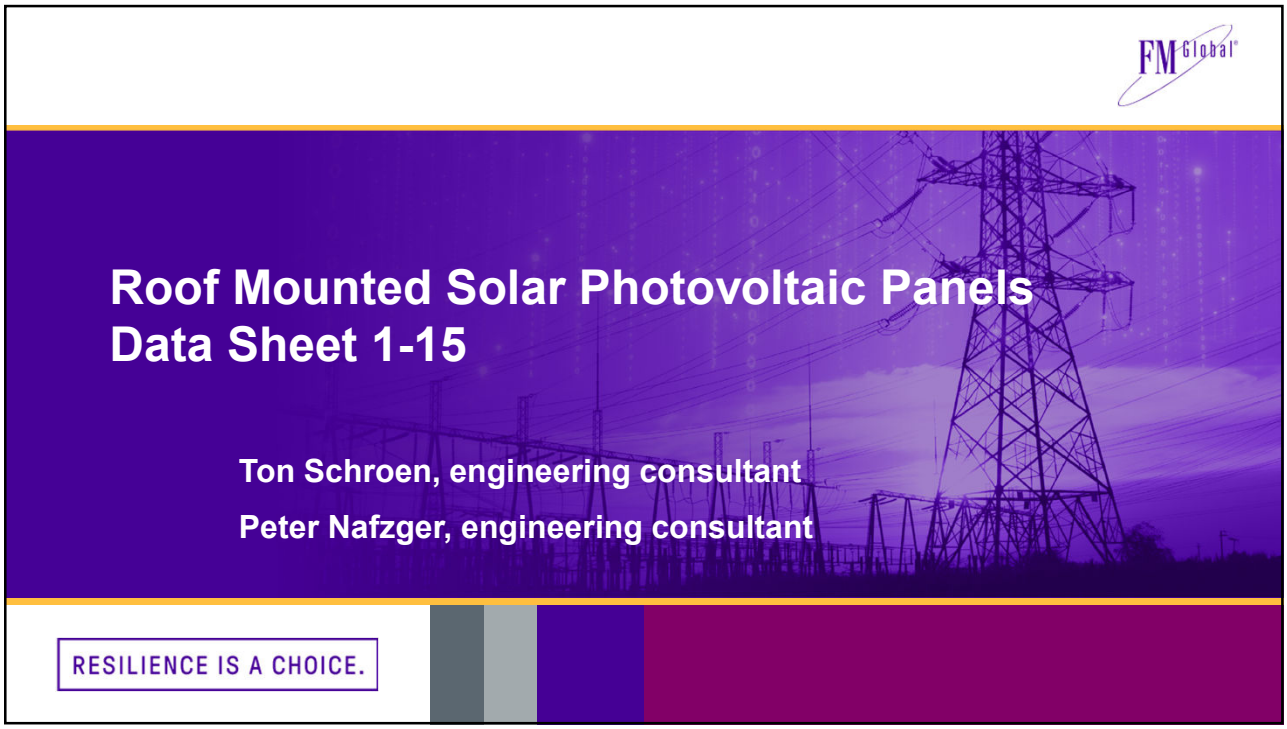


1

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

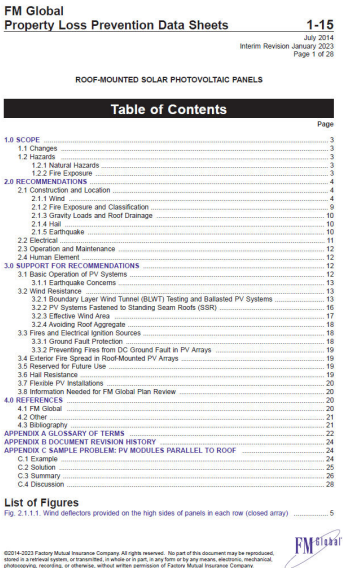
3

FM Global Data Sheet

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

4

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

Table of Contents

Page

List of Figures

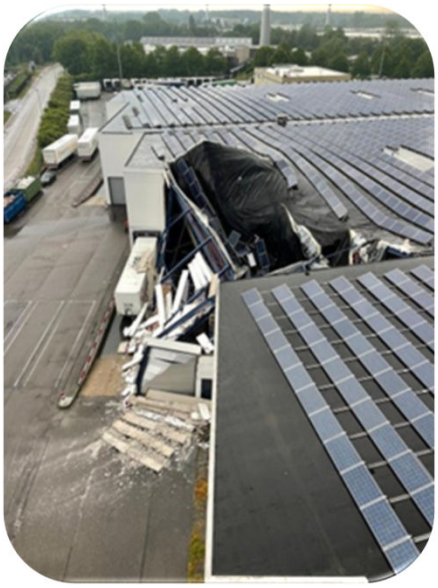
5

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

6

Wind, Collapse, Fire



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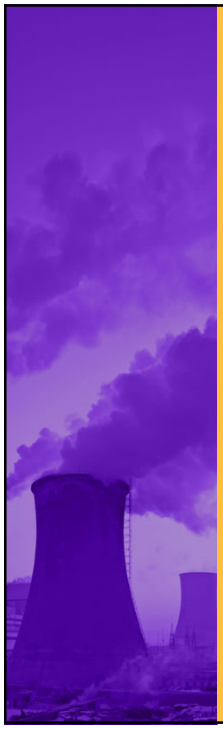


Datasheet 1-15

Wind

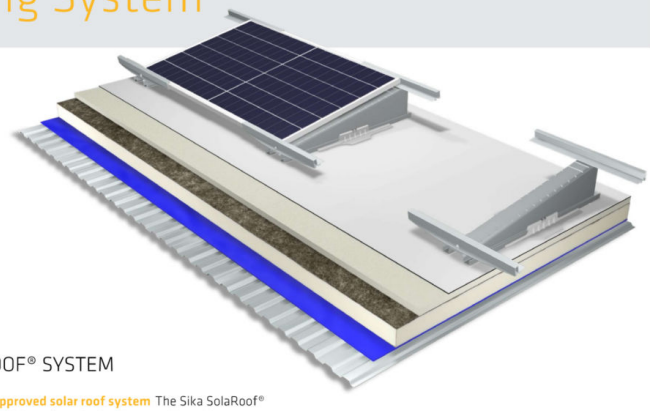
8

Wind

9

Wind – Ballast or Mechanically Fastened - Hybrid

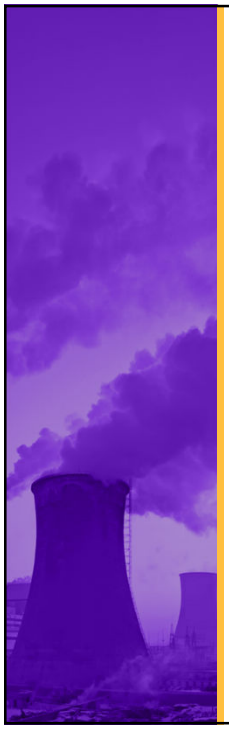
Going Beyond the Expected Solar Racking System



SIKA SOLAROOF® SYSTEM

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

10



Datasheet 1-15

Collapse

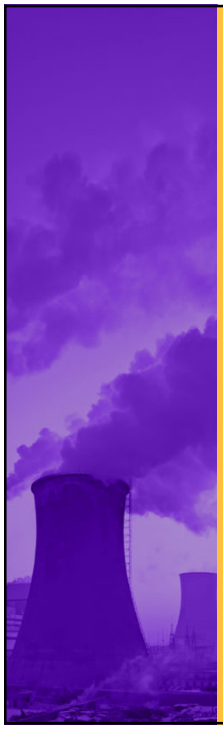
11

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

12



Fire Hazards in detail

13

Fire - Loss Examples

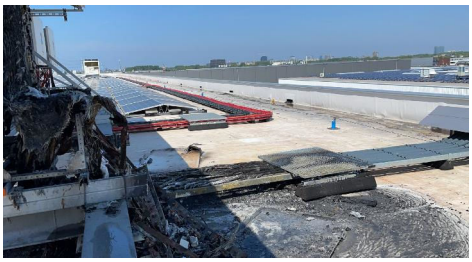
- Refrigerated warehouse, NJ, USA.
- Expanded or extruded polystryene insulation below the roof cover.
- Near total loss of the facility.

- Warehouse, Goch City, Germany.
- Appears to be a multi-ply bitumen roof cover.
- 4000 m^2 of roof involved.
- 120 fire-fighters.

14

Fire - Loss Examples

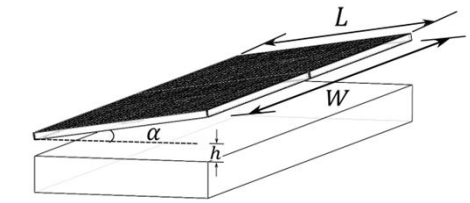
- Food manufacturing facility, NJ, USA. Fire in 2022.
- Fire started in yard storage and spread to the roof.
- Burning brands started another roof fire 30 m away.
- Significant water damage inside.

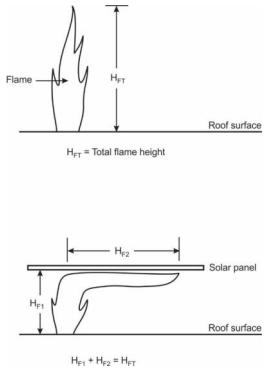


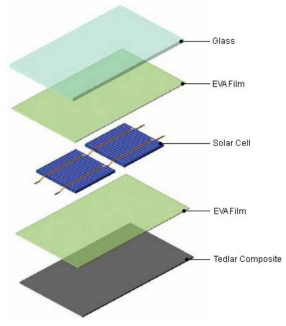
- Distribution Center, The Netherlands. Fire in 2022.
- Fire occured in a 'combiner' box on a new PV panel installation.
- Good decisions and positive factors prevented a larger loss e.g., mineral wool insulation under the roof cover, space separation.

15

Fire Dynamics of PV Panels/Roof Combination





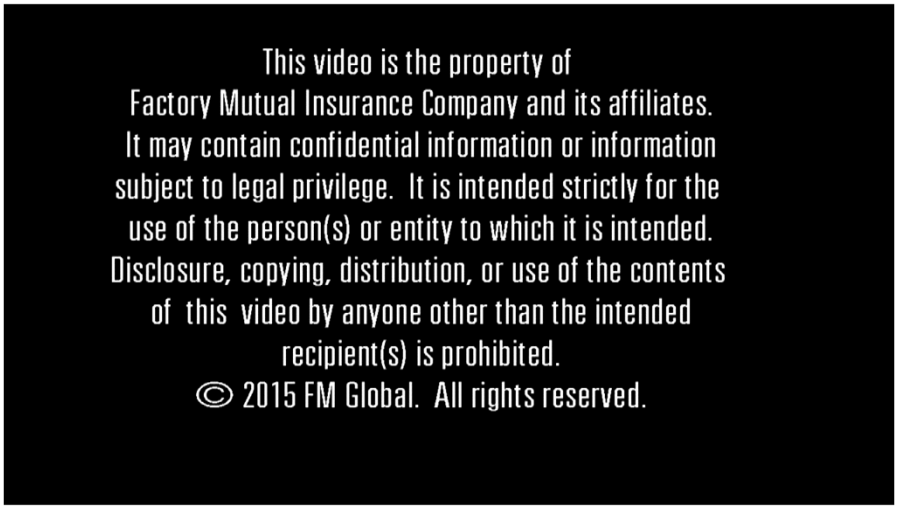


- Cavity formed between the PV panel and roof enhances flame heating effect.
- Roof cover, PV panel, and other components can contribute fuel.
- Gap height, panel slope, and panel orientation are important aspects.
- Wind can facilitate fire spread.
- Adding PV panels greatly changes the fire dynamics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

16

Metal roof system

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



17

PVC roof cover system

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

18

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.

19

Current Standard External Roof Fire Tests

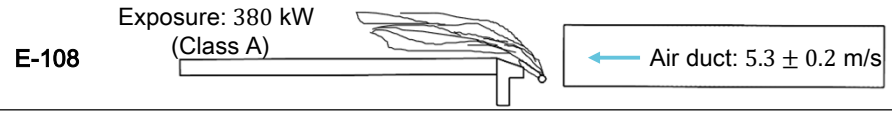
- ASTM E108/UL 790 and similar
- CEN/TS 1187 T1-T4

- 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

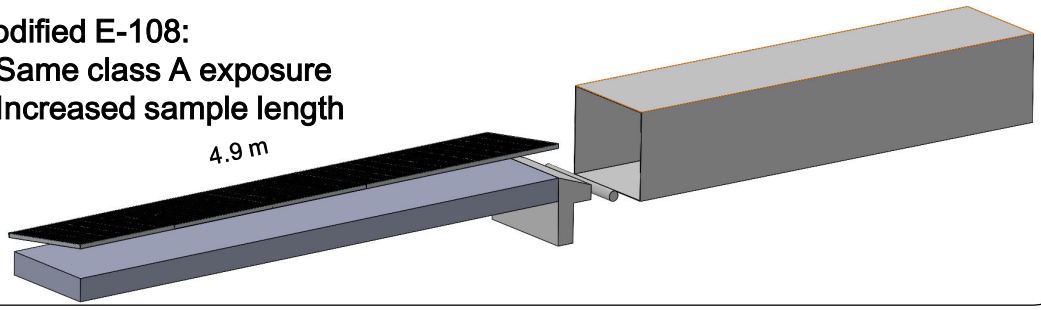
20

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



21

FM 4478 Examination Standard

FM Approvals
Member of the FM Global Group

Examination Standard
for
Roof-Mounted Rigid
Photovoltaic Module Systems

Class Number 4478

22

FM Approval

Fire

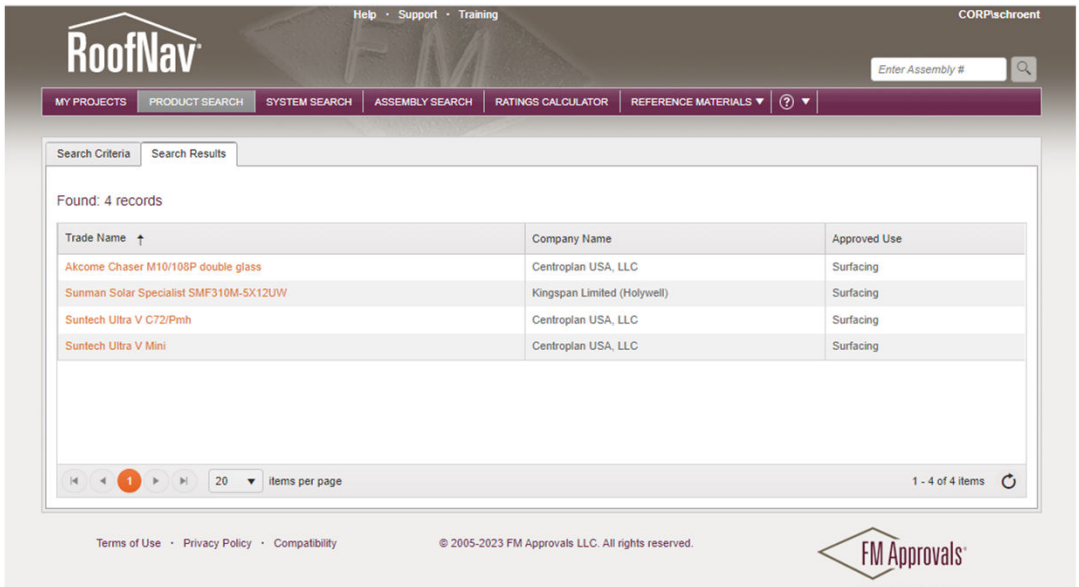
Hail

Wind

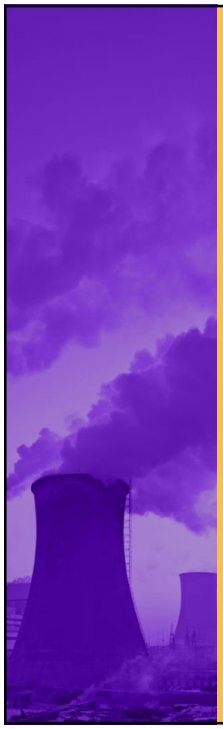
A roof mounted PV panel fire in NJ, USA in 2022 started due to panels moving due to wind, causing an electrical arc in the wiring.

23

FM Approval



24



Fire Hazards in detail

Risk based approach:
Fire loss exposures and scenarios

25

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 polystryene (EPS) insulation
- Combustible multi-ply roof cover
- Plastic-backed PV panels

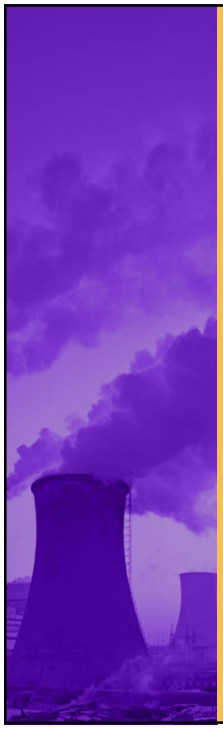
➡ Potential total loss of the facility

26

Summary

- Our aim is to support our client's green initatives.
- 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.

27



Thank you. Any questions?

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28

29

RESILIENCE IS A CHOICE.

30