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INSURANCE INSTITUTE FOR BUSINESS & HOME SAFETY

ROOF INSPECTION GUIDE

COMMERCIAL ROOF-MOUNTED BALLASTED PHOTOVOLTAIC (PV) WIND PROTECTION ON LOW-SLOPED ROOFS

Use the following guidance to conduct baseline and post-event inspections.

Photovoltaic Wind Protection Guidance

Large-scale commercial PV arrays are becoming increasingly common, with significant growth in both roof-mount and ground-mount systems. Roof-mounted systems on large flat roofs are particularly attractive as they occupy largely unused space on the roof of a building. This document addresses wind-related concerns for ballasted roof-mounted commercial PV arrays with rigid panels installed on built-up (BUR) or membrane roofs. Ballasted PV system designs must consider both wind uplift and movement due to wind loads. Most systems are engineered based on wind loads derived from small-scale model tests that are frequently peer-reviewed. However, there is no consensus on performance criteria regarding how much uplift or sliding is acceptable. Consequently, the amount of PV movement allowed may vary greatly.

When a PV array is first installed, a baseline inspection should be conducted and the location of key elements should be clearly identified. Following a strong wind event—with wind speeds exceeding the greater of 70 mph or 70% of the design wind speed of the building provided by ASCE 7-10 or later—steps should be taken to identify and address any change or damage that may have occurred due to the wind event.

While this document focuses on wind-related issues, IBHS strongly recommends business owners with roof-mounted PV arrays pre-plan for fire, including pre-planning with the local fire department.

Design Considerations

Roof-mounted ballasted PV arrays are not recommended in hurricane-prone areas. In addition to increased vulnerability to uplift and slippage due to greater wind loads, the ballast weight needed to resist wind loads in hurricane-prone regions can exceed the building's original roof design loads unless the roof was designed to handle this type of PV system. Ground-mounted PV systems are preferred for hurricane-prone regions, followed by roof-mounted structurally attached installations.

- Ensure the roof deck can support the increased PV arrays loads, including live loads such as rain, snow (including snow drifts), etc.
- Ensure the PV array being installed has been designed using wind loads from either ASCE 7-16, SEAOC PV2-2012, or a model-scale wind tunnel study that meets the requirements of ASCE 49-12.

Insurance and Damage Considerations

- Who owns the PV system?
- Who insures the system—property and liability?
- Who is liable if the PV system damages the building and/or contents, directly or indirectly?
- What is considered PV array and roof cover damage? When are repairs considered necessary?
- What are the expectations of maintenance after a storm? Who will conduct the inspection and make necessary repairs?
- Who is physically and financially responsible for returning the ballast/array back to its original location?

Initial Inspection

Create a Baseline for the Roof Cover's Physical Condition

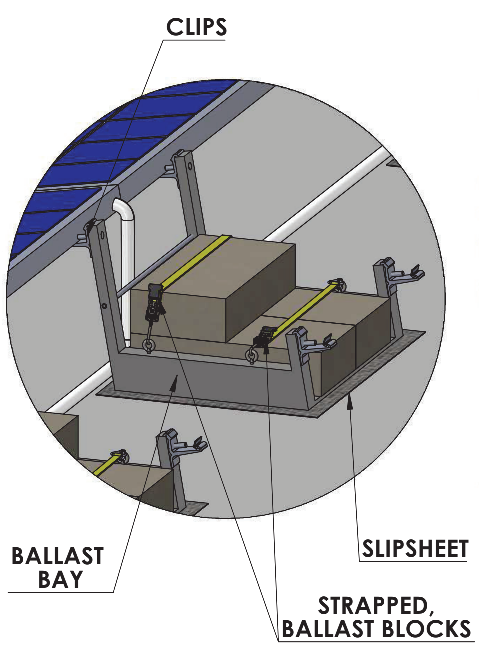
Roof Cover Condition

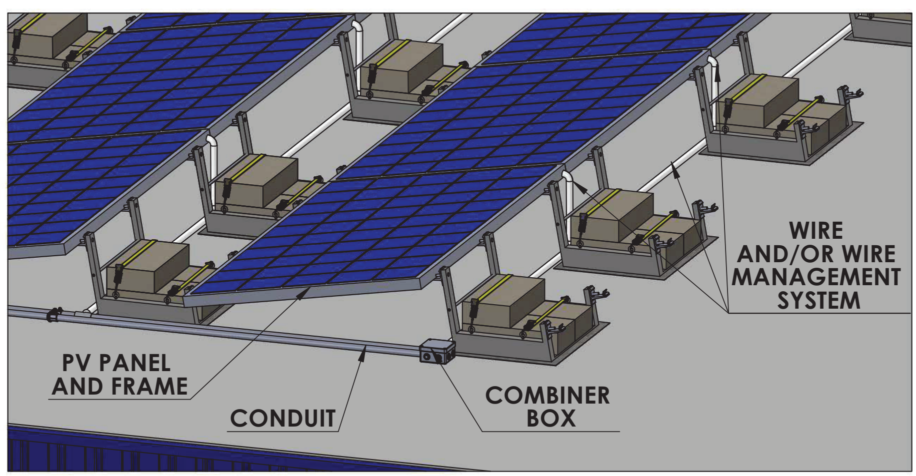
Photograph and document the roof cover prior to any work being done for a PV array installation and review the roof condition findings in detail with the manufacturer/installer. Pay special attention when documenting the condition of the following aspects of the roof system:

- For built-up (BUR) and modified bitumen roof covers, check for bubbles, ripples, and tears, and ensure aggregate stones are well embedded in asphalt for BURs.
- For fully adhered single-ply (SPM) membranes, check the quality of the adhesion, looking for ripples, tenting and tears.
- For mechanically attached SPM membranes, make sure plates and screws are properly recessed and not backing out and that the membrane is well sealed around the plates and does not have tears.
- Note insulation or cover board condition around crickets and any other roof discontinuities. Also note any depressions, standing water, and growth of mold or vegetation.
- Check condition of draining system—interior drains and gutters.
- Examine transitions to vertical surfaces —curbs, parapets, etc.

Walk the roof with the installers verifying the roof condition, including presence of existing roof-mounted equipment.

- Note needed buffer zones between the array elements and other equipment.
- Identify whether the PV system will restrict the flow of water to any interior drains.





NOTE: These drawings are for illustrative purposes only. There is a wide range of ballasted designs that include features similar to those shown here.

PV Installation

CREATE A BASELINE FOR THE PV INSTALLATION

PV ARRAY

Precisely mark the location with paint or a waterproof marker, including:

- Entire array location.
- Deflector locations.
- Each ballast location.
- Slip sheet locations.
- Any other touch point of the array to the roof cover.
- Connector boxes.

BALLAST

- Inspect and document the condition of the ballast (concrete blocks and capstones can deteriorate over time).
- Note whether ballast items are strapped to the ballast bays. IBHS recommends strapping.

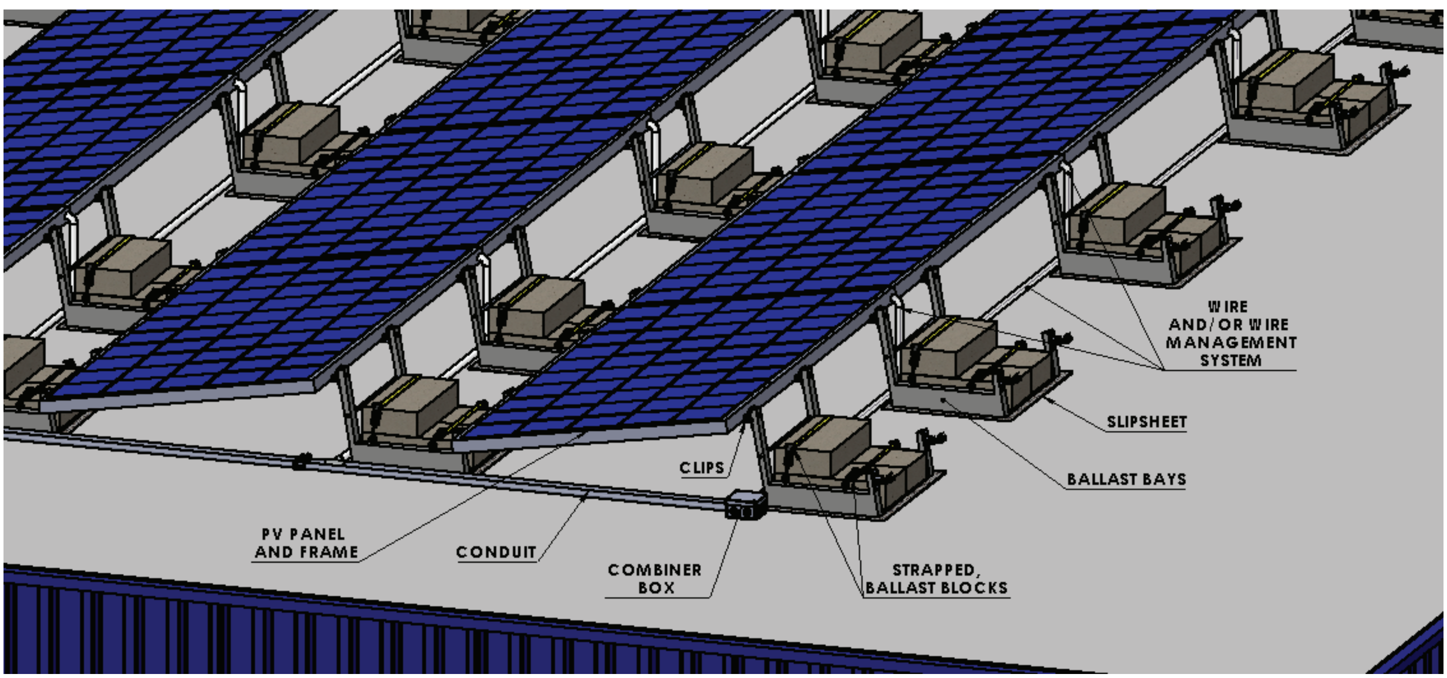
ARRAY STRUCTURAL INTEGRITY

- Inspect the metal frame of the PV panels and the support system to ensure there is no deformation.
- Check individual panel securement:
  - Inspect clips/screws holding panels.
  - Look for clips that are dislodged and/or not holding panels properly.

Electrical Connectors

BOXES, WIRING, AND CONNECTIONS

- Document the location, condition, and securement methods of electrical equipment.
- Ensure ends of flexible conduit and wiring are well secured to the array structural frame.



NOTE: This drawing is for illustrative purposes only. There is a wide range of ballasted designs that include features similar to those shown here.

Post-Event Inspection

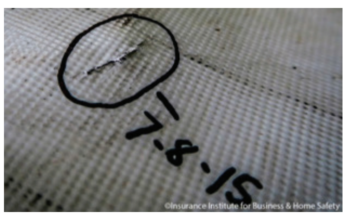
Record Damage Caused During Wind Events

Roof Cover Condition

ROOF COVER, ROOF DECK, AND DRAINAGE

Note any changes in the roof cover, including roof cover tears in all areas, paying close attention to:

  - Roof edges.
  - Seams (fasteners and plates).
  - Areas near roof-mounted equipment.
- Note any insulation board depressions.
- Identify and immediately correct any drainage system blockage or damage.
- Record any structural deck depressions.



Roof cover tear created by PV array during IBHS testing of PV arrays

PV Installation

Inspect for signs of uplift and sliding movement. Damage may not be initially evident, but it can be additive over time. With each storm, re-inspect and document the findings:

- Location of individual ballast supports. PV arrays often do not move uniformly; certain portions may have significant movement, while others have little to no movement.
- Array damage.
- Ballast movement and displacement of any ballast blocks.
- Slip sheet loss, movement, and tears.

Inspect the physical condition of the ballast.

- Look for any deterioration or crumbling of the concrete blocks/capstones. This type of ballast can deteriorate due to normal weathering.

Determine array structural integrity by looking for:

- Frame deformation.
- PV panel damage.

Examine individual panel securement.

- Inspect clips, screws, and bolts holding panels.
- Look for bent clips.
- Look for bolts and clips that are dislodged or not holding panels properly.

Electrical Connectors

BOXES, WIRING, AND CONNECTIONS

- Displacement of connector boxes/power distribution equipment.
- Loose conduit and wiring.
- Loose connections.
- Obvious signs of damage to the electrical wires such as frays, nicks or cuts.
- Flexible conduit or wires that no longer provide slack for additional movement in a future event.
- System components that are encroaching needed buffer areas around other equipment.

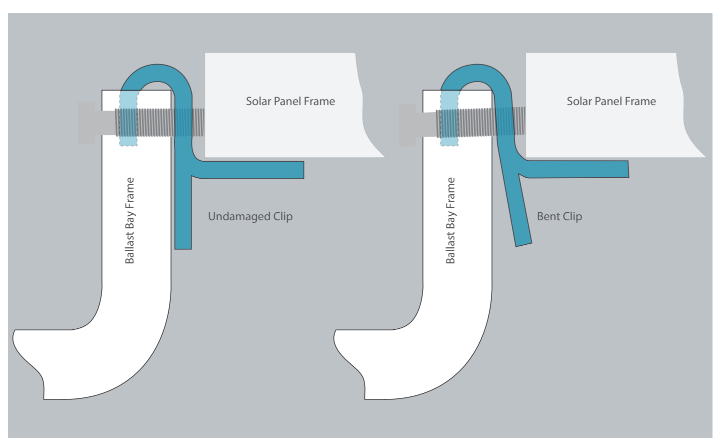


Illustration of an undamaged clip and a bent clip