Loss Prevention Standards – Asset Class(es)

Living Roofs – Design and Installation

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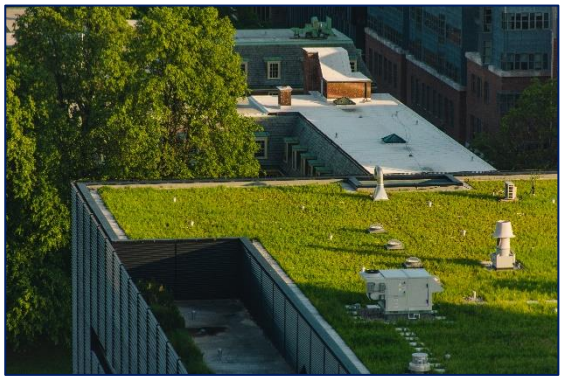
Living roofs are becoming more popular as organisations, property owners and businesses look for ways to harness the environmental benefits of green/living roofs.

This Loss Prevention Standard outlines the main risk concerns and provides guidance to reduce the risks of loss or damage associated with living roofs during the design and installation stages.

AVIVA

Living Roofs – Design and Installation

Introduction



A living, or green roof, is essentially vegetation and planting upon a permanent roof structure. They can be utilised as recreational space, particularly when located on a ground level roof, as typically found on underground car parking, or most commonly as sustainable architectural features on storied buildings.

A living roof also provides a number of environmental benefits; acting as a buffer between drainage systems; purifying the air by removing C0 particles and other pollutants; and helping save money on energy costs for the occupants or building owners, as well as encouraging biodiversity.

Living roofs can however present a number of risks which need to be carefully considered, and this Loss Prevention Standard outlines the main areas of concern and provides useful guidance on minimising the associated risks during the design and installation stages. Loss Prevention Standard **Living Roofs – Ongoing Care**, provides useful guidance on inspecting and maintaining the system post installation.

Note: This document relates to living roofs and is focussed on Property loss prevention and related risk management guidance. It is not intended to address living roofs used for agricultural purposes or Liability exposures. The presumption is that all regulatory requirements, such as Fire Risk Assessments and compliance with local building regulations, codes, or standards, have or will be met.

Types of Living Roof

There are two main types of living roof.

- **Intensive systems.** Intensive systems are effectively roof gardens and can feature decorative shrubs, trees and planting along with landscaping e.g., paving, walling, raised beds, lawns etc. They are typically used as recreational spaces and may span multiple levels. These systems are generally deep, typically 150mm and 1 metre in depth, require a higher level of care and they're accessibility allows for ease of inspection and ongoing maintenance.
- **Extensive systems.** Extensive green roofs are generally installed for visual and/or ecological reasons and are not intended for use as an amenity. Planting tends to be hardier species with more drought tolerance, such as sedums and mosses. Extensive green roofs are generally shallow, typically up to 150mm in depth, and are designed specifically to create habitats for plants and animals. Given their lack of amenity access and hardiness, maintenance and inspections may be more infrequent.

Semi-intensive green roofing is also available, which include characteristics of both extensive and intensive roofs, and which would require a hybrid approach to irrigation and ongoing care.

Understanding the Risks

Fire Risks

Fires on living roofs are rare, but foreseeable in some circumstances e.g. dried conditions during hot weather periods. Once alight, fire would normally be expected to spread and may develop into a significant fire event. Underlying roofing systems can be highly susceptible to both fire and firefighting water damage and extensive, if not catastrophic losses should be expected. Ignition hazards include, but are not limited to:

- **Hot works.** Poorly managed hot works such as brazing, welding, grinding etc., undertaken on or in proximity to living roofs can ignite combustible roofing materials and dried foliage.
- **Arson.** Deliberate ignition of combustible materials or dry foliage.
- **Heating.** Inappropriate fixed or temporary heating systems can overheat or suffer electrical fault and ignite.
- **Smoking.** Discarded smoking waste can ignite vegetation, especially in warm/dry periods. Particular attention should be paid in some occupancies that may have:
  - ✓ Roof based amenity access for tenants, visitors, workers etc.
  - ✓ Areas where people may smoke and discard waste, which could be blown towards living roofs.
- **Electrical.** Damaged, faulty, incompatible, incorrectly installed or maintained electrical equipment e.g. lighting etc., can lead to ignition of foliage, particularly during dry spells.
- **Solar Photovoltaic Systems.** Faults or damage to panels or associated equipment can develop into fires and spread to the living roof planting.
- **Exposures.** Fire can spread from other sources e.g. from within the building, waste receptacles, adjacent property. Also:
  - ✓ **Fireworks.** Either accidentally or maliciously aimed at the living roof.
  - ✓ **Catering.** Outdoor kitchens and barbeques should not be permitted on living roofs.
- **Lightning.** Lightning strike should be considered as a potential ignition source. Any resultant electrical surges can also damage electrical hardware, IT/comm's equipment etc.

The potential for fire growth and spread can be aided by:

- **Combustibility.** Livings roofs should be considered as combustible construction - The foliage can be combustible during prolonged periods of dry/hot weather and some of the components, e.g., membrane and moisture layers etc., may also be combustible.
  - ✓ The underlying roofing system can often be comprised of combustible materials.
  - ✓ Combustible furniture, raised beds, canopies etc., may also be present.
- **Irrigation Systems.** Some intensive system planting requires irrigation, which can be damaged, under designed or poorly performing, potentially allowing planting to dry out and becoming susceptible to ignition, and aiding fire spread.
- **Manual watering**. This can be inadvertently neglected e.g., due to changes to job roles and responsibilities etc.
- **Fire Breaks.** Fire breaks built into the design to limit fire spread may be corroded over time or damaged etc.

Water Related Damage

Intensive roof systems, and some extensive systems, will feature automated irrigation systems, comprising plastic pipework and drip lines into the plants rooting systems. Associated risks include:

- **Leaks.** Whether due to fault, damage or wear and tear, undetected leaks from the irrigation system can lead to water accumulating in the substrate and moisture layer. Tears, wear, or damage to the waterproof membrane can lead to water ingress to the roofing system and potential structural damage, particularly to any timber construction materials present. Damaged or faulty irrigation systems can also leak onto electrical components or equipment potentially leading to electrical fires.
- **Control System Failure.** Most irrigation systems are automated and programmed to operate at set times. Loss or damage to control/monitoring equipment, wi-fi connectivity etc., could potentially lead to watering failure, damage to the roof and the creation of combustible dried plant material.
  - ✓ The failure to formalise and adopt contingency measures in the event of primary irrigation system failure can lead to rapid drying of the roof with the associated increase in combustibility.
- **Rain and Inundation.** Water may enter the building in the event of poorly specified, blocked, or damaged drainage.

Other Risks

- **Collapse**. Living roof systems also impose significant weight loadings to buildings, and if tolerances are not correctly calculated can lead to collapse incidents, as per this collapse event at a Hong Kong university building in 2017. Living roofs when not adequately inspected and maintained can develop faults and become susceptible to storm and other weather related damage, which may also damage underlying roofing linings
- **Root Damage.** Roots systems can damage membrane systems if not maintained.
- **Windstorm.** Inappropriately secured roof systems can break free during storm conditions, potentially leading to significant property damage.
- **Roof Pitch.** Incorrect fixings for the roof pitch can lead to slippage and drainage issues.
- **Corrosion**. Some pesticides/feeds may be corrosive to system components.

General Design Considerations

Assessing the likely risk exposures during the design stage can help mitigate the main risk related concerns.

Business Impact Assessment

An assessment of the anticipated financial losses, for both the material damage and income/business interruption exposures, in the event of a significant or catastrophe loss event relating to the living roof should be undertaken to ensure the risk controls are proportionate and reflective of the potential loss estimates.

Fire Risk Assessment

The premises Fire Risk Assessment should be reviewed to ensure fire safety arrangements will remain adequate. Any actions generated should be addressed promptly. Guidance on maintenance, inspection, fire protections etc., are provided in this document, and other Aviva Loss Prevention Standards including **Fire Safety Legislation**.

Designer Competence

Ensure competent and experienced living roof designers and installers are utilised.

- The structural integrity of building and roofing systems should be compatible with the weight loading imposed by the living roof system.
  - ✓ Compliance with appropriate National Standards, Regulations and Codes should be confirmed, such as **Approved Document A** of the Building Regulations, **BS EN 1991-1-1:2002 Eurocode 1. Actions on structures - General actions - Densities, Self-weight, Imposed Loads for Buildings** in the United Kingdom.
- Systems and components should be reputable and suited for the type and size of the installation.
- Early engagement with experienced designers, architects and fire risk engineers for more complex projects can help ensure the project is designed and built to comply with regulatory building requirements, standards, or codes.

Management of Change

Ensure the installation work is managed under a Management of Change programme and all relevant stakeholders are involved in design, planning and installation discussions.

- Close project management can help reduce the potential for errors, delays, expensive rectifications, and unplanned changes.
- Refer Aviva Loss Prevention Standard **Managing Change – Property** for guidance.

Integrity

The integrity of the roofing system and it's suitability for supporting the living roof.

- A structural engineer should be engaged early in the design to ensure the weight of the living roof system will not lead to structural, or other associated damage to the property.
- In the United Kingdom weights loads should be calculated in accordance with:
  - ✓ BS EN 1991-1-1 Eurocode 1. Actions on structures - General actions - Densities, self-weight, imposed loads for buildings
  - ✓ BS EN 1991-1-3:2003+A1:2015 Eurocode 1. Actions on structures - General actions. Snow loads
  - ✓ BS EN 1991-1-4:2005+A1:2010 Eurocode 1. Actions on structures - General actions - Wind actions
- Ensure calculations reflect and potential pedestrian or vehicular access.
- Intensive green roofs should only be used in conjunction with concrete decks.

Property Insurer and Broker

Engage with your Property Insurer and broker as soon as possible, ideally at concept stage. They can provide guidance on enhancing the building resilience.

Accessibility

The roof should be designed to be fully accessible for maintenance, watering etc.

- ✓ Safe access will need to be provided including protection against falls and platforms for maintenance at height.

Substrate

- The substrate should feature a low proportion of organic matter to help improve fire resistance. This is typically achieved via the use of sand or other mineral additives.
- Ensure the substrate doesn't feature sharp materials that could damage membranes.
- Compaction resisting substrate allows for effective drainage.
- Refer **BS 8616:2019 Specification for Performance Parameters and Test Methods for Green Roof Substr**ates for further guidance.

Planting

Planting should be chosen to reflect the location/climate in addition to the aesthetic and ecological requirements.

- Some plants and foliage retain more moisture than others e.g. sedums, this may be useful for managing roof drainage.
- Hardier plants and sedums should also be considered for roofs with limited or access, where regular watering would be challenging.
- Some plants have a high oil content which increases combustibility and the risks of fire development. These plants may not be ideally suited for warm weather locations.
- Some plants will not prosper in shaded areas, and this should be factored into the design.
- A number of plant species are more vulnerable to pests and disease, these plants will require increased levels of maintenance and cost.
- Consider whether pesticides or fertilisers are suited for the system.
  - ✓ Some fertilisers and pesticides may degrade membranes or other components of the living roof or potentially the building structure.

Monitoring

- Where irrigation systems are installed, ensure a good quality monitoring system is utilised. The following features should be considered critical:
  - ✓ Soil moisture sensors to monitor water levels in the substrate, and the internal temperature of the green roof. This will ensure appropriate water volumes are delivered.
  - ✓ Pressure levels within pipework – to detect drops or rises in pressure that may indicate an issue or fault.
  - ✓ Relative humidity – critical to avoid disease and damage to certain plants.
- For optimal performance of the living roof system, monitoring should also be considered in respect of:
  - ✓ Air temperature changes - To support the soil moisture sensors and ensure sufficient irrigation is provided.
  - ✓ Precipitation levels – This helps prevent over watering during periods of wet weather.
  - ✓ Wind speed – High winds can lead to drying and the need for increased irrigation.
  - ✓ Changes in planting coverage – This may suggest issues with planting health or irrigation faults.

Fire Considerations

The following fire management guidance should be considered when designing and installing living roof systems:

Fire Performance

The roof supporting the living roof system should be non-combustible.

- Intensive green roofs should **only** be used in conjunction with concrete decks, and concrete deck roofing is recommended for other system types.
- Concrete roofing should be compatible with other construction elements such as the external and loadbearing walls, building frame etc., and should have an adequate fire resistance rating (insulation and integrity).
  - ✓ A fire resistance rating of at least 90 minutes is recommended or installed in accordance with national building regulations, standards or codes where higher fire resistance ratings are required.

  Note: National building regulations, standards and codes typically focus on life safety. The use of construction products with improved fire resistance ratings provides enhanced property resilience.

  - ✓ In the United Kingdom, **BS EN 13501-2. Fire classification of construction products and building elements - Classification using data from fire resistance and/or smoke control tests, excluding ventilation services** provides further detail.
- Other engineered roofing systems with no designated fire resistance rating should be non-combustible and the components achieve a rating of A1 or A2 under **BS EN 13501-1. Fire classification of construction products and building elements - Classification using data from reaction to fire tests**

  Note: The fire performance of roofing materials should be checked with your Property Insurer and Broker for suitability.

- The living roof's waterproof membrane and fleece linings should be non-combustible and achieve a fire rating of A1 or A2 under **BS EN 13501-1.**
- Modular living roof systems are available, as are foam or mineral wool based systems. Any such medium should be non-combustible, achieving a rating of A1 or A2 under **BS EN 13501-1.**

Fire Spread

To help slow or prevent horizontal fire spread across living roofs, fire breaks should be introduced. Ballast or concrete pavers are typically recommended, and these should be at least 50mm in depth.

- The living roof should include fire breaks at 40 metre intervals, and the fire break should be at least 1 metre wide.
- Any roof openings e.g. roof lights etc., and vertical construction elements on the living roof, such as framing, posts, columns etc., should be edged with ballast or concrete paving stone borders. A width of at least 0.5 metre is recommended.
- Any rooftop structures such as plant rooms, garden rooms, façade walling etc., should feature a continuous ballast or concrete paving stone border. A width of at least 1 metre is recommended.
- Living roofs should be edged with a continuous fire break to separate from wall junctions. A width of at least 1 metre is recommended.
- Any permanent fixtures e.g. planters, seating, furniture or finishings should be non-combustible or resistant to fire.
  - ✓ Timber decking areas are not recommended.
  - ✓ Any combustible furnishings provided should be secured away from the roof when not in use. Not only could they support fire propagation but could also become wind-blown and damage assets or cause injury.

Hot Work

Hot work should be the last resort for repairs etc., within 10 metres of the living roof. The Aviva Loss Prevention Standard **Hot Work Operations** should be followed where hot works are unavoidable during installation works, and thermographic cameras used throughout the process and during fire watches.

- Fire watches should be undertaken for up to 240 minutes after the hot works, and only reduced where supported by a specific risk assessment.
  - ✓ A minimum fire watch period of 120 minutes should be enforced.

Electrical Installations

Electrical installations, including any outlets and electrically powered monitoring equipment used within or in proximity to the living roof should be suitably rated for use in wet living roof systems.

- Advise should be sought from a qualified electrical contractor/company.
- All replacement electrical parts should be similarly rated for use in potentially wet environments.

Lighting

- Lighting types should be mounted to non-combustible surfaces and be low heat omitting to reduce the potential for ignition of foliage, or other components in the roof system.
- Lighting should also be suitably rated for external use where applicable.

Smoking

Smoking and the installation of smoking shelters should not be permitted on, or within 10 metres proximity to the living roof system.

- There should be no cigarette waste receptacles provided and sufficient warning signage erected.

Waste Management

Bin stores or other combustible storage should not be permitted on, or within 10 metres proximity to the living roof system. This can help reduce the fire load and exposure to arson or accidental fire starting.

Catering equipment

Catering equipment that uses solid fuels e.g. charcoal, wood pellets or chips etc., such as barbeques, smokers, pizza ovens etc., are not suitable for use on buildings featuring living roofs and should not be installed.

- Portable gas fired catering equipment should only be used on non-combustible surfaces and sited at least 5 metres from living roofs.
- Any fuel cylinders should be safely secured in a non-combustible store when not in use.

Heating

Ensure consideration has been given to heating systems.

- These should be suitable for use near potentially combustible living roof systems.
- Heaters should be permanently secured and mounted on non-combustible structures featuring a fire break from the living roof of at least 1 metre.
- Consider the potential for inappropriate temporary heaters being used during poor weather or failure of the normal heating systems.
- Fire-pits, chimineas and other open type heating appliances are not suitable for use on buildings featuring living roofs, nor are heaters that use liquid fuels such as kerosene or ethylene.

Lightning

Ensure lightning protections extend from the property to the structure and any living roof components and tall planting as necessary.

- The lightning risk assessment should be reviewed by a competent person or company, preferably a member of a recognised quality scheme or body. Such as The Association of Technical Lightning and Access Specialists (ATLAS) in the United Kingdom.
- Any new lightning protection systems should be installed in accordance relevant standards, such as **BS EN 62305 pts 1 to 4 – Protection Against Lightning i**n the United Kingdom.
- Ensure lightning protection systems are adequately separated from the living roof.
  - ✓ Terminals, conductor cables and associated fixings should be mounted to non-combustible building elements only and not placed or mounted within or beneath the living roof structure.

Solar Photovoltaic (PV) Systems

Solar PV systems can be installed on living roof systems, however careful management is necessary to reduce the potential for loss or damage of either system.

- Ensure Microgeneration Certification Scheme (MSC) accredited designers/installers, with experience in installing solar PV systems on living roofs are utilised.
- Solar PV panels should be mounted to pitched frames and not flush mounted.
  - ✓ The panel pitch allows prompt water runoff. This is critical in helping reduce lichen build-up.
- New solar PV installations should be fitted with voltage optimisers.
  - ✓ These increase energy yield and automatically reduce the voltage within faulty panels to safe levels, reducing the potential for fire events.
- Adequate clearance should be maintained between the solar PV panels and surface of the growing medium.
  - ✓ Plants can interfere with cabling, junctions/connectors as well as cause shading on the solar PV panels, a condition which can lead to hot spots forming and potential failure of the system, and in some cases fire damage.
- Framing should be permanently affixed to the roof structure rather than ballast mounted.
  - ✓ Ballast can work loose and it not as structurally reliable as permanent fixings.

- Spacing of solar PV systems should be carefully considered to help avoid stressing the living roof system.
  - ✓ Panel frames should be located at least 1 metre apart.
- Installing solar PV panels to a living roof can increase the risk of birds nesting. This can lead to damage to cabling as well as combustible matter accumulating beneath the panels.
  - ✓ Installing anti-nesting skirting, such as metal mesh around the framework can help reduce this potential.
- Solar PV panels for use on living roofs will need to be sufficiently thin to allow UV light to penetrate and reach the growing medium, and such panels tend to be less resilient to wind-blown impact, hail, storm damage, and general wear and tear. Ensure these issues are factored into the design.
  - ✓ Gravel/pebbles should not be used on living roof systems featuring solar PV systems. This can become wind-blown and damage panels. Birds also have been known to drop stones and gravel on panels.
  - ✓ Planting should be carefully selected to allow for the increased shading.
- Increased solar PV panel inspection frequencies are recommended as planting may flourish with the condensation and rain dispersal provided by the panels, which if left unmaintained may have a negative impact on energy production and create panel hot spots.
- Increased solar PV panel cleaning frequency may be necessary to remove lichen build up, which can thrive with increased moisture levels generated from the living roof and cause shading.
- Ensure components such as DC isolators, switches, inverters etc., are located on non-combustible surfaces away from the living roof.

The following Aviva Loss Prevention Standards provide useful guidance in managing Solar PV systems:

- ✓ **Roof Mounted Photovoltaic Solar Panel Systems – General Considerations**
- ✓ **Roof Mounted Photovoltaic Solar Panel Systems – Planning for Installation**
- ✓ **Roof Mounted Photovoltaic Solar Panel Systems – Installation and Construction**
- ✓ **Roof Mounted Photovoltaic Solar Panel Systems – Installed and Ongoing Care**
- ✓ **15 Top Tips for Roof Mounted Photovoltaic Solar Panel Systems**

Water Hazards

There are two main types of irrigation system for living roofs:

Sprinklers. These are used on intensive roof systems with supply pipework typically located beneath gravel edging or in raised beds.

Driplines. Used occasionally on extensive roof systems and designed to water directly into the root areas. Also used to water planters, large pots etc., via drippers.

Intensive living roof systems should always incorporate automatic irrigation systems. Extensive roof systems will generally incorporate irrigation systems when the roof pitch exceeds 20 degrees, however overly dry vegetation is a significant cause of fire propagation, and automatic irrigation should be considered for all living roofs.

Despite the fire related benefits, water related incidents are a leading cause of loss and damage to buildings and other property, and failure of the irrigation system a primary cause of damage to the living roof. The following guidance should be considered:

- **Escape of Water**. All potential penetrations should be adequately sealed and monitored. Any leaks which develop should be quickly investigated.
  - ✓ Emergency drainage should be considered for larger installations to redirect escaped water safely.

- **Irrigation System.** This should be engineered to deliver adequate volumes of water to ensure the substrate can maintain sufficient moisture. Periods of time in direct sunlight will impact this.
  - ✓ Separate irrigation systems into a number of zones, capable of separate isolation, this can help prevent drying of the whole roof during protracted maintenance and repairs.
  - ✓ Ensure the irrigation systems are adequately monitored and flow rates accessible to responsible and trained persons.
  - ✓ Install and monitor water level meters to help ensure water levels remain within required thresholds.
  - ✓ Ensure sprinklers heads, where present are adequately fixed to avoid becoming wind-blown.
- **Water Tanks**. Some irrigation systems may be fed from a stored water source, such as rainwater collection bunds or tanks. Consider the location of the source for the irrigation system.
  - ✓ If this is in an elevated position, consider whether the roof is capable of taking the additional weight and the potential for escape of water and freezing.
  - ✓ Locate in a position that is accessible for maintenance and inspection.
- **Membrane Systems.** The waterproof membrane should be impermeable to water.
  - ✓ During construction, ensure the membrane is tested and inspected for leaks prior to laying down other components and prohibit persons from walking on the membrane once it has been laid and tested/inspected for damage, tears etc.
  - ✓ Ensure a root barrier membrane is installed to protect the waterproof membrane from root damage.
- **Cold Weather.** The risks of freezing should also be considered.
  - ✓ Irrigation systems should be programmed to automatically adjust for seasonal requirements.
  - ✓ Pipes which supply water to the irrigation system should be lagged or otherwise protected against frost. Trace heating should be considered for areas that are prone to freezing temperatures.
  - ✓ Leak detection devices on supply pipework should be installed to help promptly recognise water escape, and isolation switches easily accessible.
- **Drainage.** Roof drainage designs should comply with the requirements of **BS EN 12056-3:2000 Gravity drainage systems inside buildings** and **BS 6229:2018, Flat roofs with continuously supported flexible waterproof coverings.**
  - ✓ Modelling of a green roof should be undertaken by an experienced hydraulic design specialist.
  - ✓ Ensure adequate inspection chambers are installed to allow for drainage checks.
- **Water Hardness.** Ensure appropriate water treatments are utilised to prevent the build-up of mineral deposits.
- **Impairments.** An effective impairment plan should be established and implemented in the event the irrigation system fails. Irrigation systems not only provide water to the living roof but may also help provide limited protection from developing fires.
  - ✓ Back up manual watering supplies and equipment should be considered should the irrigation systems fail or be isolated due to maintenance.

Other Exposures

- **Wind.** Ensure the wind related risks are fully assessed in the design stage by a competent company/engineer ensuring adequate wind deflection and mitigation is incorporated.
  - ✓ **BS EN 1991-1-4:2005+A1:2010 Eurocode 1. Actions on structures. General actions. Wind actions** requires the roof design should be able to resist wind related uplift.
    - Where living roofs are installed and self-weighting is adopted, concrete paving stone edging should be used in preference to ballast, particularly on taller buildings.

- ✓ Continuous parapet walls should be incorporated on any structures featuring living roofs. This helps deflect wind from the more vulnerable corners and edges of the living roof system.
  - This should extend at least 150mm over the height of the growing surface, however this may need to be increased for taller buildings and professional guidance should be sought.
  - Parapet walling should be installed where roof mounted solar PV panels are installed.
- ✓ Erosion control measures such as netting should be considered, particularly whilst a new living roof establishes itself.
- ✓ Avoid the use of moveable pots, planters etc., which can become wind-blown in high winds and damage valuable assets.

- **Shearing.** Living roof systems are fully suited for flat roof types. They can also be used on some pitched roofing, however, will be subject to shear forces that can lead to detachment and collapse.
  - ✓ The need for anti-shear protections should be assessed in the design and should be considered for roof pitches in excess of 10 degrees.
    - The need for anti-shear protections should be assessed by a competent company/engineer.
  - ✓ The weight of any anti-shear protections should also be factored into the loadbearing calculations.
- **Impact.** Whilst storied building roof systems are not likely to be at risk of direct impact damage, any ground level roofing systems, as often incorporated on underground car parks, may be exposed.
  - ✓ Ensure adequate impact protection is installed around any living roof that is in direct proximity to vehicle movements, parking etc., and vulnerable to such damage.
    - ✓ This may be achieved by normal kerbing where present, however fixed posts should be considered where the living roof is considered particularly vulnerable.

Fire Detection and Protections

Automatic Fire Detection

- Ensure automatic fire detection extends to all roof based rooms e.g. garden rooms, plants rooms, stores etc., and is compliant with relevant standards, such as in the UK category L1 or P1 of **BS 5839-1:2017 - Fire detection and fire alarm systems for buildings - Code of practice for design, installation, commissioning, and maintenance of systems in non-domestic premises.**
- A means of manually raising the fire alarm should also be provided.

Automatic fire Protection

- Automatic sprinkler systems are the most effective fixed fire protection systems to protect buildings from fire.
  - ✓ Where an existing automatic sprinkler system is already installed, consult with your sprinkler maintenance company, and where appropriate, extend to any new roof based buildings added as part of the installation works.

Alarms

Alarms associated from the above should raise a site fire alarm to ensure there is an appropriate emergency response and escalation if needed. If not already in place you may wish to consider connecting the alarm to a constantly attended location or an approved Alarm Receiving Centre. An accredited fire alarm installer can provide further guidance and assistance.

Interlocks

The use of interlocks may help reduce the potential for fire damage. As such, and where possible, the actuation of any fire alarms and fire protections should be interlocked to de-energise electrical power to the living roof for lighting etc. The interlocks should be tested at least annually and restored following any impairment to the fire protection and alarm systems.

Fire and Rescue Service

The height of the building, size of the living roof, and the impact of weather conditions, especially wind, can significantly impact the rate of fire spread. Local Fire and Rescue Services are often amenable to inspecting premises to evaluate fire risk exposures, firefighting response and offer guidance.

It is important to maintain suitable access for the Fire and Rescue Services and consider the distances and location to the nearest source of fire water or hydrant that they may need to use.

- The location and number of fire hydrants in the proximity of the premises should be documented in an emergency response plan or shown on appropriate drawings.

It is also good risk management practice to know what water supplies are available for the Fire and Rescue Service to use. Therefore, site management should always establish:

- What fire water is available.
- With static pressure, flows and residual pressure test results.
- Whether additional resources, such as a private hydrant system or water storage tanks are necessary.

Please refer to the Aviva Loss Prevention Standard **Manual Fire Fighting Water Supplies** for further guidance.

Business Continuity Planning

Business Continuity Plans should be reviewed to ensure disaster recovery and continuity arrangements remain adequate. Any actions generated should be addressed promptly. Please refer to the Aviva Loss Prevention Standard **Business Continuity** for further guidance.

Emergency Response

An emergency response plan should be produced specifically developed to outline key responsibilities and actions in an emergency event including failure of the primary irrigation system. The emergency response plan should include responses to all likely property and business interruption related events as described in this Loss Prevention Standard. It should also include the actions key individuals should take during emergency events.

The emergency response rules should be formally documented, and appropriate training provided. Refer to Aviva Loss Prevention Standard **Emergency Response Teams** for further guidance.

Key Action Steps

- Ensure competent and experienced design engineers/architects are utilised to design the living roof system and ensure all relevant regulatory requirements are addressed.
- Enhance the resilience of the roof to fire via the use of construction materials with increased fire resistance ratings.
- Over dried vegetation can increase the combustibility of the system. Ensure reputable, good quality irrigation and monitoring systems are utilised and appropriate contingency watering plans are in place in the event of failure of the primary irrigation system.
- Carefully consider the potential for water related damage and ensure isolation devices are accessible and drainage systems are in place to remove excessive water safely.
  - ✓ Formalise inspection, servicing and maintenance plans and routinely audit to check compliance with site rules/procedures.
  - ✓ Install leak detection to irrigation systems where possible.
  - ✓ Inspections may need to be increased during prolonged periods of hot or freezing weather.

- Ensure adequate firefighter access and water supplies are available.
- Seek advice from your Property Insurer and Insurance Broker when considering automatic fire detection and fire protection systems.
- Introduce emergency procedures and provide appropriate training to relevant staff.

Checklist

A **Living Roofs – Design and Installation Checklist** is presented in Appendix 1 which can be tailored to your own organisation.

Specialist Partner Solutions

Aviva Risk Management Solutions can offer access to a wide range of risk management products and services at preferential rates via our network of Specialist Partners.

For more information please visit:

Aviva Risk Management Solutions – Specialist Partners

Sources and Useful Links

- The Green Roof Organisation (GRO) Green Roof Code
- BS EN 1991-1-1 Eurocode 1. Actions on structures - General actions - Densities, self-weight, imposed loads for buildings
- BS EN 1991-1-3:2003+A1:2015 Eurocode 1. Actions on structures - General actions. Snow loads
- BS EN 1991-1-4:2005+A1:2010 Eurocode 1. Actions on structures - General actions - Wind actions
- BS EN 13501-2 - Fire classification of construction products and building elements - Classification using data from fire resistance and/or smoke control tests, excluding ventilation services
- BS EN 62305 pts 1 to 4 – Protection Against Lightning
- BS EN 12056-3: Gravity drainage systems inside buildings
- BS 6229:2018, Flat roofs with continuously supported flexible waterproof coverings
- BS 8616:2019 Specification for Performance Parameters and Test Methods for Green Roof Substrates

Additional Information

Relevant Aviva Loss Prevention Standards include:

- **Living Walls – Design and Maintenance**
- **Living Walls – Ongoing Care**
- **Roof Mounted Photovoltaic Solar Panel Systems – General Considerations**
- **Roof Mounted Photovoltaic Solar Panel Systems – Planning for Installation**
- **Roof Mounted Photovoltaic Solar Panel Systems – Installation and Construction**
- **Roof Mounted Photovoltaic Solar Panel Systems – Installed and Ongoing Care**
- **15 Top Tips for Roof Mounted Photovoltaic Solar Panel Systems**
- **Fire Safety Inspections**
- **Fire Compartmentation**
- **Escape of Water and Fluid Leakage**
- **Fire Safety Legislation.**
- **Electrical Installations - Inspection and Testing**
- **Emergency Response Teams**
- **Housekeeping - Fire Prevention**
- **Maintenance Regimes**
- **Hot Work Operations**
- **Thermographic Surveys**
- **What is Environmental, Social and Governance**

To find out more, please visit Aviva Risk Management Solutions or speak to one of our advisors.

Email us at riskadvice@aviva.com or 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.

Appendix 1 - Living Roofs – Design and Installation Checklist

Location	
Date	
Completed by (name and signature)	

	General Design	Y/N	Comments
1.	Have competent and experienced living roof designers and installers been utilised to design and install the roof?		
2.	Have architects, structural engineers and where necessary, fire safety engineers assisted with structural considerations and regulatory requirements e.g. building regulations etc?		
3.	Have your Property Insurers and Broker been consulted and have recommendations been addressed?		
4.	Have reputable and proven living roof systems and components been utilised, including structural elements, irrigation equipment and monitoring systems?		
5	Does the irrigation system design separate the installation into a number of independently supplied and contained zones, capable of separate isolation?		
6.	• Do monitoring systems include: ✓ Soil moisture sensors to monitor water levels in the substrate, and the internal temperature of the green roof? This will ensure appropriate water volumes are delivered. ✓ Pressure levels within pipework – to detect drops or rises in pressure that may indicate and issue or fault? ✓ Relative humidity – critical to avoid disease and damage to certain plants? ✓ Air temperature changes - To support the soil moisture sensors and ensure sufficient irrigation is provided? ✓ Precipitation levels – This helps prevent over watering during periods of wet weather? ✓ Wind speed – High winds can lead to drying and the need for increased irrigation? ✓ Changes in planting coverage – This may suggest issues with planting health or irrigation faults?		

7.	Has a planting plan been compiled detailing the most appropriate balance of planting for the living roof location and size to reduce the risks of drying, high oil content/flammability, susceptibility to disease etc?		

	Fire – Design and Structural	Y/N	Comments
8.	• Are any combustible structural elements and components utilised in the living roof system? • If so, have these materials been reviewed and the possibility of replacing with non-combustible elements considered?		
9.	If the living roof forms part of the building's structural integrity, has a fire resistance rating (insulation and integrity) of at least 90 minutes been achieved?		
10.	• Have any fire stopping installations present on the living roof area been audited recently? • Are any remedial recommendation actioned?		
11.	Is the living roof edged with a continuous fire break to separate from wall junctions to a width of at least 1 metre?		
12.	Where of an applicable size, does the living roof include 1 metre wide fire breaks at 40 metre intervals?		
13.	Are any roof openings e.g. doors, roof lights etc., and vertical construction elements on the living roof, such as framing, posts, columns etc., edged with ballast or concrete paving stone borders to a width of at least 0.5 metre?		
14.	Do all rooftop structures such as plant rooms, garden rooms, façade walling etc., feature a continuous ballast or concrete paving stone border to a width of at least 1 metre?		
15.	Are any permanent fixtures e.g. planters, seating, furniture or finishings non-combustible or otherwise resistant to fire?		
16.	• Have appropriate lightning protections been installed to the building and ancillary equipment, where recommended in a lightning risk assessment completed by a competent and experienced company? • Do any such systems run in proximity, or beneath living roof systems?		

	Property – General	Y/N	Comments
17.	• Are hot works prohibited within 10 metres of the living wall during the installation phase? • If not, are alternative options considered before any hot work? • Where undertaken, will hot works be carried out in accordance with a formal hot management programme? Refer Aviva Loss Prevention Standard – **Hot Work Operations** • Will hot work permits be regularly checked for adequacy?		
18.	• Are all electrical equipment and components utilised in the living wall rated for use in potentially wet environments? • Is there a procedure for ensuring all replacement electrical parts are similarly rated for use in potentially wet environments?		
19.	Is lighting equipment low heat emitting?		
20.	• Is adequate smoking prohibited signage displayed? • Are smoking waste receptacles present? And if so, have they been removed?		
21.	Are any bins stores or other combustible storage planned or located within 10 metres proximity to the living wall?		
22.	• Are any combustible furniture or finishings present? • If so, have these been moved to a non-combustible storage area? • Is any catering equipment that uses solid fuels e.g. charcoal, wood pellets or chips etc., such as barbeques, smokers, pizza ovens etc., present? • If so, have these been removed from use? • Are any catering gas cylinders present? • If so, have they been safely secured in a non-combustible cage store away from the roof?		
23.	• Are fixed heaters suitable for use on living roofs? • Are the fixed to non-combustible surfaces? • Are any portable heaters planned or in use? • If so, have these been removed from usage?		

24.	• Are there any malicious damage, or vandalism concerns in the immediate area? • If so, what actions have been taken to reduce the potential for damage to the living wall upon installation?		
25.	Have suitable and sufficient impact protections been commissioned (where roofing is at ground level or exposed to vehicular impact)?		
26.	• Are any Video Surveillance Systems planned? • Will any such systems be installed an accredited installer? • Will the system be adequately monitored?		

	Solar Photovoltaic (PV) Systems	Y/N	Comments
27.	• Is framing permanently affixed to the roof structure rather than ballast mounted? • If ballast is used, is it in good order and sited as per the design specification i.e. unmoved?		
28.	Is adequate spacing of at least 1 metre maintained between panel framing?		
29.	Are PV panels in good condition and cleaned routinely to remove lichen?		
30.	Is adequate clearance maintained between the panels and surface of the growing medium (cabling, junctions and connectors should be clear of any growing medium) ?		
31.	• Is anti-nesting skirting, such as metal mesh, installed around the framework? • If so, is this in good order and not compromised or damaged?		
32.	Are any gravel or pebbles used in proximity to PV panels?		
33.	Are the panels regularly cleaning to remove lichen?		
34.	Have optimisers been installed?		

	Water Systems	Y/N	Comments
35.	• Have irrigation systems, feeding systems and flow rate monitoring systems been commissioned with no ongoing faults? • Are irrigation systems automatically adjusted to meet seasonal requirements? Has this been checked for software updates, component changes etc., cancelled programming? • Are any water level meters installed working correctly? • Are alert systems working correctly? • Are responsible persons trained to deal with emergency events such as loss of pressure, leaks etc?		
36.	Are sprinkler heads adequately fixed?		
37.	• Are water tanks and pipework suitably lagged? • Have components been checked for leaks and damage prior to handover? • Are trace heating systems installed, and working correctly? • Are leak detection systems installed, and working correctly?		
38.	Are water treatment procedures in place?		
39.	Is a formal contingency plan in place in the event of failure of the primary irrigation system?		

	Wind Exposures	Y/N	Comments
40.	Has a parapet wall been installed and at least 150mm over the height of the growing surfaces or as advised by Design Engineers?		
41.	Has concrete paving stone edging been used on self-weighting systems?		
42.	• Are any moveable pots, planters etc., present? • If so, have these been removed?		
43.	• Where living roofs are installed to pitched roofing, has the need for anti-shear protections been assessed by a competent company/engineer, along with allowances for the weight of any anti-shear protections? • Is there any sign of shearing? • If so, has remedial action been urgently requested?		

44.	Additional comments:

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