GAF Commercial

Photovoltaic Installations on GAF EverGuard™ Single-ply Guaranteed Roofing Systems

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We protect what matters most™

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Introduction

GAF has developed this manual to serve as a general guide for designers of solar roofing systems, and includes information about GAF products, installation requirements, procedures, and guarantee options for the roofing system that may be available to building owners. The information provided in this manual is for general information purposes only, is not intended to provide specific advice with respect to solar photovoltaic (PV) systems, and should not be relied upon in that regard. Users of this manual are responsible for determining whether the GAF products and information in this document are appropriate for their photovoltaic installation. GAF provides no warranties or guarantees with respect to solar photovoltaic (PV) installations or this manual, except as expressly assumed in GAF's written warranties and guarantees. See sample warranties and guarantees, available at gaf.com, for complete coverage and restrictions.

This guide is constructed around GAF commercial roofing systems and impacts of solar installation. Where applicable, GAF will provide specific GAF solar flashings, products, and services that may be beneficial to the designer and building owner.

PV Technology Evaluation

There are many solar photovoltaic (PV) technologies in the market. It is critical that the designer carefully consider the roof system components to ensure the roofing system is an appropriate substrate for the specific PV system being installed.

Roofing System as a Substrate Evaluation

1. For existing roofing systems covered under an active GAF system guarantee the following should be considered:
    a. Before installing a PV system over an existing roof, consider whether the remaining guaranteeable life of the roof is equivalent to the expected life of the PV system (typically >20 years). If it is expected that the PV installation will function longer than the remaining guarantee able life on the roofing system, re-covering or roof replacement before PV installation should be considered.
    b. If the GAF Rooftop Equipment Mount 100 or GAF Rooftop Equipment Mount 240 are installed on an existing roofing system covered under an active GAF system guarantee, the new GAF flashing will be included per the terms of the existing GAF NDL guarantee, when installed by a GAF Certified Contractor, provided all GAF applications and solar notification/ installation procedures are followed.*

* GAF warranties and guarantees do not cover the performance of the mounts as anchors or any punctures caused by improperly secured mounts. Refer to applicable guarantees and warranties at gaf.com for complete coverage and restrictions.

2. For new roofing systems the following should be considered:
    a. Consider designing the roofing system in which the guaranteeable life of the roofing system and the service life of the PV are the same. GAF recommends that the design professional choose a roofing system with a longer guarantee term of 25, 30, or 35 years such as one with a 60- to 80-mil membrane or EverGuard® Extreme TPO.
3. Other factors to consider include additional roof system penetrations, increased rooftop traffic, increased surface temperatures, as a result of the PV installation, etc.
4. General recommendations for all new roofs that will be receiving PV include:
    a. High compressive strength rigid-board insulation.
    b. Cover board located directly under the roof membrane.
    c. Use of thicker roof membranes

In addition to these general recommendations, GAF recommends the following best practices to extend the life of the roof:

a. For self-adhering thin film PV, EverGuard Extreme® TPO is required for coverage under GAF system guarantees.
b. Use of slip sheets in between the contact areas of the ballasted PV and the roof. The slip sheet can be loosely laid or adhered (heat-welded or cold-applied with adhesive) to the roof membrane.
c. For ballasted PV systems, slope of the roof should not exceed 2:12.

Special Note for Mechanically Attached Systems

Mechanically attached and induction-weld attached roofing systems have the possibility of billowing due to high wind or building pressure differences. Billowing could cause ballasted PV systems to shift, and can also lead to localized abrasion of a roof membrane, as it rubs the edges and corners of a PV mounting system (at ballast trays, for example).

	GAF Single-Ply Roof Systems Suitable For Solar Installations		
	Good	**Better**	**Best**
Membrane	60 mil TPO / 50 mil Extreme TPO or 60 mil PVC Mechanically Attached	60 mil TPO / 50 mil Extreme TPO, or 60 mil PVC Adhered or Induction-Welded	80 mil TPO / 70 mil Extreme TPO, or 80 mil PVC/PVC KEE Adhered
Guarantee Durations	Up to 20 years	Up to 25 years	Up to 30–35 years (Extreme TPO 80 mil required for 35 years)
Accidental Puncture Coverage*	Up to 16 labor hours at $2.00 per Sq. fee for select systems	Up to 16 labor hours per year (no charge)	Up to 32 labor hours per year (no charge)
New or Existing Guarantee	Existing	New and Existing	New and Existing
Cover Board	Recommended	Coverboard Required‡	Adhered Coverboard Required‡
Well Roof Extension for Maintenance†	Optional	Optional	Optional

* GAF warranties and guarantees do not provide coverage against accidental punctures except where additional puncture resistance coverage is obtained on eligible jobs. Refer to gaf.com for more information on warranty and guarantee coverage and restrictions.

† The Well Roof Guarantee Extension can extend the duration of GAF Diamond Pledge™ NDL Roof Guarantees by up to 25% for eligible roofs (up to a total maximum duration of 35 years). For qualified systems only. Additional requirements apply. Contact GAF for more information. Well Roof Maintenance is recommended on all projects where GAF Tax Equity has been provided. Please refer to the Well Roof Maintenance Brochure and Inspection Checklist for all requirements and restrictions.

‡ Required for Guarantee Duration and eligibility for Additional Puncture Coverage.

Pre-Job Conference

A pre-job meeting should be held with the building owner, designer, PV system manufacturer, roof system manufacturer, general contractor, electrical contractor, roofing contractor, and any others whose work may have an effect on successful project completion. The PV system designer's specifications/plans and flashing details should be reviewed during the pre-job meeting. The following items should also be discussed at the pre-job conference:

1. Establish construction schedules and work methods that will prevent damage to the PV system flashing and the roof system. The roof membrane should be protected at all times to prevent punctures, burns, scrapes, and other damage that could cause premature failure of the roofing membrane.
2. Schedule an inspection of the roof mounts.
3. Establish procedures for reporting and repairing any damage to flashings or any part of the roof system.
4. Designate access, staging, work, storage, and disposal areas.
5. Establish suitable weather conditions and working temperature criteria to which all parties agree.
6. Establish safety regulations/requirements and good roofing practices.
7. Establish means for change orders request and approvals.

Structural Loading of PV on the Roof and Solar Layout

The following items should be verified by a licensed structural engineer through stamped drawings and calculations. GAF is not responsible for any such analysis, or for the review or acceptance of these items.

1. The roofing system and building structural framing should be evaluated to verify there is enough load capacity to support the weight of the PV system modules, conduits, electrical equipment, wind uplifts, and snow loadings.
2. The incline and height of the solar panels should be considered to address the wind uplift resistance of the PV panels.
3. All vertical and horizontal loads should be transferred to the building structure without deforming or overloading the roofing system.

4. Avoid overloading or point-loading the roof. The roof deck and roofing system should also be evaluated for loads due to traffic during installation and PV/Paver stacking. NOTE: be sure to add in pressure limits for ISO/HD/Gypsum/membrane.
5. It is recommended to use a 7/16" or thicker plywood to protect the roof during loading and installation of the racking and solar panels.
6. Ensure proper attachment or ballasting of the solar array to resist wind uplift and other forces.
7. All areas designated for staging of roofing materials and PV components prior to the installation should be protected to prevent damage.

Drainage

Installation of a PV system should not interfere with the drainage of the roof system. Consider the following:

1. Orientate and elevate framing and conduits above the roof surface to allow for proper drainage.
2. Install crickets on any perpendicular to drainage flow and greater than 24" wide.
3. Projections through the roof system should not be located within 2 feet of valleys or designated drainage areas adjacent to drains, scuppers, or gutters.
4. Consider modifying solar racking heights to counter the varying thickness of tapered insulation.

Thermal Movement

The PV array and electrical conduits are subject to thermal movement. Designers may consider reducing the effect of thermal movement by:

1. Splitting larger arrays into smaller sub-arrays.
2. Using racking clips and attachments that accommodate thermal expansion without transferring movement to the underlying roofing systems. Some racking manufacturers have provisions for thermal expansion built into the PV systems.
3. Using flexible flashing details for mechanically attached racking systems.
4. Incorporating thermal expansion fittings in straight electrical conduit runs.
5. Ensuring that racking systems do not cross over expansion joints.

Slip Sheets and Walkway Pads

1. Use sacrificial sheet of like material (min. 60 mil TPO or PVC membrane) in between contact surfaces at the roof and the base of ballasted racking systems. The slip sheet can be loose-laid or adhered/welded to the roofing membrane, not the base mount. Sacrificial slip sheets must be installed at all points where the roof and racking systems come in contact, and are a requirement for guarantee coverage.
2. The slip sheet helps reduce wear and tear from incidental movement of the array, as well as helping reduce heat build-up on the primary waterproofing membrane.
3. The slip sheets should be a minimum 4" wider than the contact surface area of the rack base mount on all sides.

PV Service Access

1. Roof-mounted PV systems generally should be mounted away from mechanical units, catwalks, permanent anchors, and other rooftop structures to provide access for service or maintenance of other rooftop equipment.
2. Space for service traffic paths should be designated and the roof system surface in these areas protected by walkways pads or pavers.
3. Consult the International Fire Code (IFC) or NFPA 1: Fire Code for firefighting requirements for roof access hatches, access pathways, and equipment clearances.

Racking Systems

The solar racking system should be designed so that external forces acting on the rack do not compromise the weatherproofing integrity of the roofing system. Loads to be considered include horizontal wind load, vertical wind-uplift/down-force load, vertical dead load, and vertical snow load, as well as non-specific vibratory loads from external forces or building equipment.

Designers should ensure that racking systems have:

1. Thermal and dynamic movement provisions within the racking system
2. Minimal UV exposure of washers/gaskets.
3. Base mounts of ballasted PV systems with sufficient area to distribute vertical loads without cutting or compressing the underlying roofing system.

4. Ballast pavers that have been tested for long-term durability (for ballasted PV systems), including freeze-thaw durability. Recommendation to use freeze-thaw resistant pavers in locations where freeze-thaw would be an issue.
5. Compatible corrosion-resistant rack components. Appropriate racking material should be used depending on the project location's environmental corrosion category.
6. Sufficient racking clearances for inspection, maintenance, repair, or reroofing.
7. Ease of removal by trained personnel without exposing the roof system to the possibility of damage.
8. Sacrificial slip sheets at all points where the roof and racking systems come in contact, in order to obtain or maintain coverage for the GAF roofing system under a GAF system guarantee.

Requirements to Obtain or Maintain Coverage of a GAF Roofing System Under a GAF Guarantee when a PV System is Installed

Roofing system guarantees are a valuable tool for the building owner, but they carry important limitations and conditions that must be addressed in order to obtain or maintain coverage for a GAF roofing system under a GAF Guarantee. NOTE: GAF guarantees do NOT cover the PV system.

1. From the start, the roofing system must be designed and installed in accordance with GAF published specifications. Roof drawings and the completed GAF Photovoltaic System Registration Form must be submitted to GAF. All photovoltaic documents must be reviewed and approved by GAF prior to the installation to avoid jeopardizing coverage of the GAF roofing system under a GAF system guarantee.
2. The following products may be eligible for inclusion under the GAF system guarantee (subject to its terms and conditions) GAF Rooftop Equipment Mount 100, GAF Rooftop Equipment Mount 240, EverGuard™ Pre-cut Slip Sheets, or an EverGuard™ pre-flashed accessory.
3. For all extended guarantees durations (i.e., 25, 30, and 35 years), the products listed above must be constructed with 80 Mil EverGuard Extreme® TPO or EverGuard® PVC KEE Membrane
4. Systems and any alterations must be installed by GAF GoldElite™ Commercial Contractors and GAF PlatinumElite™ Commercial Contractors in order to be eligible for coverage under GAF system guarantees. For roofs under 2 years old, this work should be done by the original installing contractor.
5. GAF WellRoof® Guarantee Extension — available through our PlatinumElite™ Commercial Contractors — extends the duration of GAF Diamond Pledge™ NDL Roof Guarantees by up to 25% for eligible roofs.†

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† The Well Roof Guarantee Extension can extend the duration of GAF Diamond Pledge™ NDL Roof Guarantees by up to 25% for eligible roofs (up to a total maximum duration of 35 years). For qualified systems only. Additional requirements apply. Contact GAF for more information.

6. All GAF accessories and any modification to the roofing system must be installed in accordance with all current GAF application and specification requirements and guarantee procedures in order to obtain or maintain coverage under a GAF system guarantee.

Inspections and Fees

1. Pre- and post-PV installation inspections are required on all existing and new roof single-ply systems for which coverage under a GAF system guarantee will be obtained or maintained. The inspections must be scheduled through GAF's Guarantee Services Department. The inspections must be performed by the GAF Field Services Representative, in order to review the installed GAF solar flashings PRIOR to installation of the solar panels. Solar panels may be installed upon GAF providing a completed post-PV inspection* report and acceptance for solar panel installation.
2. These inspections carry a $600 fee for each inspection conducted. For job in progress, an interim and final inspection can serve as the pre- and post-PV inspection for no additional charge.
3. Contact GAF Guarantee Services after the flashing work is completed prior to the installation of the PV panels to schedule a post installation roof inspection. Note: This inspection will not be scheduled unless/until the inspection fee is paid to GAF.
4. Complete any required repairs, including repairs to flashing details and the GAF roofing system that are identified. GAF reserves the right to require additional inspections as necessary to ensure that all GAF requirements outlined above are met. The fee for any reinspection is $600.
5. After all requirements are met and fees paid, GAF will issue the appropriate addendum the Diamond Pledge NDL Roof Guarantee.

Flashings

1. Eligible pre-fabricated accessories:
    a. GAF Rooftop Equipment Mount 100
    b. GAF Rooftop Equipment Mount 240
    c. EverGuard™ Pre-cut Slip Sheets
2. PV systems using support stands should use round steel pipes or square tubes to facilitate effective flashing installation methods. All penetrations should be flashed in accordance with the approved pre-fabricated GAF construction detail.

3. For guarantee durations over 20 years GAF requires the use of GAF factory-fabricated flashings constructed of EverGuard Extreme® TPO or EverGuard® PVC KEE as appropriate.

Electrical Connections

The electrical connection locations and pentrationations must be determined by a PV design professional.

1. The number of roof penetrations should be kept to a minimum. Cables passing through the roof assembly should not travel horizontally within a roof system, such as directly under the roof membrane or in a notched-out section of the insulation. It is recommended to keep as much electrical on the roof and outside of the building envelope as possible.
2. Penetrations of electrical conduit into the building should be properly flashed to the roof system. Electrical conduit passing through a roof assembly should be run inside a sheet-metal enclosure with roof curbs (e.g., doghouse). A gooseneck-type penetration detail can be used where a cable needs to pass through a roof assembly and be flashed.
3. GAF pre-fabricated penetration pockets (pitch pockets or pitch pans) are acceptable as a last alternative for flashing PV system electrical connections passing through a roof assembly.

Maintenance

In order to help ensure coverage of the roofing system under a GAF system guarantee, GAF recommends regular inspection and maintenance to the roofing system.

We recommend, like a roofing systems, that the panels be regularly inspected for proper performance. You should inspect the PV system at least twice a year, preferably in the spring (after last rain) and fall (before first rain). Contact your PV system supplier to coordinate.

In addition to the items required in the GAF Scheduled Maintenance Checklist to maintain the roofing system, here is a list of items that should be performed periodically by a PV professional to maintain the PV system:

During Installation:

1. Check to ensure all the electrical connections are secure. All areas designated for staging of roofing materials and PV components prior to the installation should be protected to prevent damage.
2. All debris should be cleaned from the roofing system on a regular basis, especially sharp objects including but not limited to fasteners and scraps of sheet metal.

* Post-PV inspection is for flashings prior to PV installation.

3. During the installation of the PV system, materials will be transported for the staging areas to the location of their installation. 7/16" or thicker plywood to place pallets on and carts with balloon/rubber tires are recommended to reduce the risk of puncture of the membrane.

Post Installation:

1. Check the PV racking and panels for any damage.
2. Check the PV panels for dirt and debris build-up.
3. Check any PV flashings for damage and have remained watertight.
4. Check all the areas with caulking and sealants to ensure they are adhered and free of cracking or deterioration.
5. Check all the slip sheets, if they have remained in place, in the proper location. In addition any damaged or deteriorated slip sheets must be replaced.
6. Check any areas the PV racking system interfaces with the roofing system, to ensure the PV array is not abrading the roof surface at any location.
7. Check for any debris under the PV system.

Codes, Standards & Guidelines

Below is a list of references to codes, standards, and guidelines relevant to installation of a solar PV system on a roof. This is not a complete list and may not be current. Always check with your design professional or the PV system manufacturer or installer for more information about applicable codes, standards, and guidelines. The local Authority Having Jurisdiction (AHJ) should be consulted to determine the specific requirements for code compliance of the solar PV system on a given roof.

Part	Organization	Reference	Description
Fire Rating	UL	1703, 61730-1, 61730-2, 2703	Fire-rating tests for PV
	ICC	IBC	Fire classification of PV
	ICC	IFC	PV module Safety
	ASTM	E44.44	PV system fire safety
	UL/ASTM	709/E108	Standard test methods for fire tests of roof coverings
	NPFA	1	Fire Code
Installation	NECA	412 (201x)	Standard for installing & Maintaining PV systems
	ICC	IFC	PV systems code permit requirements
	NFPA	70	National Electrical Code (NEC)
Module Mounting/ Framing	ICC-ES	AC428	Acceptance criteria for modular framing systems used to support PV modules
	ICC-EC	AC286	Acceptance criteria for roof flashing for pipe penetrations
	SMACNA	—	Sheet metal manual (For PV standoff/pipe penetration)
Design, Installation & Commissioning Best Practices	NRCA	—	Guidelines for roof systems with rooftop PV components
	NRCA	—	Membrane roof systems
	NRCA	—	Metal panel & SPF roof systems
	NECA	412	Standard for installing PV power systems
Roof	ASCE	7	Minimum design loads for buildings (snow and wind)
	ICC	IBC	Wind resistance - rooftop PV
	UL	1897	Uplift tests for roof covering systems (applicable to BIPV)
	FM	1-15	Roof-Mounted Solar Photovoltaic Panels