

Roof Mounted Solar Photovoltaic Systems - Installation

Roof mounted solar photovoltaic (Solar PV) systems are installed on many buildings and commonly considered when designing and constructing new properties. Solar photovoltaic (PV) equipment presents a number of 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 risks associated with solar PV systems during the installation phase.

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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 electrical grid, or stored for later use within a Battery Energy Storage System (BESS).

A number of risks are present during the installation phase which can be reduced by following the guidance 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.

Understanding the Risks

The risks commonly associated with roof mounted solar PV systems during the installation phase include, but are not limited to:

- **Fire.** Modules can generate electrical energy as soon as they are exposed to sunlight. Cables can short, arc and overheat, potentially igniting, or causing smoke damage, to property. Even minor damage can invalidate warranties on buildings in the course of construction.
- **Electrical Faults.** Incorrect, poorly installed, or incompatible electrical components can result in overheating and electrical fires.
- **Damage.** Poorly executed and planned installation works can result in damage to roof based solar PV components, roof systems and other roof mounted fittings, e.g., ventilation, extraction, electrical plant, telecommunications equipment, etc.
- **Water Ingress.** Poor or inadequate sealing around fixings or accidental breaches of waterproof claddings and membranes can result in water ingress, mould, and rot. Such damage can also invalidate warranties on buildings in the course of construction.
- **Wind.** PV arrays (roof-based modules, cables and associated equipment) in the course of construction or stored on roofing can move or become windblown, leading to system stress and property damage.
- **Business Interruption.** Completion delays can result in downtime / loss of earnings.

Management Systems

Risk Assessments

Ensure relevant fire related risk assessments are in place and have been reviewed to reflect the risks associated with the solar PV installation.

Note: Statutory risk assessments are deemed the minimum requirement. Following the recommendations in this document can help further reduce the risk and exposures.

Refer to the Aviva Loss Prevention Standard **Fire Safety Legislation - United Kingdom** for further guidance.

Material Damage Risk Assessment

During the planning and design phases, an assessment of the anticipated/potential financial losses for both material damage and business interruption exposures should have been undertaken, reflecting expected loss events involving the solar PV installation.

This assessment should be continually updated either as the solar PV installation reaches certain milestones, as a result of any changes to the installation specification, risk assessment and method statement (RAMS), and during the commissioning and handover phase.

This assessment, which helps ensure risk control measures are sufficient and reflective of the potential property loss estimates, should address:

- The solar PV installation
- The building and other valuable assets,
- Business interruption, and
- Environmental, social and governance (ESG) exposures.

Refer to the Aviva Loss Prevention Standards **Material Damage Risk Assessment** and **Business Continuity - Step 4: Business Impact Analysis and Risk Assessment** for further guidance.

Managing Change

The installation and commissioning of solar PV systems, and any significant planned or unexpected changes to buildings and trade operations to accommodate the installation works, 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 Standards **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 the installation of solar PV equipment 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

An emergency response plan should have been produced prior to the installation works outlining key responsibilities and actions to be followed in an emergency event during the installation works.

Ensure the emergency response is reviewed upon any unplanned or unexpected changes to the installation works specification, contractors, buildings, etc., during the installation, commissioning and handover phases.

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

Business Continuity Plans

Ensure the Business Continuity Plan is reviewed at regular intervals throughout the installation works to consider any emerging or arising exposures.

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 installation, commissioning and 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

Installer Competence

Ensure competent and experienced solar PV system installers and fitters are utilised. Reliance on installer scheme accreditations and reviews on the installers own website or literature may not provide a balanced assessment of the suitability of the installer for the planned works.

Due diligence should include assessments of the installers reputation(s), previous projects and any lessons learned, feedback from other customers including customer service and system performance, and availability to undertake urgent repairs, if ever needed.

Important: The installer **must** offer maintenance services post-installation and the maintenance offering should correlate with the guidance provided in the Aviva Loss Prevention Standard **Roof Mounted Solar Photovoltaic Systems - Ongoing Care**.

Electrical engineers should be qualified to install and maintain electrical systems in compliance with national regulations, standards, and codes. Specific solar PV system training courses are generally available to qualified electrical engineers, and any electrical engineer installing a solar PV system should have undergone such training and be able to provide certification upon request.

Manufacturer Guidelines

The system's safe operating conditions will be detailed by the Original Equipment Manufacturers (OEMs) of the various system subcomponents including the mounting structure, modules, cables, and inverters, typically in technical data sheets and manuals.

This information will detail:

- Clearances from the roof.
- Separation distances between various system components.
- String sizes.
- Cable arrangements.

Where appropriate, markings and signage should be used to support and enforce these OEM requirements.

Component Traceability

Many issues can arise from the use of incompatible solar PV components, including different module or cable connector types. Ensure due diligence procedures are in place to verify that the equipment ordered and delivered to site aligns with the design specification and including checks of certificates of conformity, etc. Any deviance or inconsistencies **must** be highlighted to the system designer and OEM and rectified.

Second hand modules should only be used where these have passed quality control tests including visual, thermographic, and electrical testing in line with the manufacturer's guidance and power performance predictions. Note that in many cases these can be damaged, even if the damage is not immediately or overtly visible, e.g., micro-cracking, and can lead to performance issues and potentially fire incidents.

Cables and Connections

Ensure all PV cables and connectors are correctly specified at the start of the project and verified during installation.

- The manufacturer's name should typically be visible on both connecting components.
- During installation, carry out spot checks on male and female connectors to confirm they are from the same manufacturer.

Important: Using incompatible connectors or connectors from different manufacturers is one of the leading causes of fire in solar PV systems and should be managed carefully.

Cables and connectors must not be left in direct sunlight or in direct contact with the roof surface, even during construction. Leaving them exposed will shorten their lifespan and poses a risk of ignition due to the electrical potential generated by the modules from the moment that these are exposed to sunlight. To avoid leaving unmated cable connectors vulnerable to water ingress, they should be capped using manufacturer-issued sealing plugs, pending connection.

Any power cables passing through into the building must enter through a non-combustible sleeve fitted to the full thickness of the wall/roof and adequately fire stopped with the material having a fire resistance rating (insulation and integrity) consistent with the existing wall.

Note: Aviva does not consider the use of expandable, aerosol 'pink foam' type materials as an acceptable fire stopping material. Refer to the Aviva Loss Prevention Standard **Fire Compartmentation** for further guidance.

Important: Ensure DC and electrical hazard warning signage is fitted to accessible cables and conduits. This should extend to any areas where there is a foreseeable risk of cables and connectors being stepped on, snagged, or items being placed on/against them. Where the risk of this is considered significant, appropriate steps or protection measures should be installed.

Commissioning and Handover

The solar PV system including mechanical and electrical connections should be thoroughly inspected prior to commissioning to ensure compliance with design specifications and installation standards.

- Electrical testing will need to be completed including insulation resistance testing, continuity testing and earth resistance testing.
- Performance testing should be completed to verify the system's performance under actual operating conditions and compare it to the design specifications.
- Where systems are connecting to the local electricity network/grid, formal approval may be required from the network operators.
- A commissioning report will be provided to confirm compliance with design specifications.

At the end of the project there should be:

- Formal installation conformity certification (or an equivalent document), along with all relevant OEM operating and maintenance manuals, issued prior to handover.
- A thorough list of identified snags to be shared if not closed out by handover.
- Witnessed testing of any fire detection, fire protection, or safety interlock systems installed.
- Field reviews or acceptance testing by the property insurer, where applicable.

- Clear guidance or instructions on how to monitor and self-inspect the solar PV system output, via the inverter display and through remote monitoring systems.
- Plans put into place for planned and remedial maintenance by a competent contractor.

Building and Roof Damage

Module Staging

Damage can be caused to the building and the roof structure, roof deck, or roof covering by the process of staging and installing the PV module array. This can be at any point in the installation process and can potentially cause structural issues or create an exposure to water ingress from the weather.

The following should be formally considered and documented within the RAMS to protect the roof:

- The method for moving equipment and material to and across roofing.
- Determining where modules can be stored on the roof awaiting installation.
 - ✓ Staging locations must be clearly marked and understood.
 - ✓ No more materials than one day's worth of installation should be stored on the roof at a given point, particularly where weather conditions are unfavourable.
- The number of modules that can be safely stacked on top of each other in one area on the roof and how to do this.
 - ✓ The maximum module stack height must be prescribed by the roof loading assessment to ensure that the maximum static point loading capacity is adhered to.

Module Damage During Installation

Damage to modules during installation can take many forms:

- Impact damage to the glass – visible cracking.
- Non-visible micro-cracking to layers below the protective outer glass.
- Protective beading/frame around the perimeter of the module – this can be deformed or damaged, which can cause water ingress or result in the module coming loose from its clamps.

To help reduce the risks of module damage during installation:

- Use manufacturer-provided padding or separators to provide a cushioning effect between stacked modules.
- During storage, ensure the manufacturer's requirements are followed.
- Handle modules with care and instruct workers to avoid bending or flexing them.
 - ✓ Excessive bending can lead to cell cracking.
- Walking on or across modules must be prohibited. Report all footprints found on modules to site management. They must not be reinstated until tested for micro-cracking.
- Care should be taken to ensure mounting bolts are neither over-torqued nor under-torqued, which can cause damage to the modules or increase the likelihood of them coming loose from the clamps.

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

- The project team considers upcoming weather patterns including high winds, hail, snow, and ice as part of planned work schedules, and plans accordingly.
- All site components are secured in advance of poor weather and all unfixed components are removed from the roof surface.
- No work is undertaken on the roof that could compromise the weather-tightness of the building in advance of heavy rain or storm events.

Waste Management

Ensure appropriate waste material storage arrangements are provided. Waste should be:

- Removed from the roof at least daily, with temporary roof-level waste accumulations secured to prevent them from becoming windblown.
- Removed at least daily from the roof at the end of every shift.
- Removed from site or to a secured waste receptacle located at least 10m from the buildings or other valuable assets.

Refer to the Aviva Loss Prevention Standard **Management of Combustible Waste** for further guidance.

Security Arrangements

Theft is a significant exposure during the construction phase when components are temporarily staged on the ground.

A security risk assessment should be completed to assess the exposure and appropriate security measures implemented. Actions for consideration include but are not limited to:

- Modules, cables, and other valuable components should be delivered to site as needed to avoid an accumulation of theft attractive contents or stored in secured buildings or containers pending installation.
- If the solar PV system is being installed on a building in the course of construction, the construction site should be secured/fenced during works to prevent unauthorised access. Security hoarding is recommended to help limit the view of the construction site.
- On site guarding may be required out of hours when components are stored overnight, particularly copper materials such as cabling.
- Ensure the laydown and roof access infrastructure is covered by CCTV, either using the premises' existing infrastructure or using temporary mobile systems.
- If there are serious theft concerns, apply forensic marking with appropriate deterrence signage.

Selectamark, an Aviva Specialist Partner, can provide appropriate support in this area if needed. [Selectamark - Aviva Risk Management Solutions](#)

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

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)**
- **Approved Document A** of the Building Regulations, **BS EN 1991-1-1 (Eurocode 1. Actions on structures - General actions - Densities, Self-weight, Imposed Loads for Buildings)** provides guidance on weight loadings.
- Grid connectivity is addressed in **EN A Engineering Recommendation G98 or G99**, which should be completed in conjunction with the relevant Distribution Network Operator (DNO) to ensure the system connects safely to the national grid, and should any output curtailment be required.

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](#)

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 - Installation**
- **Roof Mounted Solar Photovoltaic Systems - Ongoing Care**
- **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**
- **Business Continuity - Step 4: Business Impact Analysis and Risk Assessment**
- **Hot Work Operations**
- **Emergency Response Teams**
- **Fire Compartmentation**
- **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 Contractors**

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.

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