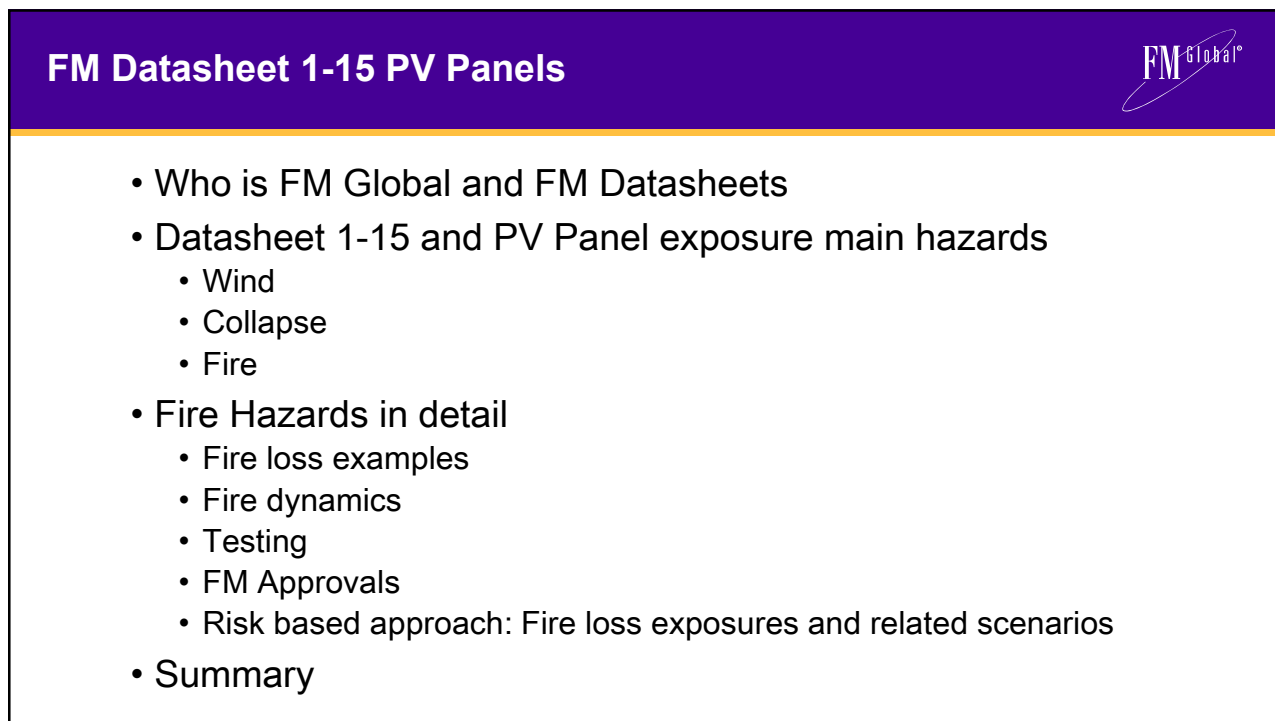


**Roof Mounted Solar Photovoltaic Panels
Data Sheet 1-15**

Ton Schroen, engineering consultant
Peter Nafzger, engineering consultant

RESILIENCE IS A CHOICE.

1



FM Datasheet 1-15 PV Panels

- Who is FM Global and FM Datasheets
- Datasheet 1-15 and PV Panel exposure main hazards
 - Wind
 - Collapse
 - Fire
- Fire Hazards in detail
 - Fire loss examples
 - Fire dynamics
 - Testing
 - FM Approvals
 - Risk based approach: Fire loss exposures and related scenarios
- Summary

2

FM Global



- Specialist commercial property insurer
- Mutual client-ownership structure
- Engineering advice based on science and research
- Founded nearly 200 years ago on the premise that the majority of property loss is preventable
- Partner with more than one-third of Fortune 1000 companies
- 60,000 client engineering visits per year



3

FM Global Data Sheet



- FM Global Research
- FM Approvals
- Loss Experience
- Free of charge at www.fmglobal.com

BOOKMARKS

- Help Getting Started
- Changes to Data Sheets
- January 2023
- Previous Changes
- FM Global Property Loss Prevention Data Sheets
 - 1. Construction
 - 2. Sprinklers
 - 3. Water Supply
 - 4. Extinguishing Equipment
 - 5. Electrical
 - 6. Boilers and Industrial Heating Equipment
 - 7. Hazards
 - 8. Storage
 - 9. Miscellaneous
 - 10. Human Factors
 - 11. Systems Instrumentation and Control
 - 12. Pressure Vessels
 - 13. Mechanical
 - 15. Welding
 - 17. B&M Miscellaneous
- Numerical Index of Data Sheets
- Disclaimer

JANUARY 2023

FM GLOBAL PROPERTY LOSS PREVENTION DATA SHEETS

FM Global Property Loss Prevention Data Sheets are engineering guidelines written to help reduce the chance of property loss due to fire, weather conditions, or failure of electrical or mechanical equipment, and incorporate loss experience, research results, input from consensus standards committees, equipment manufacturers and others.

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FM Global Data Sheet 1-15



FM Global
Property Loss Prevention Data Sheets 1-15

July 2014
Interim Revision January 2023
Page 1 of 28

ROOF-MOUNTED SOLAR PHOTOVOLTAIC PANELS

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2.0 RECOMMENDATIONS

2.1 Construction and Location

2.1.1 Wind

2.1.2 Fire Exposure and Classification

2.1.3 Gravity Loads and Roof Drainage

2.1.4 Hail

2.1.5 Earthquake

2.2 Electrical

2.3 Operation and Maintenance

2.4 Human Element

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Risk Engineering



- Data Sheet 1-15 outlines recommendations for new installations and installation of PV panels on existing roofs
- Fire is the key risk, but potential for increased risk of building collapse or damage from natural hazards
- FM Global loss prevention engineers analyze and advise on:
 - Building construction and materials, 'dakuitkraging'
 - Panel layout, aisle spaces, and skylights
 - Type of PV solar panels e.g., plastic-backed (glass-foil) or glass-backed (glass-glass)
 - Building load calculations e.g., snow, rain, wind
 - Emergency response plans, and pre-fire planning

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Wind, Collapse, Fire



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Datasheet 1-15

Wind

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Wind

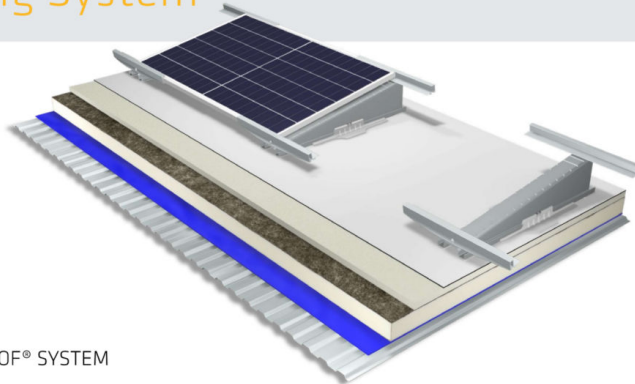


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Wind – Ballast or Mechanically Fastened - Hybrid



Going Beyond the Expected Solar Racking System



SIKA SOLARROOF® SYSTEM

Industry's first FM approved solar roof system The Sika SolarRoof® System is a groundbreaking solar solution that combines the proven



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Datasheet 1-15

Collapse

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Collapse



Best advice:

- Utilize CC2 and 50 years MRI for new buildings
- When retrofitting on existing buildings, treat the same
- Consider snow load and snow drift
- Structural analysis per project and per building

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Fire Hazards in detail

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Fire - Loss Examples



- Refrigerated warehouse, NJ, USA.
- Expanded or extruded polystyrene insulation below the roof cover.
- Near total loss of the facility.



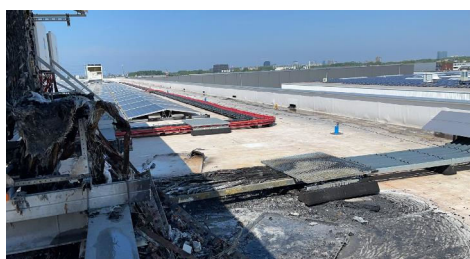
- Warehouse, Goch City, Germany.
- Appears to be a multi-ply bitumen roof cover.
- 4000 m² of roof involved.
- 120 fire-fighters.

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Fire - Loss Examples



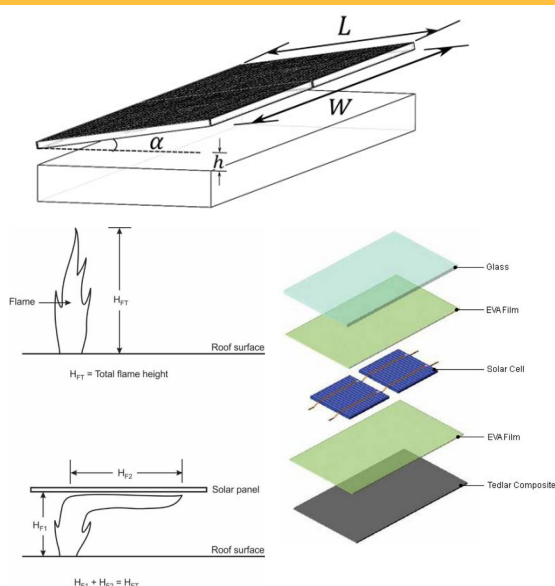
- Food manufacturing facility, NJ, USA. Fire in 2022.
- Fire started in yard storage and spread to the roof.
- Burning brands started another roof fire 30 m away.
- Significant water damage inside.



- Distribution Center, The Netherlands. Fire in 2022.
- Fire occurred in a 'combiner' box on a new PV panel installation.
- Good decisions and positive factors prevented a larger loss e.g., mineral wool insulation under the roof cover, space separation.

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Fire Dynamics of PV Panels/Roof Combination



- Cavity formed between the PV panel and roof enhances flame heating effect.
- Roof cover, PV panel, and other components can contribute fuel.
- Gap height, panel slope, and panel orientation are important aspects.
- Wind can facilitate fire spread.
- Adding PV panels greatly changes the fire dynamics of an external roof fire.

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Metal roof system



- The backsheet of the PV panel is the only fuel.
- Shows the effect of cavity fire spread.

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PVC roof cover system



- Added effect of a single-ply PVC roof cover.

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Fire test on a European roof assembly



- PVC roof cover with B_{ROOF} (t1) rating.
- 64 mm foil-faced PIR insulation.
- Plastic backed PV panel and aluminum frame.
- Failure in 1 minute.



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Current Standard External Roof Fire Tests



- ASTM E108/UL 790 and similar
- CEN/TS 1187 T1-T4
- ALL only evaluate fire on the top surface of the roof.
- Consideration to structures such as PV panels never anticipated.
- All these standards are 50 to 100 years old, all need to be modified for PV

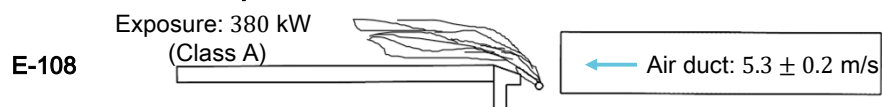
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Fire Test Approach - Modified ASTM E-108 Test



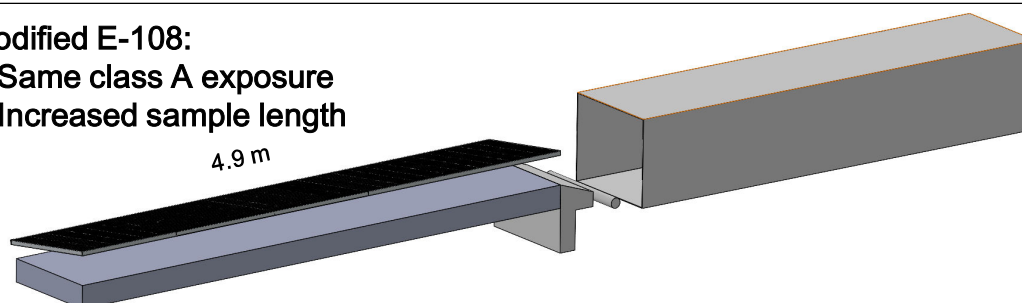
E-108:

- Large-scale test for roof fire spread test
- Class A, 10 min., max fire spread 1.8m



Modified E-108:

- Same class A exposure
- Increased sample length



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FM 4478 Examination Standard



Examination Standard for Roof-Mounted Rigid Photovoltaic Module Systems

Class Number 4478

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FM Approval

Fire

Hail

Wind

Courtesy of UL Fire Safety Research Institute, Firefighter Safety and Photovoltaic Systems

A roof mounted PV panel fire in NJ, USA in 2022 started due to panels moving due to wind, causing an electrical arc in the wiring.

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FM Approval

Trade Name ↑	Company Name	Approved Use
Alcome Chaser M10/108P double glass	Centroplan USA, LLC	Surfacing
Sunman Solar Specialist SMF310M-SX12UW	Kingspan Limited (Holywell)	Surfacing
Suntech Ultra V C72/Pmh	Centroplan USA, LLC	Surfacing
Suntech Ultra V Mini	Centroplan USA, LLC	Surfacing

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Fire Hazards in detail

**Risk based approach:
Fire loss exposures and scenarios**

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Risk based approach: Fire Loss Exposure



- FM Approved PV panel/roof system, or
- Glass-backed PV panels
- Metal top roof surface
- FM Approved or non-combustible insulation

➡ Limited damage



- Plastic-backed PV panels
 - PVC single-ply roof cover
 - Mineral wool or FM Approved PIR insulation
- ➡ Large external fire (plus water damage inside)

Water damage depends on occupancy
Hospital, pharmaceutical, datacenter



- Expanded polystyrene (EPS) insulation
 - Combustible multi-ply roof cover
 - Plastic-backed PV panels
- ➡ Potential total loss of the facility

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Summary



- Our aim is to support our client's green initiatives.
- Research shows that adding PV panels to a roof drastically changes the fire dynamics.
- Compliance to building regulations may still result in an exposure to a facility.
- Risk-based assessment and advice to help ensure sustainable and resilient operations.
- FM Approved systems of PV panels and roof assemblies.

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Thank you. Any questions?

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