment. Playgrounds would also fall into this category regardless of total occupant load.
- g) Any PV system that is installed above an assembly use (i.e. Group A-3 or A-5 occupancy classification) shall be considered an open sided building structure and all or portions of CBC provisions apply on a case by case basis. Such areas might include an outdoor amphitheater, bleacher or grandstand seating with concentrated occupant loads and heavy use.
- h) Fire Department concern for the installation of roof mounted PV systems will be addressed by DSA review to the [State Fire Marshal Solar Photovoltaic Installation Guideline available at http://www.osfm.fire.ca.gov/pdf/reports/solarphotovoltaicguideline.pdf](http://www.osfm.fire.ca.gov/pdf/reports/solarphotovoltaicguideline.pdf).
- i) When a PV system, without riser framework, is installed directly on a rated roof assembly with a required classification greater than "Class C" found in CBC, Chapter 15, and for Chapter 7A applications, the system may be tested to UL 1703 Standards.

**3.2.2 Specific Requirements for Open Sided, High Profile Ground Mounted PV Installations Above Parking Areas:** For the purposes of this IR, "open sided, high profile ground mounted PV installation" means;

- The highest point of the panels is 10 feet or more from the ground
- Meets the minimum 6' 8" clearance requirement below with a use underneath
- Structure has unobstructed openings throughout to allow heat and gases to escape and constitute a minimum of 70% of the area within perimeter of the solar array.

PV systems installed over parking spaces and limited in area to include only those areas where vehicle parking is permitted and 3,000 square feet or less are considered a Group "U" Occupancy.

The following code requirements are not applicable to PV installation considered as equipment or a Group "U" Occupancy:

- Fire Extinguishers per CFC Chapter 9, Section 906

- Exit Signs per CBC Chapter 10, Section 1011
- Emergency Lighting per CBC Chapter 10, Section 1006.3
- Automatic Fire Sprinkler System (not required by code)

PV systems installed over both parking spaces and drive aisles or PV system that exceeds 3,000 square feet without rated construction or five feet separation between systems, per CBC Chapter 4, Section 406.1.2, are considered an open parking garage (S-2 Occupancy Group), and all or portions of CBC code provisions apply on a case by case basis.

Group S-2 occupancy may be unlimited in area provided provisions found in CBC, Section 406.3.6 are met.

The following code requirements are not applicable to a Group "S-2" Occupancy PV system supported by non-combustible structure:

- Fire Extinguishers per CFC Chapter 9, Section 906
- Exit Signs per CBC Chapter 10, Section 1011
- Emergency Lighting per CBC Chapter 10, Section 1006.3
- Automatic Fire Sprinkler System (not required by code)

**3.2.3 Specific Requirements for Entirely Fenced-Off, Ground Mounted PV Installations:** A fire access gate with a lock that is capable of being cut away during emergency operations or a security lock such as "Knox Lock" shall be provided which meets the local fire authority having jurisdiction's requirements when the proposed project is entirely fenced-off. Provide 10' of clearance from all vegetation on all sides of the photovoltaic system.

**3.3 Electrical Requirements:** All provisions found in the California Electric Code (CEC) for photovoltaic systems shall apply. These CEC provisions include, but are not limited to, Articles 250, 310, and 690. Appendix A of this IR provides an example of a PV system grounding.

The interconnection, operating and metering requirements for generation facilities which are to be connected to a utility's distribution system, over which the California Public Utilities Commission (CPUC) has jurisdiction shall comply with Rule 21. The School District must be the named customer on the utility account whether connection is through the school house meter or a separate meter dedicated to the proposed project.

**3.4 Guard Requirements:** The guard requirements for mechanical equipment near roof edges in CBC 1013.5 do not apply to solar panel arrays.

**4. SOLAR PROJECT SUBMITTAL REQUIREMENTS:** All projects involving installation of photovoltaic or solar thermal systems shall have a California licensed or registered architect or structural engineer in general responsible charge per Title 24, Part 1, Section 4-316. Applications for project review shall be submitted to the DSA Regional Offices, following the normal process for project submittal. An [overview](#) of the project submittal process and requirements may be found on the DSA web site. (See Appendix B of this IR for web links.)

In addition to the above requirements, the following items are also required for a complete submittal for DSA review:

#### **4.1 General:**

- 4.1.1** Construction plans and specifications shall be signed and stamped by the architect or structural engineer in general responsible charge per [IR A-19](#). The architect or structural engineer in general responsible may use construction plans and specifications prepared by the manufacturer's California registered engineer provided the requirements of [IR A-18](#) are met.
- 4.1.2** The plans and specifications shall include anchorage or restraint details of the panels, BOS equipment, support structures, and foundations. Also submit any applicable anchorage calculations.
- 4.1.3** Shop drawings or fabrication and installation drawings of the system.
- 4.1.4** Calculations to verify that the primary structure will support the additional vertical and lateral loads from the panels and BOS equipment. Provide calculations verifying that roof deflection will not cause ponding and calculations for the racking system components, attachment to the structure, and other structural connections necessary to resist the applicable loads.
- 4.1.5** Submit wind tunnel test reports, non-linear time history analysis, shake table test, friction test, and other reports and calculations, as applicable.

#### **5. SOLAR PROJECTS NOT SUBJECT TO DSA REVIEW AND APPROVAL:**

- 5.1 Excluded Projects:** Ground mounted solar energy systems projects which are a maximum height of eight feet (8') or less, on public school sites, are not subject to DSA review, provided that all of the following conditions are met:
  - the proposed project is not used for instructional purposes,
  - students, teachers and the public will not be permitted to enter the project area, and
  - there is no reasonable availability to or usage by persons with disabilities.
- 5.1.1 Fencing and Signage Requirements:** Excluded Solar Projects, including the BOS, must be entirely fenced off to ensure that students, teachers and the public cannot gain access. The fence must be located at a distance from the equipment equal to or greater than the maximum height of the equipment. The maximum height of the equipment shall be measured from the finish grade or surface at the equipment to the equipment's highest point. Signage stating "NOT OPEN TO THE PUBLIC – MAINTENANCE PERSONNEL ONLY" must be posted on the fence and on the equipment in an area which is visible by the public.
- 5.1.2 Areas Associated with Excluded Solar Projects:**
  - Equipment viewing areas associated with excluded solar projects that are used by students, teachers or the public are not excluded from DSA review and approval.
  - Any alterations to existing electrical rooms or spaces, including those associated with but separated from ground mounted systems, for the

placement of electrical panels or electrical connections in conjunction with an excluded solar project must comply with Section 5.2, below.

**5.1.3 Excluded Project Reporting to DSA:** Per Title 24, Part I, Section 4-310, a resolution must be passed by the school board stating that the building or structure shall not be used for school purposes and that no pupils or teachers will be permitted to use or enter the building for said purposes or be subject to a hazard resulting from its collapse. A copy of the resolution shall be submitted to a DSA Regional Office upon award of the construction contract. Refer to Appendix "C" for "Sample Resolution." See also Section 5.3 for inspection requirements that apply to all solar projects.

**5.2 Projects Exempt from DSA Review:** Alterations projects that consist only of installations of solar energy systems on existing school buildings may be exempt from DSA Structural Safety and Fire review when the total cost of the project (including any other construction, site work, etc.) is less than the cost limit indicated in [IR A-10](#) for alteration projects. The cost limit is adjusted annually, from a baseline cost of \$25,000 in 1999 dollars as required by Title 24, Part 1, Sections 4-308 and 4-309. Refer to IR A-10 for published cost limits, updated in January, and additional requirements.

Projects may be exempt from DSA Access Compliance review and approval per the provisions stated above, if there is no reasonable availability to, or usage by, persons with disabilities, or the project meets the requirements of CBC Section 1134B.2.1, Exception 4.

Free standing structures containing solar energy systems, shade structures, lunch shelters, canopies, large arrays of panels supported on a single pole, etc., are not exempt from DSA review.

**5.3 Project Design and Inspection Requirements:** All solar energy systems and their installation, including Excluded and Exempt projects not subject to DSA review, shall meet the design and construction requirements of Title 24 and applicable provisions of this IR, including inspection by a DSA certified project inspector.

## **Appendices:**

**Appendix A – Example of PV System Grounding**

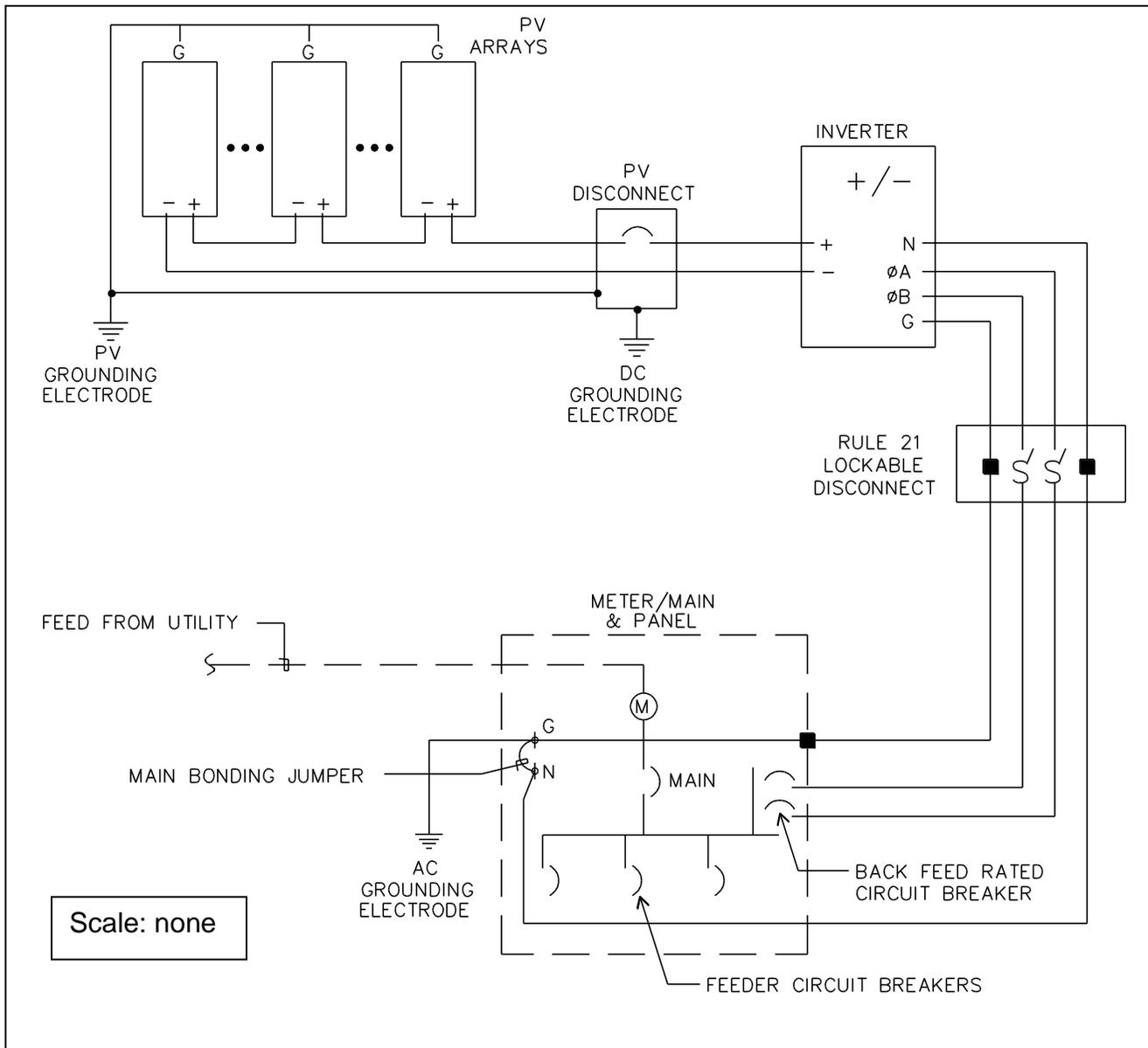
**Appendix B – Hyperlinks to Web Pages**

**Appendix C – Sample Resolution**

**Appendix D – Standing Seam Metal Roof Testing**

**Appendix E – Lowest Average Monthly Low Temperature**

### Appendix A: Example of PV System Grounding



### Appendix B: Hyperlinks to Web Pages

Documents referenced in this IR are available from the DSA Internet web site:  
<http://www.dgs.ca.gov/dsa/home.aspx>

**DSA Interpretation of Regulations:** IR A-5, IR A-10, IR A-18, IR A-19, IR 11B-6 are all available at <http://www.dgs.ca.gov/dsa/Resources/IRManual.aspx>

**Overview of DSA Submittal Process:**  
<http://www.dgs.ca.gov/dsa/Programs/progProject/overview.aspx>

**Fire Marshall's Guideline:**  
<http://www.osfm.fire.ca.gov/pdf/reports/solarphotovoltaicguideline.pdf>

## Appendix C: Sample Resolution

### RESOLUTION

of the

*(Governing entity i.e. School Board, Governing Board)*  
*(Name of School District, Community College District, UC)*

#### NEW GROUND MOUNTED PHOTOVOLTAIC PANEL PROJECT

**WHEREAS**, concerning the construction of ground mounted photovoltaic panel installation at (specify location, i.e. School site, address, campus) shall not be used for instructional purposes, and that no pupils or teachers or the public will be permitted to use or enter the said panel fenced enclosure for said purposes or be subject to a hazard resulting from its collapse.

#### NOW, THEREFORE, IT IS RESOLVED:

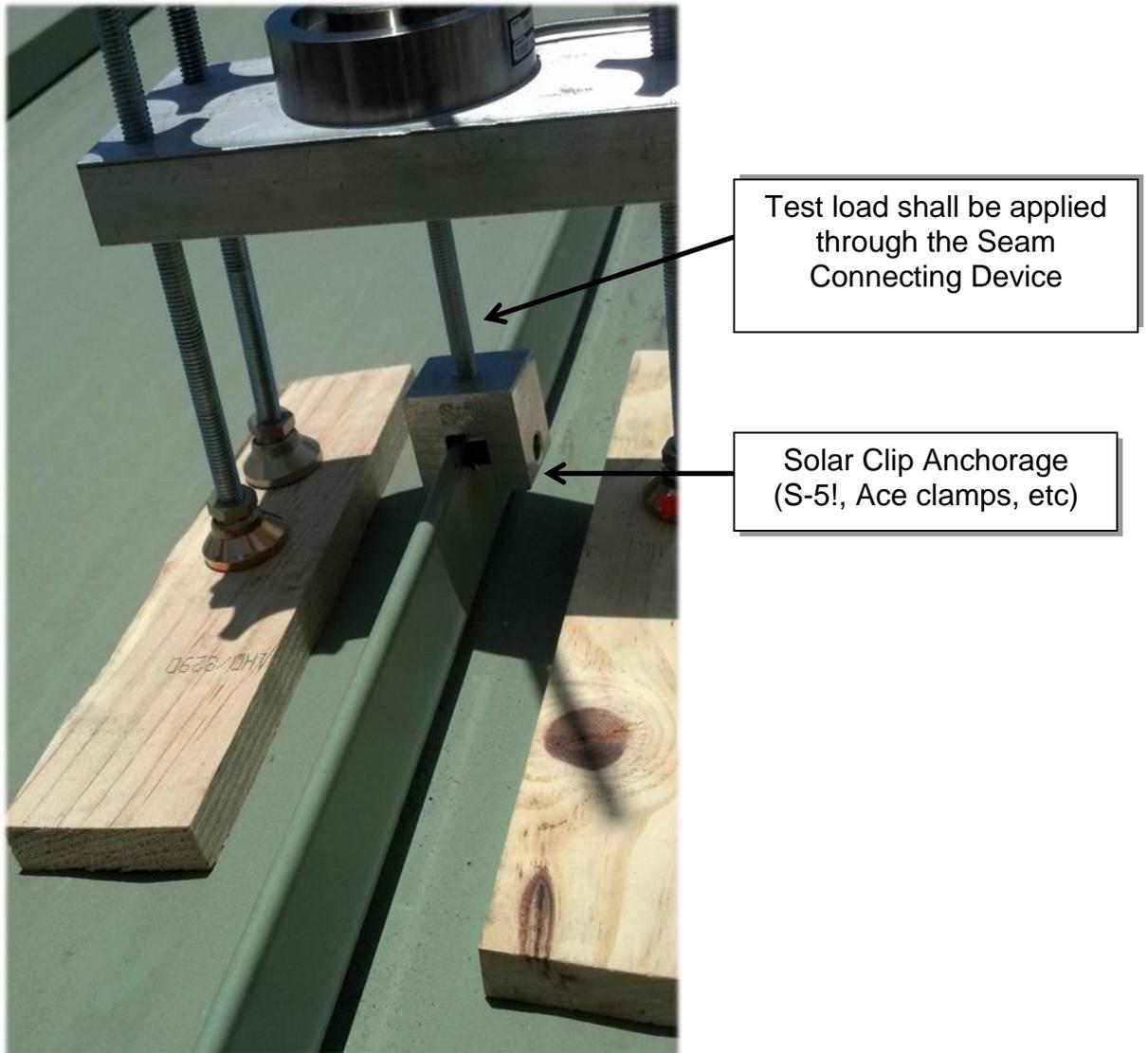
- The *(Governing entity)* of *(Name of School District, Community College District, UC)* directs the Administration as follows:
  - 1) Plans must be prepared by a California licensed Architect or Engineer
  - 2) The school board assumes responsibility for adequate inspection of the materials and work of construction to ensure compliance with the provisions of Parts 2, 3, 4, 5, 6, 7, 11, and 12, Title 24, C.C.R., as adopted by the California Building Standards Commission.
  - 3) The photovoltaic panels shall be ground mounted, less than or equal to 8 feet maximum in height, entirely fenced from student and public use, not associated with public viewing areas, not located in required side yards, do not encroach into fire access lanes, and provide signage stating "Not open to the Public – Maintenance personnel only."
  - 4) To provide a fence such that the project is entirely fenced off from the rest of the campus and the fence is located at a distance from the equipment equal to or greater than the maximum height of the equipment. The maximum height shall be measured from the finish grade or surface at the equipment to the top of the equipment at its highest point. A fire access gate with a lock that is capable of being cut away during emergency operations or a security lock such as "Knox Lock" shall be provided which meets the requirements of the local fire authority having jurisdiction. 10 foot clearance from all vegetation on all sides of the photovoltaic system shall be provided.
  - 5) To provide a disconnect location which is identified and accessible for fire department fire-fighting operations. Architect/Engineer of record to coordinate with local utility provider for requirements regarding connection to service.
- That the *(Governing entity)* hereby adopts the resolution; and
- Directs the District staff to forward a copy of the adopted and signed resolution to DSA upon award of contract.

**PASSED AND ADOPTED** at (type of meeting; i.e. Regular board meeting, special session) of the *(Legal governing entity)* of the *(Name of School District, Community College District, UC)* on *(Date)*

#### ATTEST:

*(Signature governing entity representative)*

## Appendix D: Standing Seam Metal Roof Testing



**Photograph #1:** Example of Test Apparatus to: (1) Determine the capacity of the Seam Connecting Device as required per Section 2.3.2, (2) Production testing of installed devices per Section 2.3.3 a).



Test apparatus to bridge over adjacent seam on each side

Stand outside of the area that is being tested so as not to alter the test results

Test load shall be applied through the Seam Connecting Devices

Seam Connecting Devices (S-5!, Ace clamps, etc.) are to be installed at the locations shown on the approved plans

**Photograph #2:** Example of Field Test as require per Section 2.3.3 b).

## Appendix E: Lowest Average Monthly Low Temperature

City	Lowest Average Monthly Low °F
Bakersfield	39
Big Bear	21
Chico	35
Fresno	38
Hesperia	31
Lake Arrowhead	30
Los Angeles	47
Mammoth	20
Modesto	40
Palm Spring	44
Palmdale	34
Redding	36
Ridgecrest	31
Sacramento	38
San Francisco	46
San Luis Obispo	43
Santa Rosa	39
Truckee	15

\*Source: [www.weather.com](http://www.weather.com)