Installation guide

Protan FPO / TPO membranes

Roofing and membranes

PROTAN

PROTAN PROTECTS VALUES

Protan is a Norwegian industrial group that is a world-leader in membrane technology. We develop and supply membranes, roof systems, ventilation systems and technical textiles.

Our head office is in Drammen, Norway, and we have more than 900 employees and a total turnover in excess of NOK 2.6 billion.

Our largest business area is roofs and membranes. We have also specialized in tailor-made, flexible ventilation ducts for mines and tunnels. In addition, we supply multi-purpose technical textiles for a range of applications. Protan is also one of the largest roofing entrepreneurs in the Nordic region.

With 80 years' experience, Protan has developed innovative solutions that are adapted to a global market and demanding climates. We work closely with our customers and supplier to stay at the forefront in technology, the environment and competence. This gives us unique experience and insight that means that we can deliver flexible, tailor-made solutions adapted to local needs – if the customers need waterproof environmental roofing, demanding ventilation or other technical protection.

Our most important role as an international group is to protect values by supplying world-leading solutions.

PROTAN

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Think Personal Security

Renovation

New construction

High solar reflectivity
Long life expetancy
Low carbon footprint

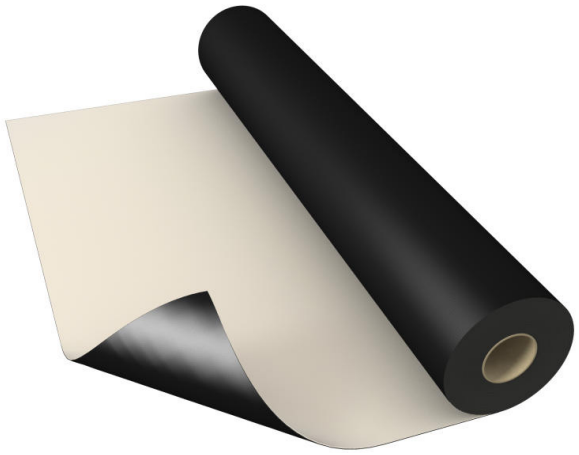
What is a FPO / TPO?

FPO / TPO (flexible polyolefins/thermoplastic polyolefins) are a group of materials based on rubber-modified polyethylene and/or polypropylene. The added rubber makes the product flexible. A FPO / TPO is a thermoplastic, therefore the material will melt/ harden at a high temperature and can thus be processed and welded with hot air.

A FPO/TPO has fillers, stabilisers and functional pigments added to achieve the properties required.

Product details

Protan FPO/TPO is a waterproofing membrane made of flexible polyolefins with an internal polyester reinforcement. The membrane is easy to install in most weather conditions due to its flexibility and robustness. Due to its excellent elongation properties, it will adapt optimally to all weather conditions.



Protan FPO / TPO properties

Thickness (mm):	1.2 / 1.5 / 1.8 / 2.0
Width (m):	1.6
Length (m):	20 / 20 / 15 / 15
Weight (kg/m²):	1.5 / 1.9 / 2.1 / 2.3

Suitable for:
Mechanically attached exposed roofs
- new build & renovation

Protected constructions
- new build & renovation

Roof structures

FUNCTIONAL REQUIREMENTS

The most important functional requirements of a roof are:

- Water must not penetrate into the structure through the roofing membrane.
- Materials used must withstand the influence of sunlight, wind and mechanical impacts.
- Rain and water from melting snow must be drained away properly.
- Snow must be able to lie on the roof or slide off at no risk to the roof or the surroundings.
- Water vapour and damp indoor air must be prevented from penetrating into the roof structure.
- Noise reduction.

COMPACT/WARM ROOFS

In compact/warm roofs, the various material layers lie directly on top of each other with no form of air gap or ventilated layer. In such roofs, the roofing membrane will be able to function as part of the air seal. Extra attention must be given to details, such parapets and penetrations, where the airtightness of the system may be compromised.

In compact roofs, the use of organic materials between two vapour-tight layers must be avoided because any condensation/ moisture can cause rot.

Tools

The application and installation of the membrane is critical for a watertight and durable system. All installers must have the appropriate training and experience, and must have access to the necessary tools. For a successful application of Protan FPO/TPO membrane, the following tools are necessary:

- Hot air hand gun, hot air automatic welding machine
- Silicone pressure roller, width 28 mm / 40 mm
- Narrow pressure roller
- Cutting knife with hook shaped or trapezoidal blade
- Pair of scissors
- Wire brush
- Folding rule

Automatic welding machine

- Self-moving hot air welding machine
- VDE-checked, with variable temperature control up to + 620 °C and variable movement velocity
- Width of nozzle and pressure roller must be 40-45mm

Warning:
With a cable length 50 m at 230 V and 100 m at 400 V the use of mobile power aggregates is recommended to avoid power loss

Hot air hand gun / welder

- VDE-tested, 230 Volt, with variable tempertaure control
- Up to + 620 °C with a flat nozzle, width = 20 mm / 40 mm
- Heat capacity of 1600 Watts

Substrates and vapour control layers

It is the duty of the applicator to check the substrate, in particular the surface, for its suitability. In accordance to flat roof regulations, roof areas should have a continuous slope towards the water outlets. We recommend a slope of at least 1:40, but national or local regulations must be followed. Water outlets should always be placed at the lowest points of the roof.

STEEL DECKING

Only galvanized sheets with factory-made corrosion protection should be used and must comply with European and/or national standards. The thickness should be minimum 0,75mm, or as recommended by the fastener manufacturer and/or national/regional requirements.

CONCRETE

Concrete roofs have to be sufficiently cured and dry on the surface in accordance with flat roof regulations and/or the fastener manufacturer. The surface has to be abraded, plain and free of rock pockets, cracks, sharp gratings and nibs.

PRE-CAST CONCRETE ELEMENTS

The installed concrete elements have to provide a plain surface. Construction joints must be sealed and closed. The supporting joints (butt ends) should be covered with protective strips and fastened mechanically against movement.

TIMBER DECKING AND WOODEN DERIVATIVES

The wooden construction must be protected against moisture. When laying wooden construction materials, the thermal co- efficient should be observed. The thickness of the boards must be able to withstand the expected load and the distance of the supports should be calculated accordingly, the boards should be at least 24 mm thick when using timber and 18 mm when using plywood or OSB products. Local/national minimum requirements may differ and is subject to the product type, quality, thickness and the type of fasteners used.

OLD ROOF SURFACES

Before any renovation can take place, several openings in the existing roof down to the load bearing layer should be made to ensure its integrity (Vapour barrier condition, thermal insulation thickness, moisture condition of the thermal insulation and possibility of drying out the roof construction if moisture is present). On Bitumen Substrates, waves, blisters and other factors causing unevenness should be mechanically removed and levelled. In some cases a protective layer may be required.

VAPOUR CONTROL LAYERS

A vapour control layer is designed to prevent moisture from penetrating from inside a building out into the walls and roof by means of diffusion and via air leaks (convection). It is also designed to prevent the occurrence of draughts and heat loss via air leaks. It is thus important to ensure all laps and terminations of the vapour control layer are sealed with tape to increase airtightness.

In compact/warm roofs, it will normally be enough to have polyethylene (PE-foil) as the vapour barrier, but this depends on the building's function and/or requirements of the roof structure, e.g. buildings with high humidity such as swimming pools need a higher performing vapour control layer. Consult the client if there is any doubt about the function/quality of the vapour control layer.

Insulation

The most important requirements of insulation materials for use on roofs and membrane structures are:
- Thermal insulation capacity
- Fire resistance
- Compressive strength

The most widely used insulation materials are:
- PIR / PUR (Polyisocyanurate / Polyurethane)
- Mineral wool (stone wool/glass wool)
- XPS (extruded polystyrene)
- EPS (expanded polystyrene)

Fire classification of a roof construction is dependent on the combination of the roofing membrane and the type of insulation. The full build-up must be tested to obtain a fire classification. Please contact Protan for further details.

Separation and Protection Layers

Depending on the roof construction and the type of system installed, other protection layers may be required to enable the roof to function during its expected life.

Protan FPO/TPO membranes are plasticiser and PVC free and do not require any separating layers when in contact with bitumen and polystyrene as they are fully compatible. Protection layers are not required in all roof constructions, and are primarily used to separate incompatible products or to prevent damage.

PROTECTIVE LAYERS BELOW THE MEMBRANE

Rough and uneven surfaces can damage the waterproofing membrane and therefore often require a protective layer beforehand. Polyester / Polypropylene fleeces are suitable as protection layers or a single layer of insulation can be used. A protection layer is always required between the membrane and concrete substrates. A protection layer is recommended when installing over other substrates. A separate fleece layer is recommended to prevent discolouration of the membrane when installing over bituminous substrates.

PROTECTIVE LAYERS ABOVE THE MEMBRANE

In order to protect the membrane from damage in ballasted systems, a protective layer is required above the membrane if the roof is to be used as a recreational area or if the gravel ballast is to be installed via pneumatically blowing.

For green roofs, the drainage/water retention layers often provide a layer of protection.

Wind Load Calculation

There are national wind load standards for calculating the local wind load to which a building is exposed. National wind load standards must always be used as the basis for the installation of a mechanically fixed or ballasted roofing membrane. The Protan design guide is based on work from SINTEF Building and Infractructure and the Norwegian Roof Producers' Research Group, TPF. It is tailored to meet the specific requirement of EN 1991-1-4. In addition, national and regional guidelines must be followed regarding minimum fastener requirements.

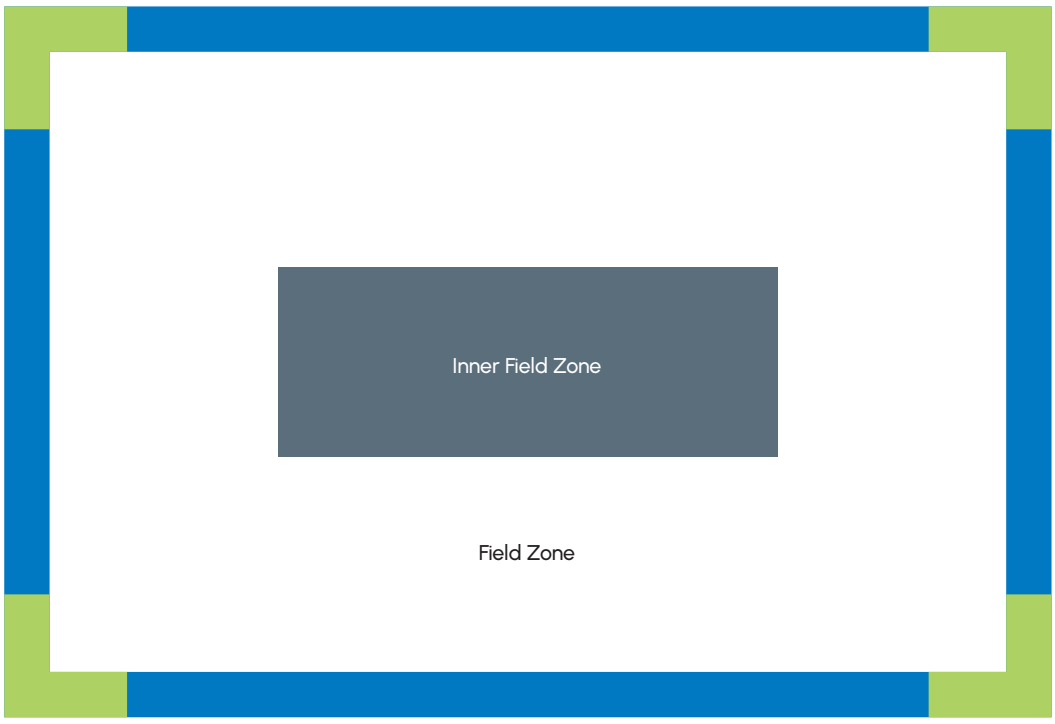
A wind load calculation must be performed for all roofing projects, both refurbishments and new builds. The information required to perform a wind load calculation for a building is as follows:

- Building location
- Reference wind speed
- Height above sea level
- Height of the building
- Roof type
- Terrain category
- Topography

When the location of the building is known, the reference wind speed can be determined from national tables or maps in the wind load standard. The roof type and the height, length and width of the building are also important information for the calculation and the division of roof zones and their size for the roof area.

A wind load calculation must be carried out before the roof is installed.

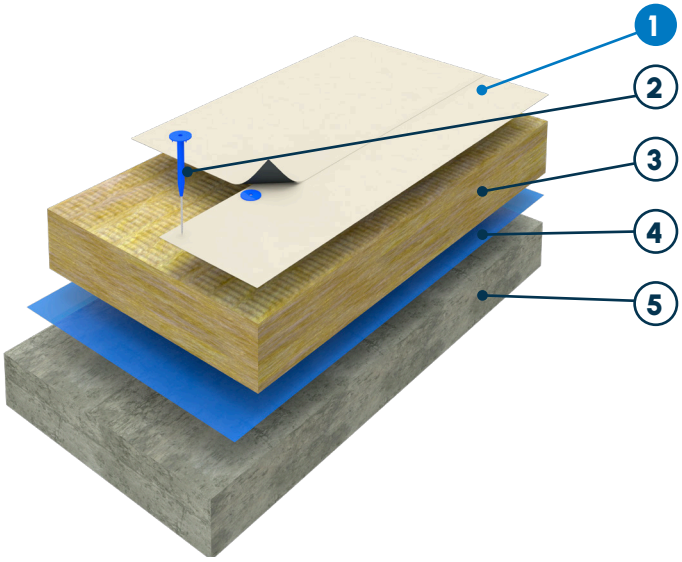
WIND LOAD ZONES



Exposed Roof Systems

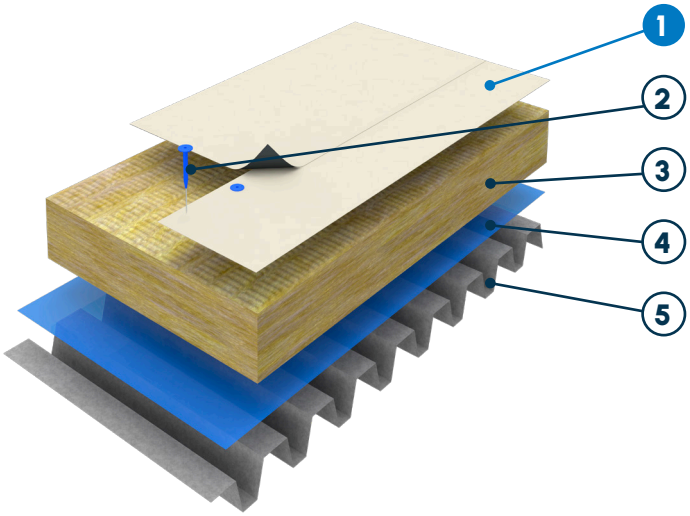
On profiled steel decks and timber boards, the membranes have to be installed across the profile direction, or across the longitudinal direction of the boards. The highest wind loads always occur in the corner zones and the external perimeter zones. For this reason the calculated fastener density will be higher than in other areas of the roof.

Please follow local/national guidelines with regards to minimum fastener densities and membrane widths.



Protan standard overlap system

1. Protan FPO / TPO membrane
2. Fasteners
3. Insulation
4. Vapour control layer
5. Load bearing substrate



Protan standard overlap system

1. Protan FPO / TPO membrane
2. Fasteners
3. Insulation
4. Vapour control layer
5. Load bearing substrate

There are various types of fixings on the market that are approved for use with Protan roofing membranes (ETAG 006). The combination of fixings (screws/tubes) must be selected on the basis of their suitability for the supporting structure, as well as the insulation layer, and the type of roofing membrane.

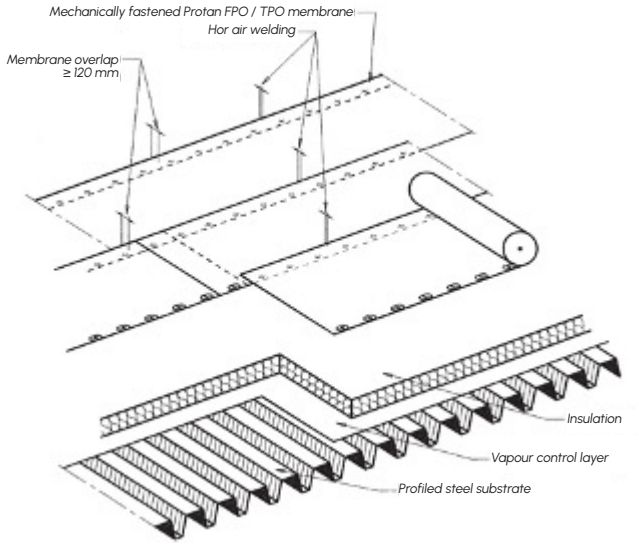
Only use tested and approved fasteners with Protan FPO/TPO membrane.

Please contact Protan for further information

METHODS FOR MECHANICALLY FASTENING

Standard Overlap System - Protan FPO/TPO membrane is fixed mechanically by the rolls being rolled out, straightened up, tightened, fixed at both ends, welded together and fixed systematically along one longitudinal edge of the sheet with fixings. The fixings are installed with the edge of the screw/ core 30 mm from the edge of the sheet. The next sheet is laid with a minimum of 120 mm overlap. The joints are normally formed with an automatic welding machine and a 40 mm welding nozzle.

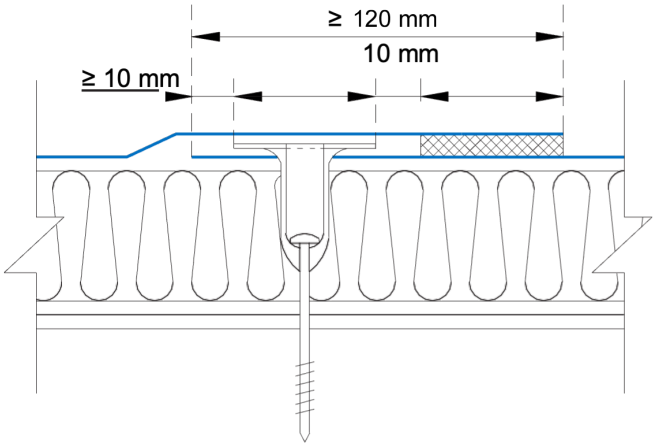
A marked line is provided on the membrane at 110mm distance from the edge to provide guidance whilst installing.



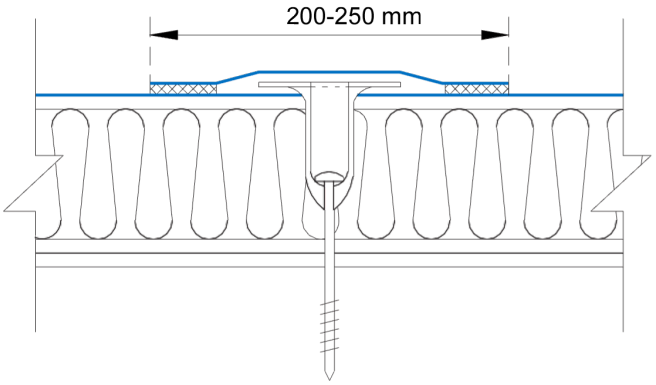
The overlap consists of:
≥ 10 mm distance of the washer plate to the membrane edge, approximately 40-50 mm width of the washer plate, 10 mm tolerance and approximately 40 mm hot air welding.

Please follow local/national guidelines with regards to minimum fastener densities and membrane widths.

Please note, for protected constructions, the overlap can be reduced to ≥ 80 mm.

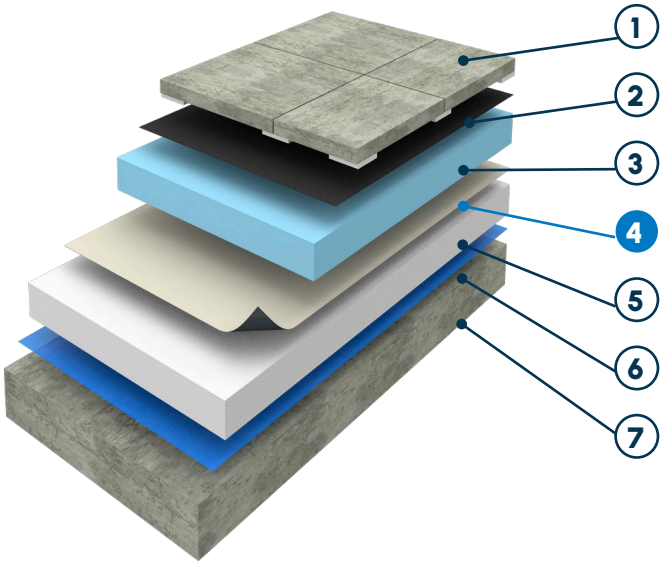


Symmetrical Fastening System with intermediate fastening rows - This system is mainly used as an intermediate fixing method in perimeter and corner areas instead of using narrower membrane widths. The intermediate fixing lines are covered by Protan FPO/TPO membrane strips, width approximately 200-250mm mm. This system can be combined



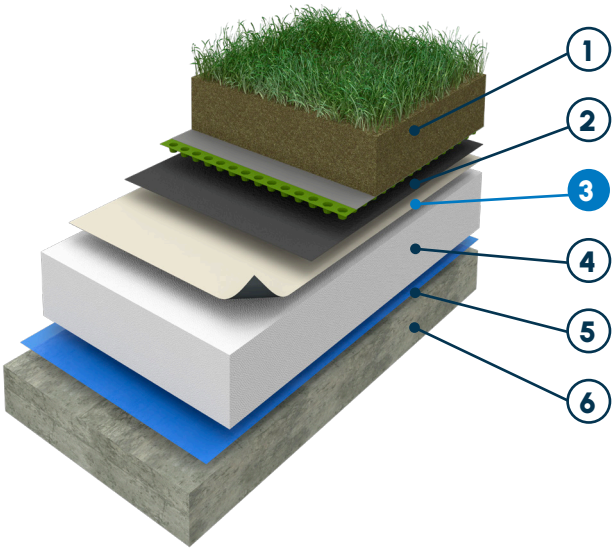
Protected Constructions

Protected constructions include systems in which the membrane is covered with, for example, cast concrete, concrete slabs, gravel (crushed stone or natural gravel) or soil as the basis for green roofs. The advantage of ballasting a roof may be aesthetic effects and the opportunity to use the roof area for other purposes. The supporting structure in ballasted roofs must be designed to withstand the weight of the ballast. Ballasting is, therefore, mostly used on concrete decks.



Protan ballasted duo system

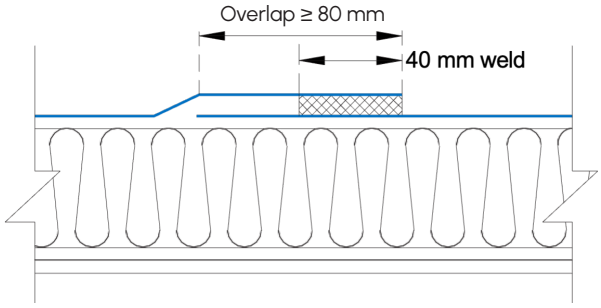
1. Concrete slabs on support
2. Filter layer
3. XPS insulation
4. Protan FPO / TPO membrane
5. Insulation
6. Vapour control layer
7. Load bearing substrate



Protan intensive green roof system

1. Intensive green roof layers (vegetation, growing medium, drainage)
2. Protection layer
3. Protan FPO / TPO membrane
4. Insulation
5. Vapour control layer
6. Load bearing substrate

In protected constructions, the membrane is wind protected by the ballast thus no fasteners are required. Due to this the overlap can be reduced from 120 mm to ≥ 80 mm.

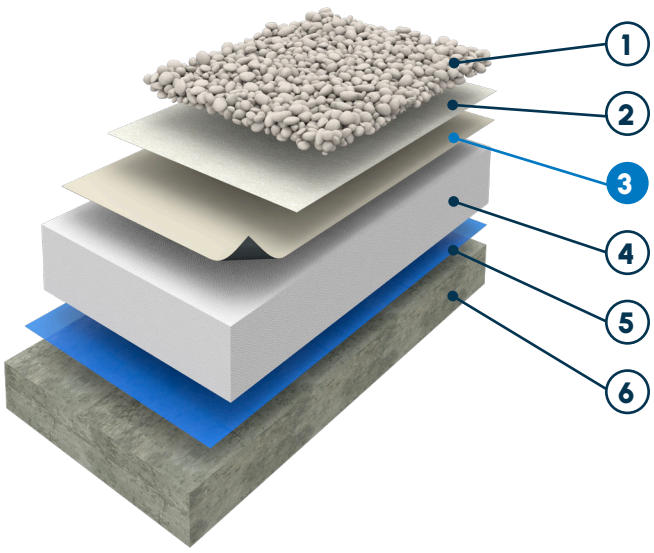


For protected constructions, the overlap must be ≥ 80 mm.

The main purpose of the ballast is to prevent the wind from affecting the roofing membrane. The critical factor in this respect is not just the total weight of the ballast but also the type of ballasting material used. For example, fine-grained gravel can be blown off a roof surface more easily than concrete slabs.

If the underlying structure is to be defined as airtight, a 50 mm layer of round-grained natural gravel with a minimum grading of 16-23 mm provides adequate protection against evenly distributed wind suction; dimensioning load (Qd) < 3 kN/m^2 (in the corner zone, that is usually most exposed).

A grading of 16-32 mm is considered able to resist a wind speed of 80 m/s in a wind vortex before there is movement in the gravel. The speed in a wind vortex is calculated on the basis of the roof's dimensioning wind speed/load, which is calculated using the applicable wind load standard for the building in question. 50 mm concrete tiles are considered adequate protection against constant suction on the roof, qd < 5 kN/m^2.



Protan ballasted system

1. Rounded pebbles

2. Optional protection layer

3. Protan FPO / TPO membrane

4. Insulation

5. Vapour control layer

6. Load bearing substrate

If the ballast consists of crushed stone with sharp edges, the roofing membrane must be protected with polyester or polypropylene fleece or similar with a minimum surface weight of 300 g/m^2.

Welding procedures for exposed roof systems and protected constructions

Protan membranes are thermally welded together using hot air welding machines. The overlapping sheets are homogeneously plasticised and joined together under pressure. Temperature, roller pressure and speed while welding are important parameters and must always be adjusted to the ambient working temperature. Adjustment of the welding temperature may be necessary with changing ambient conditions. Dependent on this the welding can be carried out within a temperature range of + 400 °C up to + 600 °C. A correctly welded joint is weather stable and does not require any further treatment.

QUALITY CHECK

Before commencing work, test welding should be completed to ensure welding quality.
The overlapping distance for both manual and automatic test welding is 50 mm in which the edge must be kept clean before welding to ensure a complete bond. Butt joints of the sheets have to be covered with a strip of Protan FPO/TPO membrane, width min. 120 mm.

WELDING BY AUTOMATIC WELDING MACHINE

Switch on the machine and adjust the temperature to a recommended + 400 °C up to 600 °C. The welding is done in one continuous operation. It is not necessary to make the pre-welding (tacking) line as when using manual hot air hand guns as the automatic welders have a special heat shield system which ensures that the sheets are pressed together and no hot air can escape. The welding speed is adjustable and will be determined by the ambient temperature.

T-JOINTS

T-joints must be used when three membranes intersect. We recommend using an edge trimmer to cut the intersection of the overlapping joint between the two underlying membrane sheets in a T-joint. Trimming the overlap edge saves time and simplifies installation to ensure water tightness in the welding of T-joints.

T-joints must be reinforced with patches made on site or supplied as prefabricated.

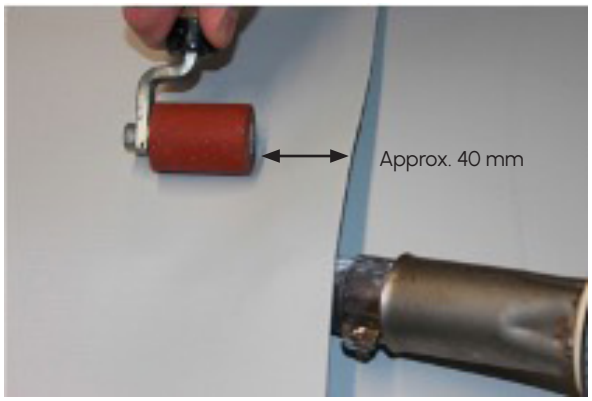
WELDING SEAM CONTROL

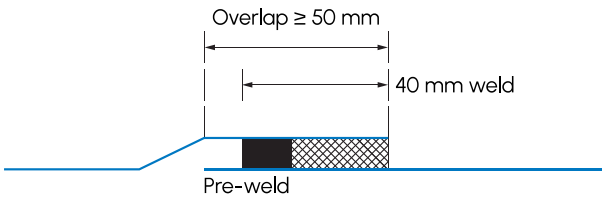
Before commencing work, test welding must be completed to determine the ideal welding parameters and to ensure welding quality. A seam check can be done by using a suitable hook/probe and by a peel test. Both seam check and peel test can only be done after sufficient cooling-down of the welding seam (after a 24 hour period or after submersion in a bucket of cold water). The membrane temperature should be < 20 °C.

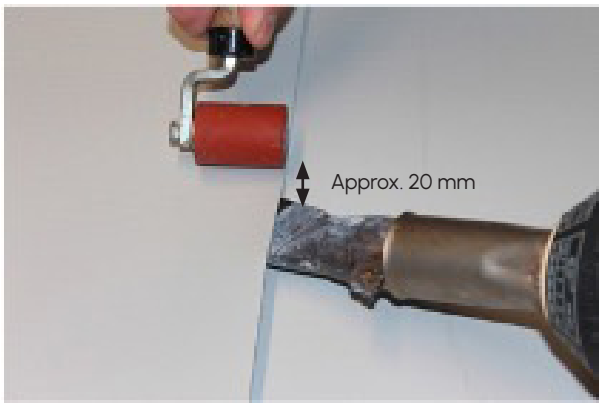
A test weld must be carried out at the start of machine welding and peel tests conducted at intervals of 200 linear metres to ensure a proper welding quality.

CONNECTION OF NEW MEMBRANES TO ALREADY INSTALLED MEMBRANES

New membranes may be joined together with already weathered membranes. The surface of the already weathered membrane only has to be cleaned using a one-handed angle grinder with a rotating wire brush to remove all accumulated dirt and patina layers. Use of another method? Please contact Protan for recommended cleaning methods and products.







Welding by hot air hand gun / welder

Set the temperature of the hot air hand gun/welder (such as a Leister Triac) to a recommended + 400 °C up to + 600 °C. The welding is usually done in 2 steps:

1. The upper sheet in the overlapping is fixed, approximately 50 mm from the edge, by pressing the silicone roller (see picture 1) on the edge of the underneath sheet to create a narrow pre-weld. This pre-weld line ensures that during the main welding process no hot air escapes and the necessary welding temperature is maintained which ensures homogeneous welded seams. This additionally ensures correct installation of the membranes.

2. The main welding is carried out on the remaining width of approximately 40 mm. In this case, the welding unit and the silicone roller are moved in a slow continuous movement along the seam (see picture 2). After welding, turn down the temperature of the welding machine, but keep the blower on until the air is no longer hot (preserves the heating elements).

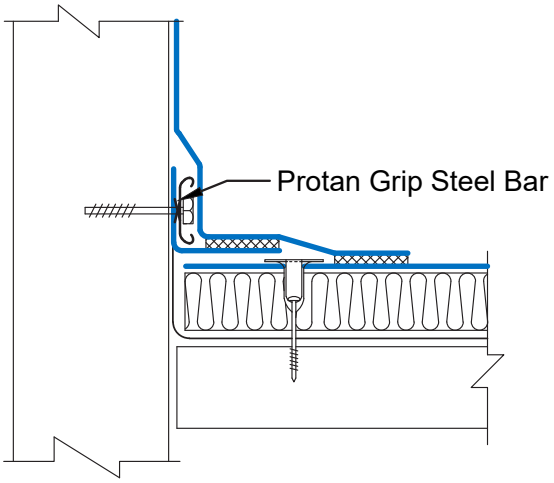
When using polystyrene insulation sheets the overlapping area has to be increased in order to avoid any damage caused by hot air.

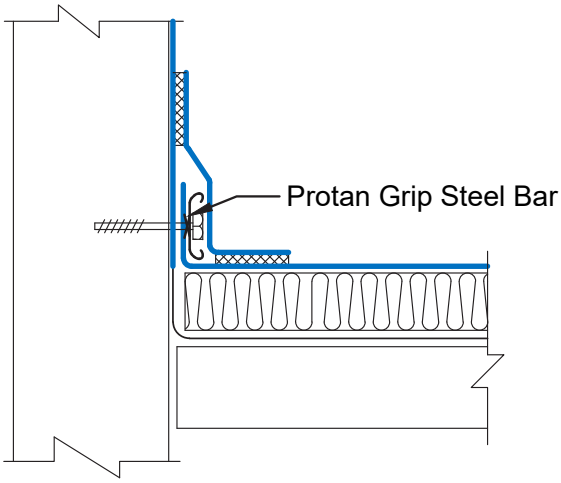
Remember, overlaps for exposed roof systems with fasteners need to be ≥ 120 mm and overlaps for protected constructions ≥ 80 mm.

Details/Parapets

FLASHINGS

Connections to roof waterproofing are done using strips of Protan FPO/TPO membrane. According to Flat Roof guidelines, all connections and terminations must be structurally fastened to prevent horizontal forces from damaging the membranes. The sheets must be fastened with the Protan Grip Steel Bar (mechanically fixed every ≤ 200 mm) or TPO coated metal (mechanically fixed every ≤ 200 mm). Rigid connections of two structurally separated sheets should be avoided. Damages caused by shear and tensile loads can be avoided by installing sensible details designed to cope with these movements. All these connections should be wind proof. All details must be constructed in such a manner that no water can run behind or underneath the sheets. At junctions individual seams facing the direction of water flow cannot be avoided. This does not constitute a disadvantage for hot air welded seams.





The connection of the flashing strips to the field membrane must not be more that 20 cm from the up-stand.

To seal the profile, suitable sealants or mastics can be used. A perimeter fixing in front of all upstands and penetrations must be carried out with Protan Grip Steel bars (approx. 5 fasteners / linear metre) or laminated metal strips (5 fasteners / linear metre).

Also in valleys with a change of the angle of 3° from horizontal, a fixing row is necessary. Wall connections have to be fixed at ≤ 200 mm.

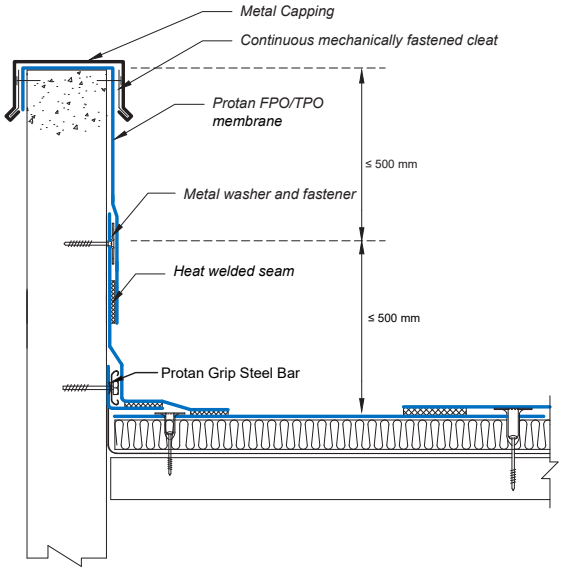
FLASHING TO HIGH PARAPET

If the height of the parapet exceeds 500 mm, the vertical flashing membrane must be fully bonded with contact adhesive to the substrate and mechanically fixed on the top of the parapet. Alternatively, the membrane flashing can be loose laid with a mechanical intermediate fastener row.

It can be carried out as a 2-part covered connection or as a single flashing strip with intermediate fastener plus cover-strip. As fastening elements, suitable wall connection profiles plus screws (5 fasteners / linear metre) can be used. Also single membrane fastener washer plate/screw combinations with European Technical Approval (ETAG 006), 4 fasteners / linear metre can be used.

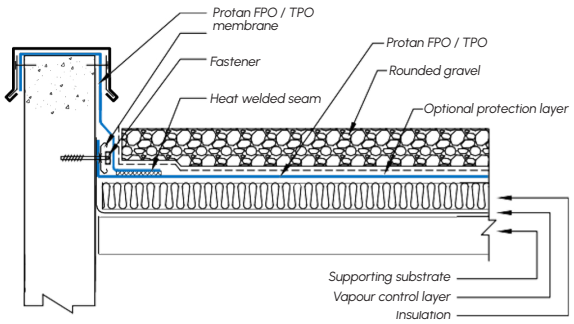
As an alternative, a strip of laminated metal can be installed below the flashing strip and fixed with 5 suitable screws / linear metre. In this case, the flashing strip needs to be hot air welded to the laminated metal strip.

The maximum distance between fastener rows on high parapets is 500 mm.



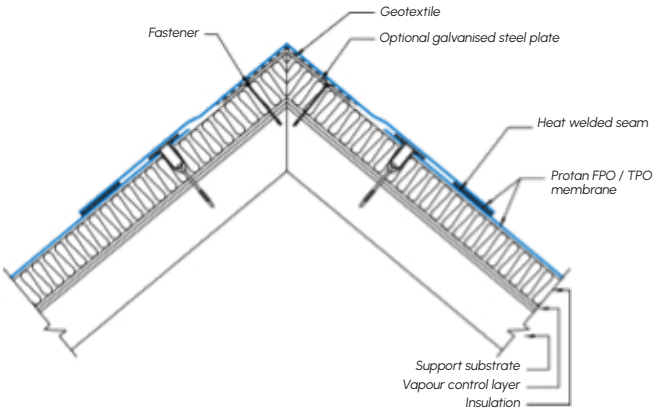
PARAPET FLASHING ON PROTECTED CONSTRUCTIONS

Strong winds often results in the movement of the gravel ballast (wind scouring), to avoid damage it is important to have mechanical fastening around the perimeter of the roof. The linear perimeter fixation is also important to give resistance against probably occurring horizontal forces (compare flat roof guide lines). We also recommend using concrete slabs in the edge and corner areas when using this design in high rises and / or wind exposed building locations. Then a suitable coping profile is placed windproof on the parapet crown. The ballast quantities are to be used according to the Flat Roof guidelines and EN 1991-1-4 (Wind loads; national requirements and standards must be observed).



RIDGE DETAIL

At ridges with a defined change of angle from the horizontal, perimeter zone fixation is required. We recommend to finish with the field membranes on both sides of the ridge and to fix them mechanically by single membrane fasteners (washer plate / screw combinations with ETAG 006 approval), 4 fasteners / linear metre, in parallel direction to the ridge. Finally they should be covered with an approx. 250 mm to 520 mm wide Protan FPO/TPO membrane strip which should cover the mechanical fasteners and then welded on both sides.



INTERNAL AND EXTERNAL CORNER

In corner areas, homogenous membrane strips are used around the corners and welded (see sketch). The sealing can be done by using prefabricated external and internal corners or round corner protections made of homogeneous material. The size of the corner protections depends on the detail which has to be sealed. External corners can also be used for sealing straight angled or square roof penetrations such as ventilators or dome lights.

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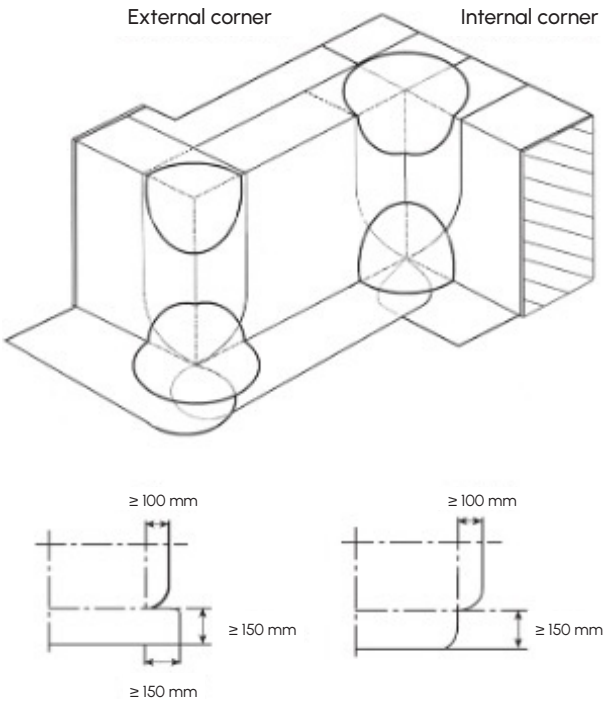
Folded corners are acceptable when using the homogeneous detailing membrane.



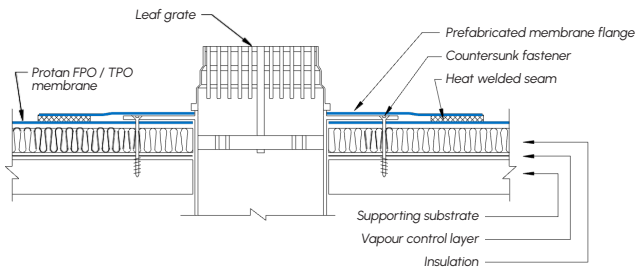
FLASHING TO RAINWATER DRAINAGE OUTLETS

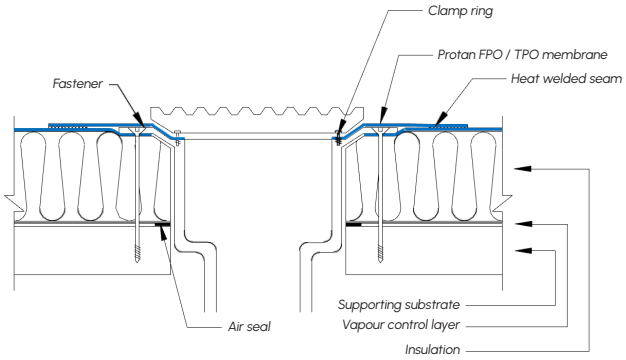
For this detail, we recommend the use of prefabricated drains with factory-made membrane collars or drains with clamp rings.

It is best practice that drains must be placed with the external edge of their flange min. 300 mm from walls, parapets, joints and other separating objects. Structures separated by expansion joints must all have individual drains. Please observe local or national regulations regarding this matter.

Roof outlets with clamping flange and sealing gaskets (top- and bottom gasket), the membrane can be directly clamped in. The installation guide lines of the roof outlet manufacturer must be observed. The outlet must be installed at the lowest point on the roof. It may be necessary to create a shallow sump by cutting out the thermal insulation to provide drainage without hindrance.

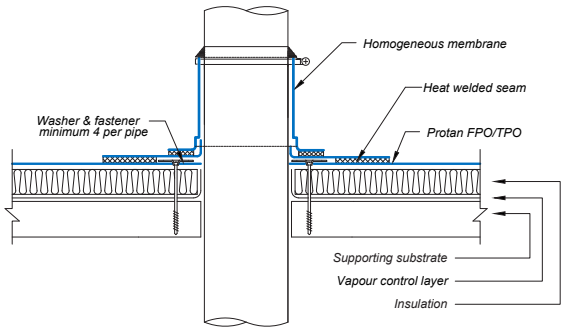
Attention: The drainage system must be dimensioned in accordance to national requirements. Also emergency overflows must be considered and calculated. Drains must





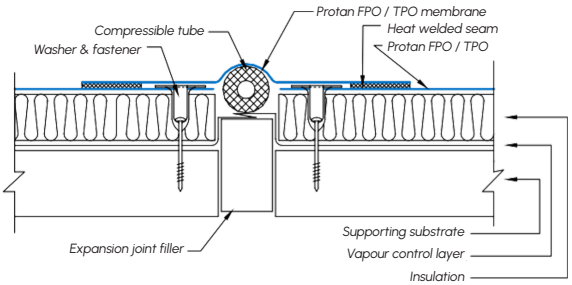
FLASHING TO PIPE PENETRATIONS

Pipe penetrations are normally sealed using prefabricated pipe details from our accessories range - or from a flange approx. 500 x 500 mm and a collar made from homogeneous membrane. Four fasteners must be installed in the field membrane around the base of the pipe. In the middle of the flange a hole must be cut. The hole should be approx. 60 mm smaller than the pipe diameter. Using a hot air hand gun/welder, the flange is heated to make it pliable and plastic so that it easily can be pulled over the protruding pipe. In some cases it is easier to make this shape adjustment on a loose pipe with the same diameter. Because of the smaller diameter in the membrane collar, the collar material stands up a few centimeters around the pipe. The collar must be welded to the field membrane. The flashing strip can now be installed and hot air welded to the up standing material from the collar.



EXPANSION JOINTS

The layers in the structure of the roof must have joints wherever there are joints in the underlying supporting structure of the building. Their design depends on the anticipated settlement. Structural and expansion joints should normally be designed as high points. They must not run through openings in the roof and must not be closer than 500 mm to such points.



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Think personal security - it is your health

The 12 rules of safety

1. Always use safety equipment in perimeter areas on flat roofs.
2. Pay particular attention when working in perimeter areas and on pitched roofs.
3. Keep the building site orderly.
4. Be aware of any overhead cranage.
5. Ladders should be long enough to be secured against slipping, and in good condition.
6. Provide fire-fighting equipment when working with naked flames on roofs.
7. Remember: Helmet, safety shoes and respiratory equipment.
8. Follow instructions for working with hoists and other lifting equipment.
9. Ensure that all safety equipment is secure before leaving for the day.
10. Secure openings, skylights and corners.
11. Follow instructions for electrical tools and equipment.
12. Keep emergency exits and escape routes open.

YOUR PLACE OF WORK

– ensure your safety precautions meet the minimum standards laid down by the relevant authority.

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