



Standard Practice for Installation of Roof Mounted Photovoltaic Arrays on Steep- Slope Roofs¹

This standard is issued under the fixed designation E2766; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice details minimum requirements for the installation of roof mounted photovoltaic arrays on steep-sloped roofs with water-shedding roof coverings. These requirements include proper water-shedding integration with the roof system, material properties, flashing of roof penetrations, and sufficient anchoring per regional design load requirements.

1.1.1 This practice does not apply to building-integrated or adhesively attached photovoltaic systems that are applied as roof-covering components.

1.2 This practice does not cover the electrical aspects of installation.

1.3 Installation considerations are divided into two distinct aspects: the interface between the photovoltaic module and the array mounting structure, and the interface between the array mounting structure and the roof or roof structure.

1.4 Safety and hazard considerations unique to this application, such as worker fall protection, electrical exposure, accessibility of modules, and roof clearance around the perimeter of the array are addressed by other codes, standards, or authorities having jurisdiction.

1.5 This practice is intended to provide recommended installation practices for use by installers, specifiers, inspectors, or for specification by photovoltaic module manufacturers.

1.6 This practice provides minimum guidelines and should be used in conjunction with module and mounting system manufacturers' instructions. This practice offers a set of instructions for performing one or more specific operations. This document cannot replace education or experience and should be used in conjunction with professional judgment. Not all aspects of this practice may be applicable in all circumstances. This ASTM Standard is not intended to represent or replace the standard of care by which the adequacy of a given professional service must be judged, nor should this document be applied

without consideration of a project's many unique aspects. The word "Standard" in the title means only that the document has been approved through the ASTM consensus process.

1.7 This practice is not intended to replace or supersede any other applicable local codes, standards or Licensed Design Professional instructions for a given installation.

1.8 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* Specific hazards are given in Section 8.

2. Referenced Documents

2.1 ASTM Standards:²

[D1079 Terminology Relating to Roofing and Waterproofing](#)
[D1761 Test Methods for Mechanical Fasteners in Wood](#)
[E136 Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C](#)
[E772 Terminology of Solar Energy Conversion](#)

2.2 AAMA Standards:³

[AAMA 800 Voluntary Specifications and Test Methods for Sealants](#)

2.3 ASCE Standards:⁴

[ASCE 7 Minimum Design Loads for Buildings and Other Structures](#)

2.4 IEC Standards:⁵

[IEC 61730-1 \(2004-10\) Photovoltaic \(PV\) Module Safety Qualification-Part One: Requirements for Construction](#)

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

³ Available from American Architectural Manufacturers Association (AAMA), 1827 Walden Office Sq., Suite 550, Schaumburg, IL 60173, <http://www.aamanet.org>.

⁴ Available from American Society of Civil Engineers (ASCE), 1801 Alexander Bell Dr., Reston, VA 20191, <http://www.asce.org>.

⁵ Available from International Electrotechnical Commission (IEC), 3, rue de Varembe, P.O. Box 131, CH-1211 Geneva 20, Switzerland, <http://www.iec.ch>.

¹ This practice is under the jurisdiction of ASTM Committee E44 on Solar, Geothermal and Other Alternative Energy Sources and is the direct responsibility of Subcommittee E44.09 on Photovoltaic Electric Power Conversion.

Current edition approved June 1, 2013. Published July 2013. DOI: 10.1520/E2766-13

2.5 *UL Standards:*⁶

UL 1703 Standard for Flat-Plate Photovoltaic Modules and Panels

UL 746C Polymeric Materials—Use in Electrical Equipment Evaluations

UL 60950-1 Table J.1 Electrotechnical Potentials (V)

2.6 *Other Standards:*

IBC International Building Code⁷

IEC International Electrical Code⁷

IFC International Fire Code⁷

NFPA 1 Fire Protection Code⁸

NDS National Design Specification for Wood Construction⁹

3. Terminology

3.1 *Definitions:* Definitions of terms used in this standard may be found in Terminology **D1079** and **E772**.

3.1.1 *steep-slope, adj—in roofing*, that which commonly describes an incline of a roof which is greater than 25 % (14° or 3:12 vertical rise to horizontal run). **D1079**.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *array mounting structure, n*— all structural and mechanical materials used to support and anchor the photovoltaic modules on the roof system between the attachment system and the roof deck.

3.2.2 *attachment system, n*—all structural and mechanical materials used to support and anchor the photovoltaic modules to the array mounting structure.

3.2.3 *design life, n*—the period of time during which a system component is expected to perform its intended function, without significant degradation of performance and without requiring major maintenance or replacement. **E772**

3.2.4 *licensed design professional, LDP, n*—an individual licensed to approve structural designs in the state or jurisdiction where the roof mounted photovoltaic array will be installed.

3.2.5 *representative section, n*—one or more modules connected to an array mounting structure utilizing the same connecting devices as would be used in an installation.

4. Significance and Use

4.1 With the rapid growth of the use of photovoltaic systems in buildings, roof mounted arrays continue to be one of the most prevalent forms of installations. These roof mounted arrays typically feature penetrations into the roof system, which can result in water leakage issues if not properly flashed or applied to the roof system.

4.2 Structural integrity and durability of the application of the roof mounted array to the roof system must be adequate per applicable codes and regulations. This applies to both the

photovoltaic module-to-array mounting structure interface and the array mounting structure-to-roof interface.

4.3 The installation of roof mounted arrays presents certain hazards that must be addressed, which include fall protection, carrying loads up ladders, wind and rain exposure during installation, and electrical exposure during connections.

4.4 The topics covered in 4.1 through 4.3 are potentially a significant barrier to broad acceptance of roof mounted photovoltaic systems if not adequately addressed.

5. Material Requirements

5.1 *Design Life Alignment between the Array and the Roof*—In many cases, the design life of the photovoltaic array may be significantly longer than the estimated design or remaining life of the roof covering. The condition of the roof structure and surface shall be evaluated to determine whether it is sufficient to meet the design life of the roof mounted array. Consultation with a roofing professional and building owner is recommended.

5.2 *Design Life (Exposure and Durability) of Array Mounting Structure*—Materials used in the array mounting structure shall be selected such that the expected design life of the array mounting structure is no less than the design life of the photovoltaic modules. Test data from similar exposure applications is acceptable.

5.2.1 Polymeric based materials used in the array mounting structure shall maintain structural integrity through expected thermal exposure. Any polymeric materials in the structure shall have a relative thermal index (RTI), as defined in UL 746C, of at least 90°C. The thermal resistance of any polymeric material in direct contact with the module shall be specified by the module manufacturer.

5.3 *Adhesive Sealant Requirements:*

5.3.1 *Adhesives Used in Structural Elements*—Bond strength must be sufficient to withstand structural loading as determined by 6.1 and be durable through the expected design life of the array mounting structure. The structural integrity of the bond joining the components of the mounting structure to the array (or to each other) shall be verified through system testing per the structural requirements detailed in Section 6.

5.3.2 *Adhesives Used in Non-Structural Bonding*—Sealants (such as for glazings or other components) must be verified to meet the criteria for exterior perimeter sealants set forth in Section 808.3 of AAMA 800.

5.4 *Corrosion of Resistance of Metals:*

5.4.1 Dissimilar metals in direct contact may corrode. Use appropriate precautions per UL 60950-1 Table J.1 Electrochemical Potentials (V).

5.4.2 Requirements for the array mounting structure shall be the same as the corrosion requirements for the module as set forth in UL 1703 Sections 37 and 14 and Section 4.2 in IEC 61730-1.

5.5 *Material Combustibility*—Where applicable by local jurisdiction fire code, materials used for the array mounting structure to the roof shall be made of non-combustible material per the requirements set forth in Test Method **E136**. If not

⁶ Available from Underwriters Laboratories (UL), 2600 N.W. Lake Rd., Camas, WA 98607-8542, <http://www.ul.com>.

⁷ Available from International Code Council (ICC), 500 New Jersey Ave., NW, 6th Floor, Washington, DC 20001, <http://www.iccsafe.org>.

⁸ Available from National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02169-7471, <http://www.nfpa.org>.

⁹ Available from the American Wood Council, <http://www.awc.org>