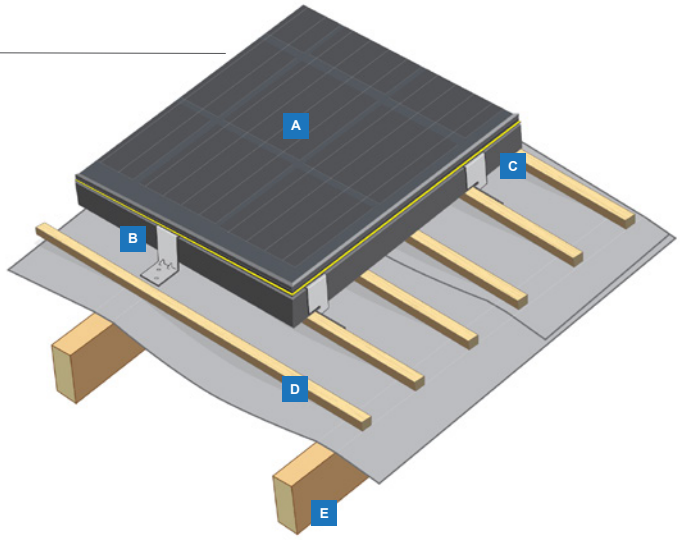
Clearline fusion Resistance to Wind and Snow Loads

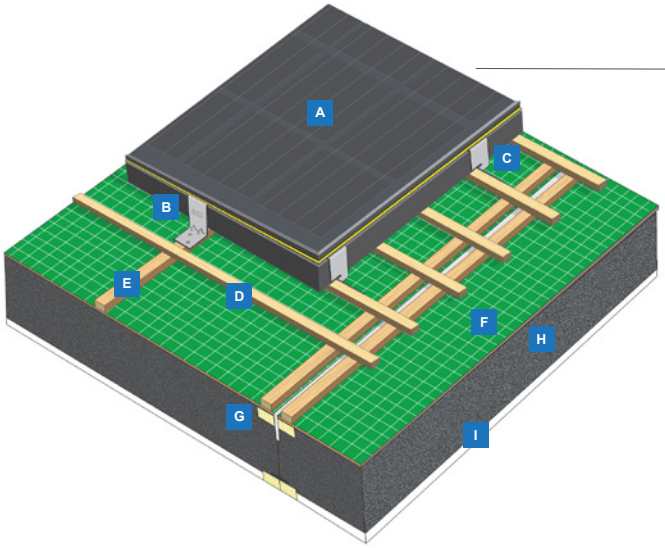
Rafter and tile battens

Characteristic Wind Resistance	5.32 kPa
Maximum Design Wind Uplift Resistance[1]	5.32 kPa
Positive Design Resistance	5.40 kPa

Sample Tested

A. Clearline fusion roof integrated solar panel, portrait installation
B. Rafter bracket, wherever panel crosses a rafter
C. Batten bracket, 3 per side
D. Tile batten 50mm wide x 25mm thickness
E. Rafter 35mm wide x 75mm deep, 600mm centres





Structural insulated panel

Characteristic Wind Resistance	3.72 kPa
Maximum Design Wind Uplift Resistance[1]	3.72 kPa
Positive Design Resistance	5.40 kPa

Sample Tested

A. Clearline fusion roof integrated solar panel, portrait installation
B. B22 - rafter bracket for 22mm battens, where panel crosses counterbatten
C. Batten brackets, 3 per side
D. Tile batten 50mm wide x 22mm thickness, nailed to counter battens

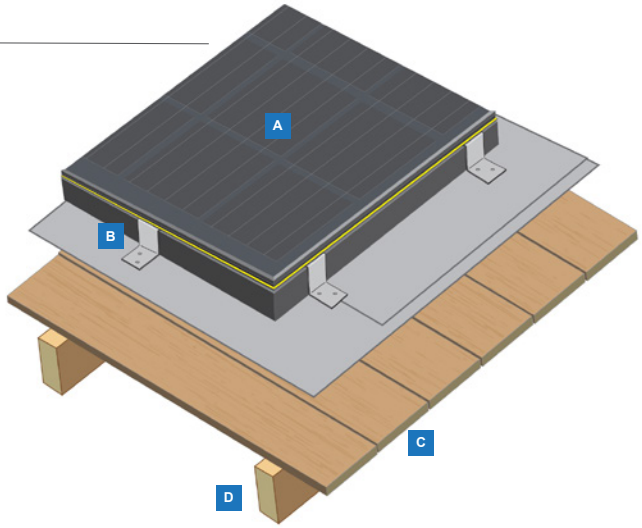
Kingspan Unidek Aero, span 3550mm:
E. Counter batten, 30mm wide x 20mm thickness, bonded
F. Chipboard facing, 3mm thickness, top and bottom faces
G. Integrated stiffener 45mm wide x 19mm thickness
H. Polystyrene insulation board 191mm
I. Plasterboard 12mm

Boards over rafter (sarking)

Characteristic Wind Resistance	5.32 kPa
Maximum Design Wind Uplift Resistance[1]	5.32 kPa
Positive Design Resistance	5.40 kPa

Sample Tested

A. Clearline fusion roof integrated solar panel, portrait installation
B. Sarking brackets, fixed into rafter where it crosses a panel
   3 per long side and 2 per short side
C. Softwood board 100mm wide x 22mm thick
D. Rafter 35mm wide x 75mm deep, 600mm centres



Notes
1. Maximum Design Wind Uplift Resistance includes a partial material safety factor of 1.0

Clearline fusion Resistance to Wind and Snow Loads

It is a requirement of building regulations that solar panels are resistant to the forces they will experience during their lifetime. Installers of solar panels are required to demonstrate that the products they fit have sufficient resistance to the highest likely weight of snow and wind pressures for the location in which they are being installed.

Solar panels for pitched roof integration might be fixed to a range of different roofing sub-structures. Since it is not always possible to safely extrapolate results from testing on one roof-type to another, Clearline fusion has been tested with a wide range of different roof build-ups.

1.0 Wind Uplift Pressure Resistance

Wind can produce a suction pressure which acts to pull a solar panel off the roof. The weakest link is just as likely to be a timber component of the roof to which the solar panel is fixed.

Common failure modes for roof-integrated solar systems include a fixing screw pulling out of timber batten, a batten breaking or a batten pulling away from a rafter to which it is fixed. Consequently a test done with one timber size absolutely cannot be used where any timber in the real-life situation is more slender than that in the test upon which the declared wind resistance is based. Conversely, test results can be used safely when the real-life roof structure is equivalent to the test structure, but with larger timber sections (both thickness *and* width).

Clearline fusion has been independently tested at an accredited laboratory using the methodology in MCS012 based on EN 14437. A sample roof section is built up with the solar panels fixed in a worst-case configuration. Vacuum pads attach to the panel surface and the force pulling the panel off the roof is increased in steps until a component breaks, a maximum displacement is reached under load or a maximum displacement is reached after the removal of the load (a permanent set).

The test is repeated at least three times and a characteristic wind resistance is calculated based on how closely the failure scores cluster.

The Characteristic Wind Resistance is then reduced by a Partial Material Safety Factor to determine a Maximum Design Resistance. The safety factor depends on the material of the element that failed, with a higher safety factor applied for failure in wood (high natural variablity) than metal (a consistent material).

2.0 Positive Pressure Resistance

Wind and settled snow can also apply a positive pressures to roofs, pushing the panels down onto the roof structure. In this case it is the robustness of the panel to withstand the forces and to continue to function afterwards that should be tested.

Clearline fusion has been tested for positive pressure according to EN 61215 at the maximum level specified in the test without visual damage and with power output maintained above 95% of rated, achieving a pass rating.

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