SPRA
Single Ply Roofing Association

TECHNICAL GUIDANCE

PROTECTION OF SINGLE PLY MEMBRANE ROOFS – GUIDANCE AND CHECKLISTS

ENSURING THAT CLIENTS OBTAIN HIGH QUALITY POLYMER-BASED SINGLE PLY ROOFING, THROUGH A PARTNERSHIP OF QUALITY ASSURED MANUFACTURERS AND CONTRACTORS

S13/17

GUIDANCE DOCUMENT

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1. INTRODUCTION

1.1. Flat roofs are accessed and used for a variety of functions so they must be suitably protected from damage. Whether it's glazing, cladding or modern roofing technology, the full performance of the system will only be realised if it is protected from environmental and human actions. There are two important reasons to protect all roofing technology:

- To avoid damage during construction: modern construction often means tight programmes, multiple, overlapping trades and limited space for ground-level storage. It is also frequently desirable to achieve a dry interior early in the programme. All these can impact on the roof finish
- To avoid damage due to access and loading during service: roofs require inspection and many also have secondary uses which require access. For example air handling services, renewable energy equipment and amenity features may be placed on the roof.

1.2. Note that exposed single ply membranes do not require supplementary protection from solar UV and heat; their formulation is designed to resist such exposure. Membranes should not be painted or sprayed and repairs should be only undertaken in compatible materials using manufacturer's procedures, to ensure longevity and to comply with the terms of any product warranty.

2. DESIGN FOR PERMANENT PROTECTION

2.1. WHAT TO CONSIDER

2.1.1. Variable loads:

- Impact: objects may be dropped during construction and service. All types of roof system must be protected appropriately during each phase to resist such accidental events.
- Foot and equipment traffic: foot traffic and wheeled equipment causes cyclical point loading, which is likely to adversely affect most common insulation boards. Measures to reduce slip hazard (for example with embossed heavy duty sheets) may not significantly reduce such effects unless suitable load-spreading is incorporated.
- Wind action: not covered in this guide - see SPRA Design Guide, Checklist for wind load calculation and Protocol for wind load calculation.

2.1.2. Static loads: in addition to snow loading these include landscaping ballast, plant and equipment, green roof planters, grey water storage tanks and the feet of ladders and stanchions.

2.1.3. Contaminants: establish what the roof may be exposed to during service and any unusual ancillary materials that may be in use at roof level.

2.2. WHAT ARE THE RISKS?

2.2.1. Impact: may puncture the single ply membrane and cause local damage to the insulation (warm roofs).

2.2.2. Excessive foot and equipment traffic: may compress the insulation beyond design levels, causing permanent damage. In adhered systems, the bond between the single ply membrane and insulation may be weakened, thereby reducing resistance to wind load. This may in turn, increase the single ply membranes susceptibility to impact damage.. Modern single ply systems with mechanically fastened membranes use thermally broken (telescopic tube) fasteners, which are designed to resist occasional foot loading; older coverings may not be secured in this way so care is required during refurbishment.

2.2.3. Static loads: in excess of design levels may also deflect the insulation, causing local ponded water or may stress the single ply membrane.

2.2.4. Contaminants: including volatile hydrocarbons, animal fats and dairy products may reduce the service life of the single ply membrane or contravene the conditions of the product warranty.

2.2.5. All the above: may reduce the service life of the roof system and increase maintenance cost. Both may impact on building value. In buildings subject to leasehold arrangements this can increase sinking fund allocations and hence service charges.

2.3. HOW TO REDUCE RISK?

2.3.1. Good design information: as with all design, information from the client is critical for success. At the earliest possible stage, the likely use of the roof should be estimated in terms of:

- Preferred roof finish, e.g. pavers on pedestals or exposed single ply membrane. Pedestals create increased point loading yet this effect may be overlooked as roofs to terraces or podia are loaded.
- Function of access routes: maintenance and /or fire escape.
- Frequency of foot traffic.
- Likely activity, e.g. heavy tools for servicing HVAC equipment.
- Plant and equipment likely to be placed on the roof (rather than on a frame or plinth).
- Presence of contaminants in the environment, for example discharge from extract ventilation.

Historically[1], a fitness-for-use classification of insulation has been used to define roof usage (see Table 1). Manufacturers should be able to advise on suitable protection for each category.

2.3.2. Future-proofing: good design should allow for some intensification of use during the service life of the roof, which may exceed thirty years.

2.3.3. Good records: operation and maintenance records must state the design loading limits of the roof system and provide accurate as-built product information. This will ensure that facilities management and maintenance staff use the correct procedures.

Table 1 Classes of roof access, from UEAtc MOAT 50

A (LEAST ONEROUS)	B	C	D (MOST ONEROUS)
Roof only accessible for purpose of maintenance. Only to be used with special assessment of the Institute	Roof only accessible for purpose of maintenance. May be used without any restrictions	Roof accessible to pedestrian traffic. May be used where frequent maintenance of equipment is envisaged.	Roof accessible to lightweight vehicles. Only to be used where the waterproof covering is protected by concrete paving or similar

[1] European Union of Agrément Technical Committee – Method of Assessment and Testing No. 50: 1992 ' Technical guidelines for the assessment of thermal insulation systems intended for supporting waterproof coverings on flat and sloping roofs'

2.4. DESIGN FOR PERMANENT PROTECTION

2.4.1. Specification of single ply membrane: all single ply membrane supplied by SPRA Membrane Manufacturers are designed for use on roofs subject to access and loading. However, each will have specific characteristics for resistance to slipping or contaminants.

2.4.2. Specification of insulation: products may be selected for their thermal and acoustic properties, but this must not override other considerations. In warm roof systems, all loads are transferred to the structure via the insulation. So the selection and protection of this component is vital for the performance of the roof as a whole.

Manufacturers generally declare a resistance to compression based on a 10% deflection, which is a useful measure for comparison and quality control purposes. However, it is not an acceptable design value as it could result in serious deflection (for example, a typical 120mm board might compress by 12mm). Design values will be lower and should be set at a load which does not cause crushing failure of the cells (cellular products such as PIR or EPS) or fracture of fibres (fibrous products such as mineral wool). This is typically the 2% deflection value. See SPRA Component Quality Standards and contact SPRA Associate Manufacturers for advice.

Table 2: Thermal insulation: typical values for resistance to compression (guidance only; designer should always check with manufacturer)

INSULATION TYPE	COMPRESSIVE STRESS AT 10% DEFLECTION	DESIGN STATIC LOADING - EVENLY DISTRIBUTED MAXIMUM LOAD BASED ON 2% DEFLECTION*	
	kPa	kPa	Kg/m^2
PIR (Polyisocyanurate)	150	30	3000
Mineral Wool	80	16	1600
Vacuum Insulated Panel	150	30	3000
EPS (expanded polystyrene)	150-500	30-100**	3000-10000**
XPS (extruded polystyrene)	300-500	60-100**	6000-10000**

*Figures presume static dead loads only and exclude any allowance for dynamic / live loading.
** Figures for EPS are based on 1% deflection. Check with SPRA Associate members for advise on grade

Insulation products also differ in their ability to resist cyclical loading (e.g. from foot traffic) at levels below that described above for static loading. There is a European Standard test for characterising products under these conditions. Contact SPRA Associate Manufacturers for advice.

2.4.3. Load-spreading: if design loads exceed the compression-resistance of the insulation load-spreading will be required. This may range from galvanised steel sheet beneath the single ply membrane to paving or decking above it, depending on circumstances. As a minimum, galvanised steel sheet is recommended at all roof access points on warm roofs. See checklist 1.

2.4.4. Designated walkways: regular foot access to equipment or fire escapes should be designated by suitable slip-resistant finishes which clearly mark a route. These should be as direct as possible, avoiding obvious trip hazards, because users will inevitably take the easiest option.

3. PROTECTION DURING CONSTRUCTION

3.1. WHY PROTECT?

Whatever the waterproofing type, all roofs must must be appropriately protected from damage, therefore the choice of waterproofing should be made based on its merits as a waterproofing solution and not its resistance to damage during construction. This may require different materials for different areas of roof (for example as between open field areas and plant installations; warm roofs and inverted roofs; main roofs and balconies). Choosing a system on the basis of what is less likely to be damaged is the wrong approach because protection should be covered by good design and construction management. SPRA Contractor Members are generally able to offer a wide range of options, with appropriate protection where required, so this targeted specification approach will not complicate contractual arrangements for the roofing package or the occupier's facilities management process.

3.2. WHAT ARE THE RISKS?

3.2.1. Safety: a poorly protected and managed roof is often a less safe one, more prone to slip and trip hazards.

3.2.2. Water ingress and patch repair:

- Warm roofs: water ingress will pass to the insulation, where depending on type it may be absorbed or pass downwards to the vapour control layer where it could spread to other areas.
- Inverted warm roofs or uninsulated roofs: water ingress will pass directly to the deck. Concrete decks may be slow to dry out.

3.2.3. Delay to programme: water ingress or damage requiring repair will delay following trades and could have high consequential cost if insulation has to be dried out or replaced. The client will be unsettled and may legitimately ask why they are expected to be handed a new roof that has been repaired. Cost and delay will also be caused if it is necessary to undertake additional testing for integrity.

3.2.4. Reduced resistance to wind load: the attachment may be affected by repeated loading, especially if the single ply membrane is adhered.

3.2.5. Inverted and green roofs: a damaged membrane may go unnoticed before the insulation and ballast are applied. Investigation and repair will then be very difficult.

3.3. HOW TO REDUCE RISK?

3.2.1. Plan: early consultation with SPRA members will allow consideration of:

- Two-stage system installation: in warm deck roofs, it may be possible to install the vapour control layer early in the programme, to achieve a dry interior. When other disruptive activities at roof level are complete the VCL can be repaired or overlaid before the remainder of the system is installed.
- Two-stage membrane installation: in warm and inverted warm roofs, it may be possible to install the details at interfaces to abutments and parapets to enable cladding or rendering to be completed before the roof field areas are installed. This will greatly reduce the risk of contamination or damage to the membrane and ensure that the roofing contractor is the last trade to access the roof.

3.3.2. Select appropriate solutions: there are several options for temporary protection; select to suit site conditions, taking into account how much it will need to be moved as work progresses, the type and level of risk. Whichever option is selected, all points of access to the roof from scaffold or internally must be provided with protection which spreads loads and avoids damage. See checklist 5.2 (below).

3.3.3. Agree: at the pre-start meeting, use checklist 3 to ensure that all factors have been taken into consideration and agreed with the roofing contractor. See checklist 5.3 (below).

3.3.4. Manage: whilst specification is important, effective management of the construction process is vital. This is a shared responsibility between main and roofing contractor, which must be reflected not only in the terms of the Contract but also in the day-to-day monitoring of the site. In particular:

- A permit-to-work system with controlled access to the roof should operate wherever other trades will be working at roof level.
- A site diary should be kept, including a photographic record filed by roof location. See checklist 5.4.

4. ROOF MANAGEMENT

4.1. CONTRACTUAL RESPONSIBILITY FOR PROTECTION

There is clear historic evidence that in the event of dispute regarding responsibility for defects and consequent loss during construction, evidence in the form of site records and liability as defined in the Contract play a key role in the outcome. However, in relation to protection of the works during construction, responsibility is often unclear and/or the terms of the Contract are breached by the action of one or other party.

Examples include:

- Main contractor accessing the roof for scaffold alterations or to allow work by following trades without the express consent of the roofing contractor.
- Roofing contractor failing to protect their own work from actions by their own sub-contractor.

Many contracts do not define the responsibilities clearly and do not allow for exigencies which occur as a result of, for example, design changes or severe weather. See checklist 5.5 (below).

4.2. TESTING

It may be appropriate to test the completed roof (or its completed phases) by electronic methods. In the event of a failure to protect during construction, testing (if feasible) is likely to be essential. See SPRA Guide S8/09 Non-destructive testing of single ply membranes

5. CHECKLISTS

5.1. DESIGN

The design must take account of the in-service use, loading and access of/to the roof:

LOADING ACTIONS	FACTORS AFFECTING DESIGN	COMMENT
Static loading	Location	
	Location	
	Anticipated change during service	
Access during service	Type of access	
	Roof access location(s)	
	Frequency of access	
	Equipment likely to be used	
	Avoidance of slip hazard	
	Designated walkways routes	

5.2. TEMPORARY AND PERMANENT PROTECTION

Options for temporary and permanent protection:

METHOD	ADVANTAGES	CONSIDERATIONS	TEMPORARY	PERMANENT	SUSTAIN-ABILITY RATING
Re-cycled plastic lattice matting	Re-usable. Safe in use. Resistant to wind.	Small items can penetrate. Does not protect from point loading.	✓	✓	Good
Recycled rubber crumb matting	Re-usable. Safe in use.	May be affected by wind. Does not protect from point loading. Not compatible with some thermoplastics	✓	✗	Good
Recycled heavy duty rigid plastic sheets	Re-usable. Safe in use. Provides good load-spreading.	Must be linked to avoid wind effects.	✓	✗	Good
Fibre-reinforced polymer-cement sheets	Re-usable. Safe in use. Reasonably lightweight Provides good load-spreading.	Must be loaded and linked to avoid wind effects. Liable to crack if not fully supported.	✓	✗	Moderate
Plywood or OSB	Provides good load-spreading.	Heavy – difficult to handle. May damage membrane.	✓	✗	Poor
Membrane product tile or sheet	Safe in use. Resistant to wind.	Does not protect from point loading.	✗	✓	Good
Load-spreading below membrane; membrane product tile or sheet finish	Safe in use. Resistant to wind.	Protect from moderate frequent point loading.	✗	✓	Good

When considering any loose-laid protection materials, consult the roofing manufacturer as a separation/isolation layer may be required.

5.3. PRE-START AGENDA

The pre-start agenda for the roofing package should include the following:

AGENDA ITEM	ITEMS TO BE AGREED	INCLUDED	COMMENT	AGREED (DATE)
Access to the roof	Step-off points Likely changes Security measures Confirm permit to work			
Protection during roofing package	Confirm responsibility Method Phasing/changes during works Temporary rainwater drainage			
Transfer* and storage of materials for the roofing package	Type Estimated load and volume Location Protection measures			
Transfer of other materials**	Location Protection measures			
Other trades	Sequencing Protection Responsibility for protection Avoidance of contamination			
Testing	Roofing contractor attendance			

* To the roof
** Typically, HVAC ductwork, green roofing materials, landscape ballast, renewables (photovoltaic and solar thermal panels).

5.4. SITE MANAGEMENT

Use the following checklist to ensure that site operations are suitably managed to minimise risk of damage to the roofing system:

SITE RECORDS	Roof status	
	Photographs (referenced to location)	
	Weather records: rainfall, wind, ambient temperature	
STORAGE OF ROOFING MATERIALS	Load-spreading	
	Protection	
	Access	
STORAGE OF NON-ROOFING MATERIALS	Load-spreading	
	Protection	
	Access	
MEMBRANE INTEGRITY TESTING (IF REQUIRED/ SPECIFIED)	Obtain RAMS	
	Clear obstructions to avoid exclusions	
	Coordinate with scaffold/edge rails	
	Roofing contractor to be in attendance	

5.5. CONTRACTUAL ARRANGEMENTS

Use the following checklist to ensure that responsibility for protection is clearly defined in the Contract:

		RELEVANT?	COVERED?
1	Is it clear who is responsible for moving temporary protection to suit new access locations?		
2	Does roofing contractor have sole possession of the roof whilst installation is in progress?		
3	If the roof system is sub-sub-contracted, is it clear which party is responsible for protection?		
4	Under what circumstances may other (non-roofing) trades access the finished roof?		
5	Which party is responsible for protection once the roof system is at practical completion?		

5.6. TOOLBOX TALK

To ensure that all protection methods are effective, all trades that either need to access or work on a roof system should be educated in how to respect the waterproofing. Attendance at the following Toolbox Talk is recommended as part of the overall strategy and may be included in the process to obtaining a permit to work on the roof area.

TOOLBOX TALK: RESPECTING THE ROOF

Who should attend? All trades that will have access to the roof area(s).

Objective: less risk of leaks; keeping to programme; fewer call-backs; safer working.

Outline: this talk outlines the reasons why the roof should be respected and the methods which can be used to prevent damage to the single ply membrane and other vital materials in the system.

Risks:

- Damage to single ply membrane: puncture, cut, tear.
- Damage to insulation: crushing or loss of facing.
- Less resistance to wind load: adhesive bond weakened by compression.
- Slip and trip hazards.
- Programme delays.
- Manufacturer warranty may be delayed.

Personal responsibility:

1. Access the roof only via designated route.
2. Never work off an unprotected roof.
3. If in doubt, check what protection should be in place before starting work.
4. Never store materials on the roof before checking on protection arrangements.
5. If you see damage or protection is missing, report it immediately.

Site operations:

1. Wet trades: load-spreading and full waterproof protection required.
2. Brick and block laying: load-spreading and full waterproof protection required.
3. M&E installation: load-spreading and protection from swarf required.

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