Roof Mounted Solar Photovoltaic Systems – Ongoing Care

Roof mounted solar photovoltaic (Solar PV) systems are installed on many buildings and present a number of potential hazards and exposures requiring careful management to avoid fire and other material damage losses.

This Loss Prevention Standard is one of a series of related documents and provides guidance on managing the ongoing care of solar PV systems.

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Introduction

Roof mounted solar PV installations produce electrical power via the conversion of light energy. The power generated by the modules, also known as panels, can be used by the occupiers of the buildings, sold to the grid, or stored for later use within a Battery Energy Storage System (BESS).

Once installed, solar PV systems require structured ongoing care to help maximise energy production, and reduce the risks of damage, fire and business interruption losses. This care includes:

- Systems monitoring,
- Self-inspection,
- Service and maintenance,
- Cleaning, and
- Testing.

Practical guidance on managing these care requirements is provided in this document.

Note: This Loss Prevention Standard relates to roof mounted solar PV systems and is focussed on asset loss prevention and related risk management guidance. It is not intended to address building integrated solar PV systems or liability/general liability exposures. The presumption is that all local regulatory territory requirements, and compliance with national/local building regulations, codes, or standards take precedence and have, or will be, met. In territories where local authorities have jurisdiction, compliance with applicable laws and regulations is assumed as a minimum requirement. The recommendations in this document are intended to supplement, not replace, local requirements.

Management Systems

Managing Change

The ongoing care and maintenance of solar PV systems may result in adaptations to the system. Any significant planned works that could impact the buildings and business activities should be managed through a formal Management of Change process. This helps ensure all stages of the change are progressed with minimal exposure to the existing arrangements.

Refer to the Aviva Loss Prevention Standard **Managing Change - Property** for further guidance.

Hot Works

Hot works are tasks or equipment that use or create heat, flame, or sparks. Examples include, but are not limited to, the use of welding equipment, blowtorches, grinders, drilling, and brazing. Hot works are associated with many fires and must be closely controlled.

- Roof-based hot works in relation to solar PV maintenance and care should be prohibited and any necessary hot works should be undertaken in a remote and safe location.
- Where this is not possible, any hot works must be conducted in strict accordance with the Aviva Loss Prevention standard **Hot Work Operations.**
  - ✓ Fire watches should be undertaken for up to 240 minutes after the hot works and only reduced where supported by a specific risk assessment.
  - ✓ Thermographic cameras should be used throughout the works and during the fire watch periods.

Refer to the Aviva Loss Prevention Standards **Hot Work Operations** and **Managing Contractors – Property** for further guidance.

Emergency Response

Emergency response plans should be extended to include the solar PV system, detailing the key responsibilities and actions that are to be followed in an emergency event during the ongoing care of the solar PV system.

The emergency response plan should include best practice responses to all likely property and business interruption risks, including fire, malicious damage and weather-related exposures, e.g. storm, hail, excessive rainfall, etc.

The emergency response rules should be formally documented, and appropriate training provided to key workers and contractors prior to works commencing.

Refer to the Aviva Loss Prevention Standard **Emergency Response Teams** for further guidance.

Business Continuity Plans

Ensure Business Continuity Plans are routinely reviewed to consider any changing exposures created by the solar PV installation. This may include the need to engage with specialist solar PV system contractors to safely recover the building post incident and understand the financial impact if the array (roof-based modules, cables and associated equipment) is not available to generate power.

Refer to the Aviva Loss Prevention Standard **Business Continuity – Seven Steps to Continuity** for further guidance.

Training

Any persons engaged within the organisation to support the ongoing care of the solar PV installation, or whose work activities may bring them into proximity to the system components, including any emergency response procedures, should be appropriately trained and skilled to complete such tasks and be aware of the risks associated with solar PV systems and the safety management systems that support them, e.g., hot work management systems, lock out tag out, etc.

Managing the Risks

System Monitoring

The solar PV system's ongoing performance, including any fault conditions, should be continuously tracked using the string inverters, or where fitted, the Module Level Power Electronics (MLPE). The data generated by the solar PV system's Supervisory Control and Data Acquisition (SCADA) system should be integrated with building management systems, where present, in order to streamline monitoring and response capabilities.

- The monitoring system, including communications equipment, should be checked at least weekly for signs of dropped energy generation, which can be indicative of array faults, soiling or shading, etc.
  - ✓ Trees, other structures and soiling from bird waste, lichen, etc., can cause partial shading to modules, which can result in energy generation losses and the formation of hotspots, which can deteriorate and lead to module damage and fire.
- Monitoring systems should be checked after any changes to the solar PV system to ensure normal operation.
- Ensure the inverter's online portal is checked at least monthly.

Note: MLPEs are devices used at module level to provide monitoring, energy optimisation, and safety features, including automatic isolation of faulty or damaged modules. The two most common types are:

- **Micro-inverters**. A type of MLPE which provides module-level monitoring, energy optimisation, and safety features. Power is inverted at module-level from DC into AC. There is therefore no need for string or array inverters.
- **Optimisers**. A type of MLPE which provides module-level monitoring, energy optimisation, and safety features. Power from the string or array remains in DC until turned to AC by an inverter. Note that there are significant variations between optimiser models in energy optimisation and safety features, therefore this should be verified in detail prior to selection.

Self-Inspection

Regular visual inspections should be completed for signs of wear, tear, damage, water ingress, etc., and any remedial work scheduled and undertaken promptly. Self-inspections should include:

- **System checks**. Check the solar PV system is generating electricity through either the monitoring system, inspecting the generation meter, or via the inverters. Check that the monitoring platform and inverter display(s) are free from error messages or alarms.
- **Inverters**.
  - ✓ Check that the inverters are free from signs of wear and tear, heat damage, corrosion, discolouration, unusual smells, or moisture ingress.
  - ✓ Check that any cooling fans are operating normally and are not impeded.
  - ✓ Check that the inverter area is clear of combustibles. Aviva recommend at least 5 metres separation is maintained.
  - ✓ Where located outside, check that the inverters are adequately protected from weathering.
- **Isolators**. Check the isolators are free from signs of wear and tear, heat damage, corrosion, discolouration, unusual smells, or moisture ingress.
- **Modules**. Check modules for surface damage or contamination, e.g., stone strike, cracking, tree sap, lichen, moss, or perimeter seal damage.
- **Fixings**. Check fixings, frames and means of securing, e.g., bolts.

- **Cables and Connectors**. Check for visible/loose cables on the roof, if exposed to sunlight, touching roof surfaces, or lying in pooling water.
- **Roof Materials**. Loose items or waste materials on the roof:
  - ✓ These should not be allowed to accumulate as they can be lifted in high winds and cause mechanical or impact damage.
  - ✓ Consider any nearby deciduous trees, especially in the autumn.
  - ✓ The roof should be maintained in clean and sterile condition.
- **Nests**. Birds may nest below modules, which increases the risks of damage to cables and connectors, as well as stone strike from dropped pebbles. Any areas being used by nesting birds should be cleared as soon as possible, and bird netting or vermin-repellent mesh installed to prevent future habitation.
  - ✓ Rodents can also nest below the modules or in the wiring / module network, and cause damage to equipment. Where this is evident ensure appropriate pest control measures are taken.
- **Thermographic Cameras**. Use a handheld thermographic device to spot check solar PV equipment for overheating, taking note of peak temperatures for the equipment.
- **Green Roofs**. Where possible, inspect the undersides of modules for vermin and to ensure planting is in good health and is not interfering with components or fixings.
- **Emergency Procedures**. Check the emergency shutdown procedure is displayed, visible and in good condition.

The frequency that the self-inspection steps listed above should be conducted will be based on risk assessment, the exposure and the nature of the installation. A monthly frequency is recommended.

Important: Inspection of solar photovoltaic systems should be carried out during peak sunlight hours as faults may not be detected whilst the array is not generating. The self-inspection should be visual and non-invasive. Do not open electrical enclosures, remove covers, disconnect connectors, touch conductors, reset equipment repeatedly, or attempt repairs unless authorised and competent to do so.

Refer to the Aviva Loss Prevention Standard **Roof Mounted Solar Photovoltaic Systems - Self-Inspection Checklist** for further guidance.

Module Contamination and Cleaning

Depending on the location of the site, contamination of the modules from bird droppings, tree sap, lichen, etc., may be a problem. Module contamination impacts the performance of the system and can also lead to the formation of hotspots, which can become an ignition risk.

Module cleaning frequency should be condition-driven to establish a schedule that is both practical and effective. Local conditions can vary significantly and should be considered when determining the appropriate frequency. Relevant factors include the prevalence of birds in the area, nearby vegetation, local sources of dust or contamination, and the tilt angle of the PV modules.

Whilst steeper module angles generally promote greater natural cleaning through rainfall, no PV system should be considered entirely self-cleaning. Consequently, periodic inspection and cleaning may still be required to maintain performance and prevent excessive soiling.

Note: PV arrays should not be cleaned using pressurised jet cleaning equipment and should only be cleaned in accordance with Original Equipment Manufacturer (OEM) guidance on methods and materials.

Formal Maintenance

The solar PV installation should be subject to formal testing, inspection and maintenance on a periodic basis by a qualified, competent and experienced company/contractor. Such works are to be carried out as per local or national regulations, standards or codes.

Relevant International Electrotechnical Commission standards include:

- **IEC 61730-2:** Photovoltaic (PV) module safety qualification – Part 2: Requirements for testing
- **IEC 62446-1**: Grid-connected PV systems, commissioning tests, documentation and periodic verification.
- **IEC 62446-2**: Maintenance of grid-connected PV systems.

Important: The frequency of such work should be confirmed by the inverter OEM, installer or maintenance provider in line with industry standards as a minimum, and confirmed with your insurer, broker or authority having jurisdiction. The frequency of formal maintenance can be impacted by issues such as building and asset values, exposures, building type and occupancy, accessibility, etc.

Further guidance is provided in **Appendix 1 – Recommended Maintenance Frequency** at the rear of this document.

Key considerations include:

- **Labelling**. Ensure appropriate signage is present and legible including dual supply, system diagram, direct current hazard, shutdown instructions, and 'solar PV on roof' warning signage.
- **Switchgear**. Ensure breakers, AC and DC isolators are functional, checked for damage or overheating, free of moisture and dust ingress, protected from weathering, and terminations tightened where necessary.
- **Earthing**. Ensure earth termination points and associated wiring are free from corrosion and appropriately connected.
- **Inverters**. Ensure inverters are operating within normal parameters; are free of moisture ingress; are checked for overheating; that the cooling ducts and associated filters are free from blockages and obstructions; and that they are installed and serviced according to the manufacturer's guidelines, with the error log checked and faults remedied.
- **DC Connections**. Ensure inverter connectors are secure and undamaged.
  - ✓ **Insulation Resistance Test**. Complete and record insulation resistance testing on all strings at the circuit design voltage rating as a minimum, with low outliers or values below 1MOhm isolated and investigated.
  - ✓ **Voltage and Current Tests**. Complete open circuit voltage and short circuit current tests with all readings recorded.

- **Physical Inspection**. The service should include a physical inspection of the modules, mounting structure, cabling and any other roof-based equipment to help identify damage, faults, levels of module soiling and shading, array movement, the presence of pests, etc.
  - ✓ **Modules**. Module surfaces should be clean and not have any visible cracking, scorch marks, or delamination.
  - ✓ **Module Cables**. Check junction boxes, string cables and connectors for damage or corrosion.
    - **String Cables**. Check the cables are secured, not pressed against sharp edges, connectors not exposed to direct sunlight / UV damage, or laid on surfaces where water can pool.
    - **Elevated**. Check cable runs are elevated from the roof surface, laid in perforated cable trays to prevent water pooling, and capped to protect from direct sunlight.
  - **Mounting Structure**. Ensure rails are secured, positioned correctly, and module clamps are secured without signs of damage to the modules.
    - **Torque**. If torque markings are visible, check they all align, retightening bolts where necessary up to the torque level recommended by the OEM.
    - **Skirting**. Ensure any skirting to prevent nesting birds and/or detritus accumulation is correctly fitted and undamaged.

Any damaged modules or components noted during the inspection / maintenance works should be immediately isolated and replaced as soon as possible. Any other remedial actions, including any other structural issues or faults should be remedied in line with OEM or maintenance company guidance.

Fire Detection Systems

Fire detection systems, including those installed to the roof arrays, should be maintained in accordance with the OEM and installer guidance and any national regulations, standards or codes.

Inaccessible Roofing

All components of the solar PV system should be accessible at any time to undertake self-inspections, repairs and maintenance, including roof-based equipment. Where this is not the case, consideration should be given to providing permanent, safe fixed access.

Where unfeasible, drone inspections of the roof-based equipment should be completed.

Drone inspections should be undertaken by an experienced company or person approved by the relevant authority governing civil aviation to undertake commercial drone work and hold appropriate drone insurance protection.

The inspection should include all of the roof mounted elements, including, but not limited to the modules, the framework/mounting structure, cabling, connectors and any other relevant equipment.

- **Hazards**. Any observed damage, soiling or shading, movement, etc., should be recorded and discussed with your solar PV maintenance company, and remedied in line with their recommendations.
- **Modules**. Module surfaces should be clean and not have any visible cracking, scorch marks, or delamination.

- **Mounting Structure**. Rails and module clamps should be secured and positioned correctly with no signs of damage to the modules.
- **String Cables**. The cables should be secured, not pressed against sharp edges and connectors not exposed to direct sunlight, or laid on surfaces where water can pool.
- **Elevated**. Cable runs should be elevated from the roof surface and laid in perforated cable trays to prevent water pooling and capped to protect them from direct sunlight.
- **Skirting**. Ensure any skirting to prevent nesting birds and/or detritus accumulation is correctly fitted and undamaged. Check for the presence of pests.
- **Thermographic Checks**. Drones should perform thermographic scans of the array to identify hotspots and other unusual heat patterns.

Any damaged modules or components noted during the drone inspection should be immediately isolated and replaced as soon as possible. Any other remedial actions, including structural issues, hotspots or faults should be remedied in line with OEM or maintenance company guidance. Where roof access is arranged to undertake such repairs, the roof-based equipment should be subject to a full inspection/testing and any other identified damage or issues remedied.

Aviva has a drone proposition that can be accessed by its customers as required. Please speak to your local Aviva representative. Drones - Aviva Risk Management Solutions

Thermographic Surveys

Aviva recommends all ground-based electrical systems are inspected with a thermographic camera during planned maintenance. This is a powerful, low cost, non-destructive, and non-intrusive tool that could be considered as part of the maintenance strategy on any site.

Solar PV modules themselves can be inspected using handheld thermographic imaging, however thermographic drones are more suitable as they can be configured to inspect them at the correct angle to avoid reflections and can scan much larger surface areas than handheld devices.

Note: Where there are enhanced exposures such as mass timber/timber frame or other combustible construction, consider increasing the inspection frequency.

Weather Events

Poor weather or weather events can also lead to component damage. Ensure:

- All roof mounted equipment is adequately fixed and secured in advance of poor weather, and any unsecured components or items are removed from the roof surface.
- Following any high wind, storm or hail events, and after any heavy snowfall or ice accumulation the array is visually checked for damage or loose fixings.

Contact Information

United Kingdom

Please visit Aviva Risk Management Solutions or email us at riskadvice@aviva.com. To speak to one of our advisors, call 0345 366 6666.*

*The cost of calls to 03 prefixed numbers are charged at national call rates (charges may vary dependent on your network provider) and are usually included in inclusive minute plans from landlines and mobiles. For our joint protection telephone calls may be recorded and/or monitored.

Canada

Please visit Aviva Risk Management Solutions | Aviva Canada or email us at arms.canada@aviva.com

Ireland

Please visit Insurance Risk Management | Business Risk Management Insurance - Aviva Ireland or Email us at armsireland@aviva.com

Specialist Partner Services

Aviva have created a network of Specialist Partners to complement our in-house capabilities and to enable our policyholders to benefit from a wide range of risk management solutions at preferential rates and terms. Together, we provide solutions to help with the significant challenges of modern-day risk management.

Note: These partner relationships are wholly for the benefit of our policyholders with no income to Aviva.

The following Specialist Partners provide products or services in relation to risk guidance provided, discussed or referenced in this Loss Prevention Standard.

United Kingdom

- Solar PV servicing and maintenance - **Solarsense**
- Direct low pressure suppression systems – **Secom**
- Solar PV cleaning - **Rentokil**

For more information please visit: Aviva Risk Management Solutions – Specialist Partners

Ireland

For more information please visit: Insurance Risk Management | Business Risk Management Insurance - Aviva Ireland

Canada

For more information please visit: Our Specialist Partner Network | Aviva Canada

Standards, Sources and Useful Links

- CSA standards for photovoltaic systems and electrical installations. CSA Catalogue - Standards and Learning Store - CSA Group
- Canadian Electrical Code (CEC), Part I.
- PV maintenance guidance from CanREA (Canadian Renewable Energy Association) and provincial utilities Canadian Renewable Energy Association

Ireland

- Safe Electric National Rules for Electrical Installations (I.S. 10101).
- ESB Networks and EirGrid connection requirements.
- SEAI-Solar Photovoltaic (PV) Manual of Consenting Procedures

United Kingdom

- Industry best practice manual : Guidelines for the operation and maintenance of rooftop solar photovoltaic systems
- RC62 - Recommendations for Fire Safety with PV Panel Installations
- In the United Kingdom electrical requirements are addressed in **BS 7671: 2018 Requirements for Electrical Installations IET Wiring Regulations (18th Edition)**

Other

- RETC Module Reports
- IEC 61215-1-1: Terrestrial photovoltaic (PV) modules – Design qualification and type approval – Part 1-1: Special requirements for testing of crystalline silicon photovoltaic (PV) modules
- IEC 61730-1: Photovoltaic (PV) module safety qualification – Part 1: Requirements for construction
- IEC 61730-2: Photovoltaic (PV) module safety qualification – Part 2: Requirements for testing

Additional Information

Loss Prevention Standards

These documents set out best practice recommendations to help reduce the likelihood and impact of losses.

Relevant Aviva Loss Prevention Standards include:

- **Roof Mounted Solar Photovoltaic Systems - Planning and Design**
- **Roof Mounted Solar Photovoltaic Systems - Installation**
- **Roof Mounted Solar Photovoltaic Systems - Decommissioning**
- **12 Top Tips for Roof Mounted Solar Photovoltaic Systems**
- **Roof Mounted Solar Photovoltaic Systems - Self-Inspection Checklist**
- **Material Damage Risk Assessment**
- **Hot Work Operations**
- **Emergency Response Teams**
- **Business Continuity - Seven Steps to Continuity**
- **Small Scale Battery Energy Storage Systems**
- **Planning a Battery Energy Storage System - 12 Top Tips**
- **Emergency Response Planning with Fire and Rescue Services**
- **Manual Fire Fighting Water Supplies Managing Change - Property**
- **Managing Change - Property**
- **Managing Contractors - Property**

Please visit Loss Prevention Standards to view the full library.

Aviva Risks Training Solutions (United Kingdom Only)

Aviva Risk Training Solutions, delivered through our Specialist Partner, SafetyCulture, provide free, bite-sized learning modules exclusively for Aviva policyholders.

Please visit Aviva Risk Training Solutions for further guidance.

Appendix 1 – Recommended Maintenance Frequency

Planned Maintenance

Local industry best practice should be adhered to when identifying the most effective planned maintenance frequency.

When such guidance is neither available nor applicable, Aviva's minimum recommended self-inspection and planned maintenance frequencies are indicated in the following table.

Client Self-Inspection	MLPEs Fitted / Optimised	No MLPEs / non-optimised
All Commercial Risks	Monthly	Monthly
Planned Maintenance	**MLPEs Fitted / Optimised**	**No MLPEs / non-optimised**
Domestic Risk	10-yearly	5-yearly
Low Risk	2-yearly	Annually
Medium Risk	2-yearly	Annually
High Risk	Annually	6-monthly

Low Risk: Solar PV installations with a generating capacity of less than 50 kW.
Medium Risk: Solar PV installations with a generating capacity of 50 kW to 500 kW.
High Risk: Solar PV installations with a generating capacity exceeding 500 kW.

Important: If the roof is considered combustible or the array is on a hospital, care facilities, or other premises with high hazard occupancy, the system should be considered as a **high risk.**

The guidance provided above are recommendations and specific guidance can be obtained from your installer, maintenance provider, insurer, broker or authority having jurisdiction.

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