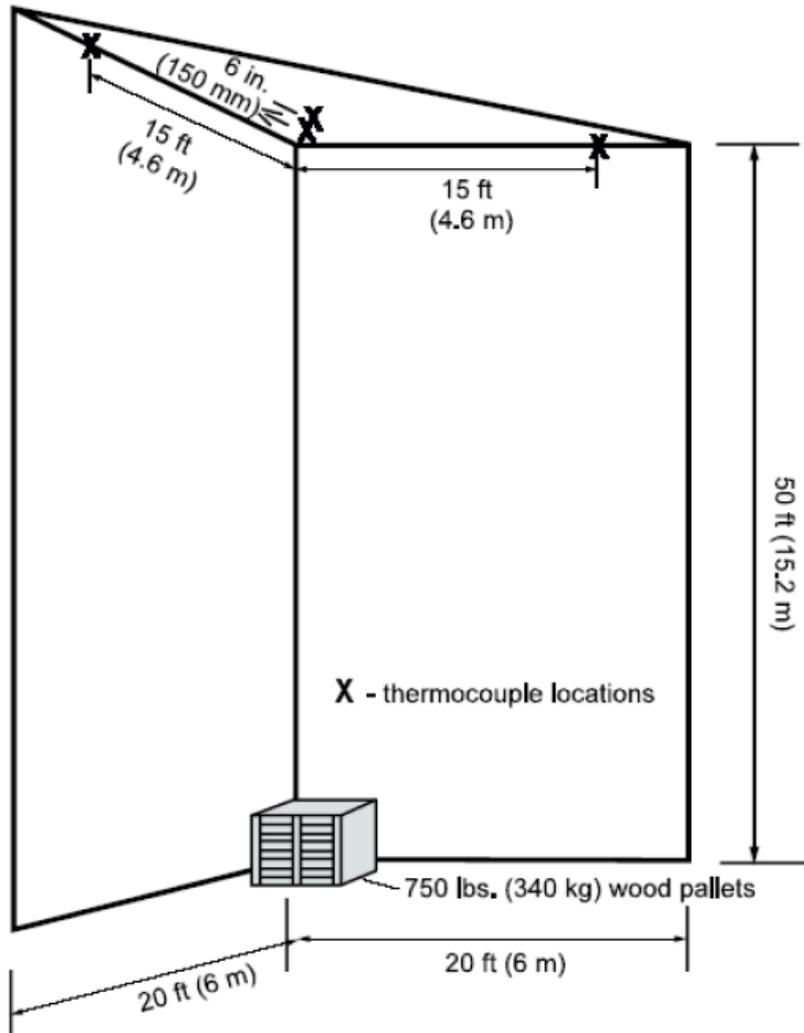


The Impact of Radiative Heat Flux from Building Fires on Insurer Certified PIR sandwich panels.



Mostyn Bullock BEng CEng FIFireE

What does insurer-approved mean?

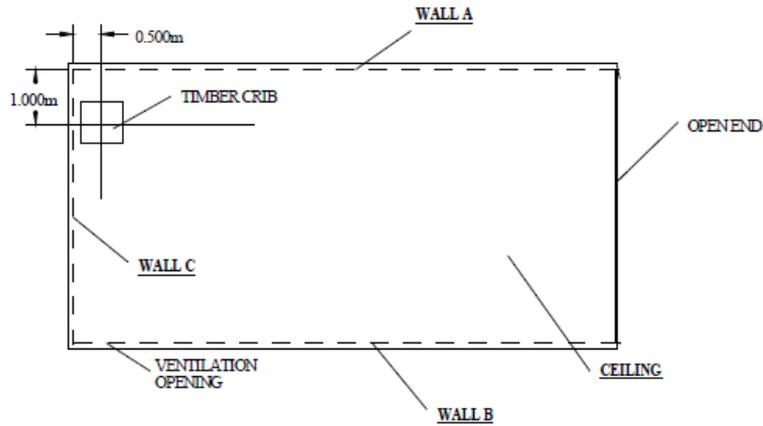
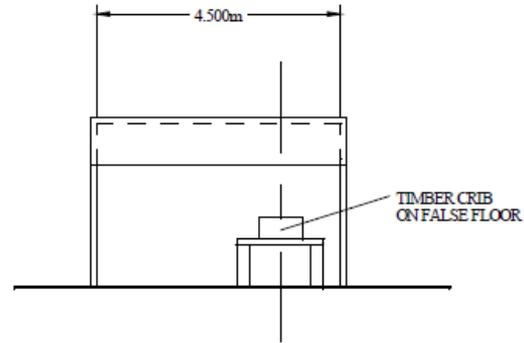
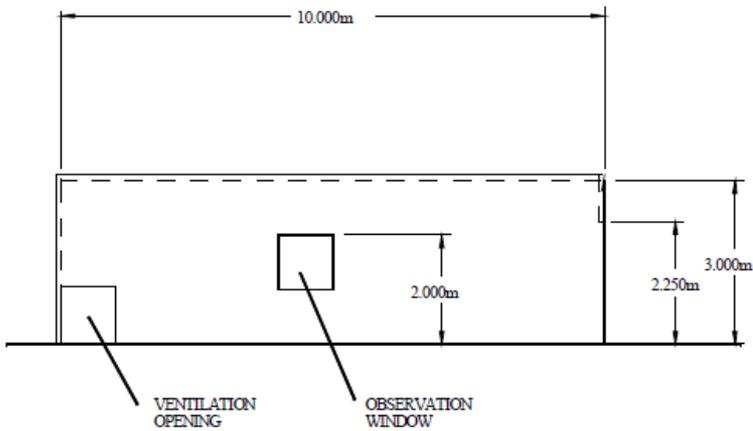


FM4880



tenos

LPS1181



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Investigation of performance in real fires

- Kingspan PIR panels
 - Kingspan polyisocyanurate (PIR) foam
 - Certified to FM 4880 and/or LPS 1181
 - The PIR foam is manufactured using a proprietary formulation of polyester polyol, methylene diphenyl diisocyanurate and specialised catalysts
- Over the course of the last 10 years a number of fires have occurred in buildings with Kingspan's PIR cored panels
- Tenos has worked with Kingspan is assessing the performance of the PIR panels in these fires.

External fires with (predominantly)
radiative heat transfer...

Spider Transport, Ireland - 2008



Spider Transport, Ireland - 2008

25 minute exposure 60-100kW/m²
Significant charring of PIR core



Spider Transport, Ireland - 2008



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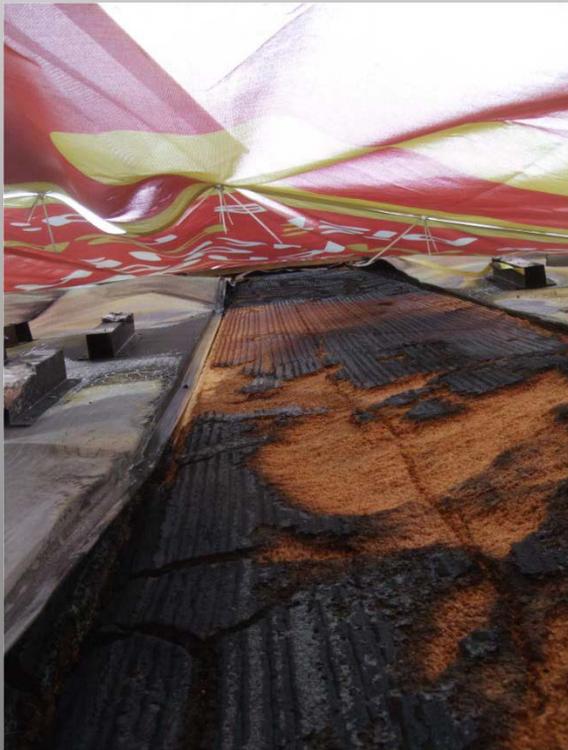
Furniture Store Slovakia - 2012



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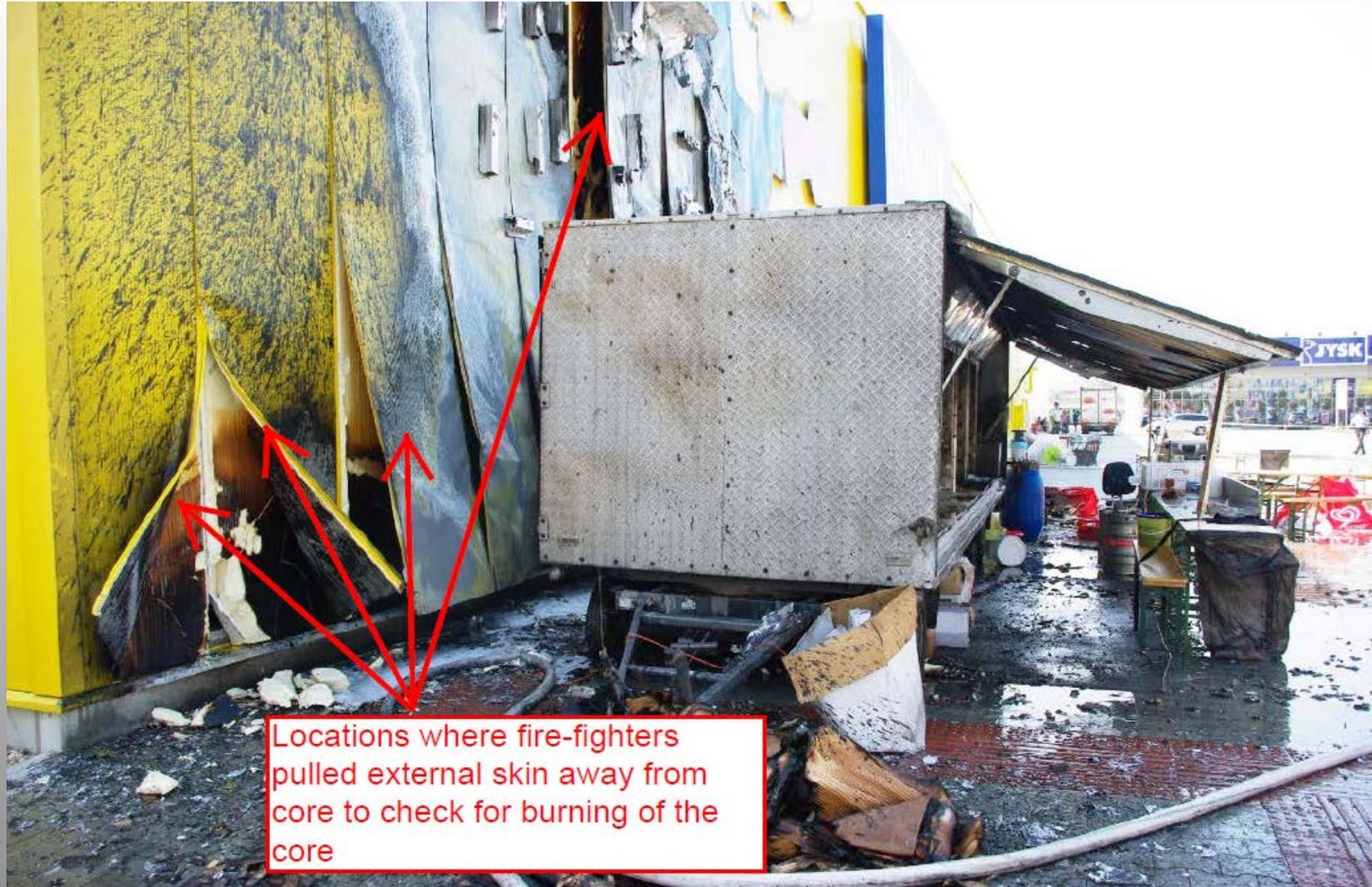
Furniture Store Slovakia - 2012

10 minute exposure 60-100kW/m²
Charring of PIR core to 10mm depth



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Furniture Store Slovakia - 2012



Locations where fire-fighters pulled external skin away from core to check for burning of the core

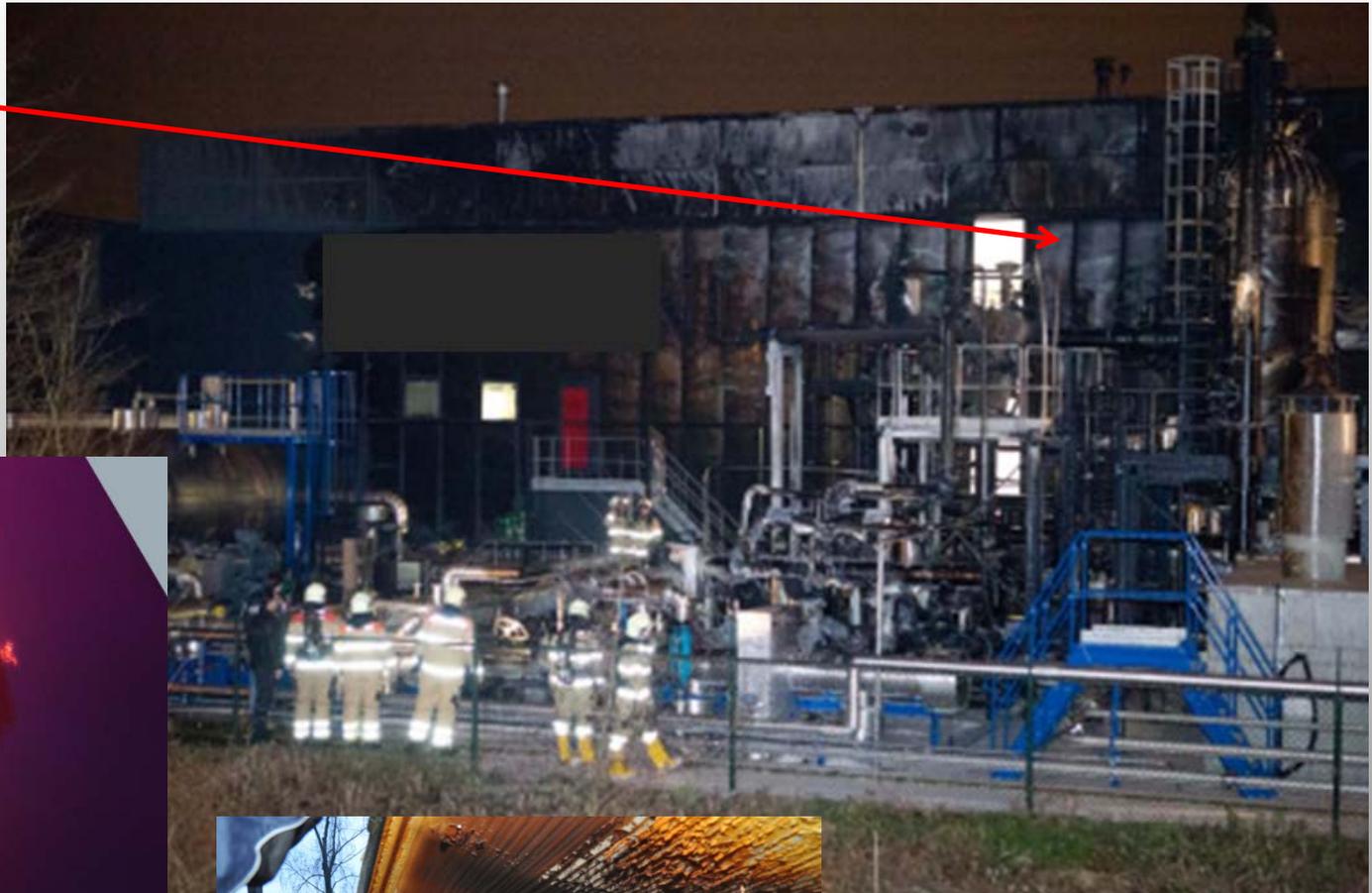
Furniture Store Slovakia - 2012



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Oil facility, Netherlands - 2013

8 minute exposure
24kW/m²
Surface charring of
PIR core



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Oil facility, Netherlands - 2013



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Oil facility, Netherlands - 2013



Oil facility, Netherlands - 2013

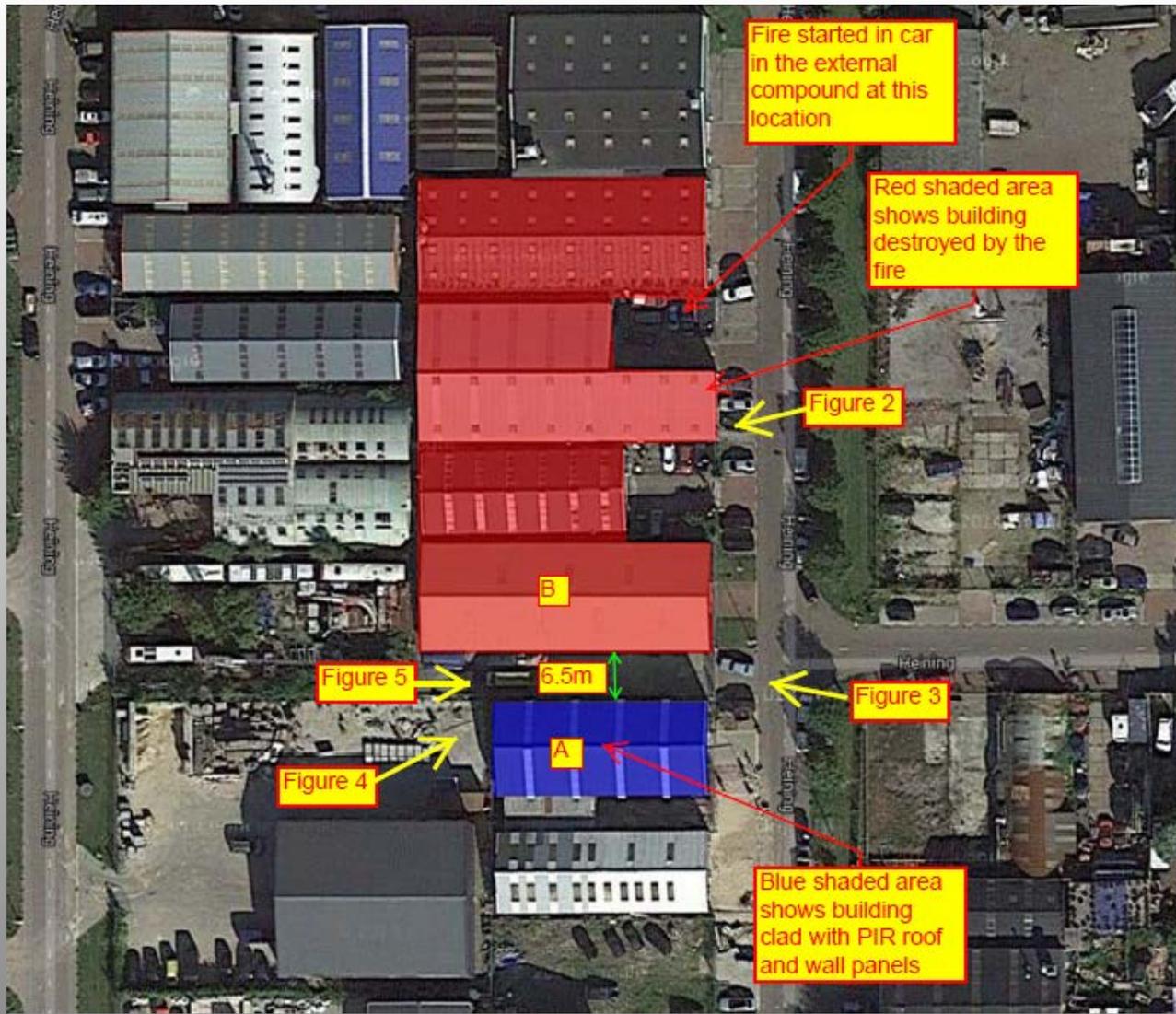


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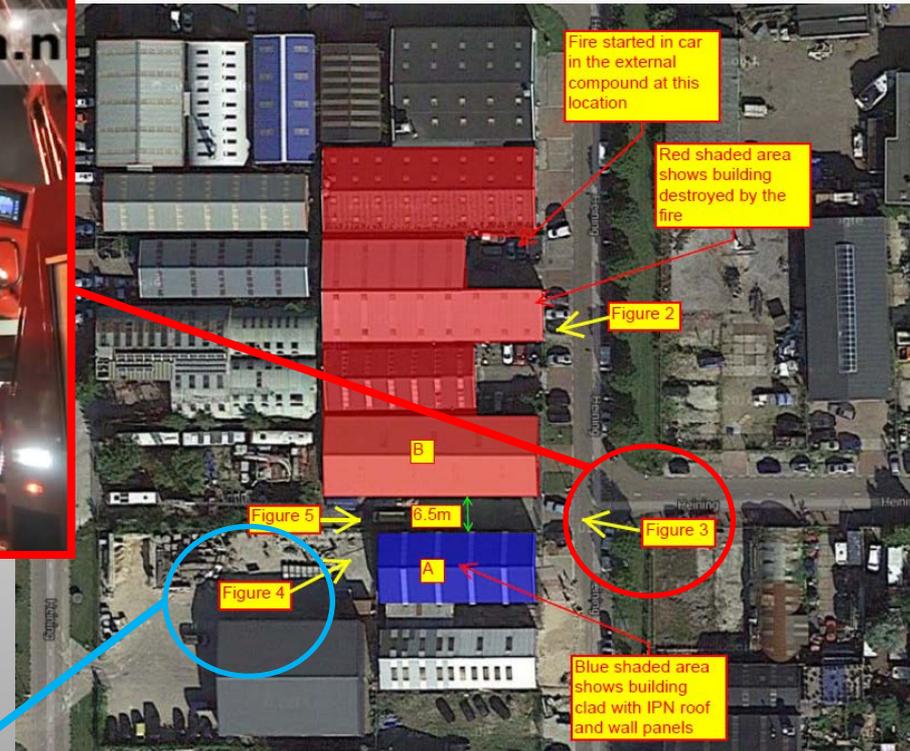


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Heining, Netherlands - 2013



Heining, Netherlands - 2013



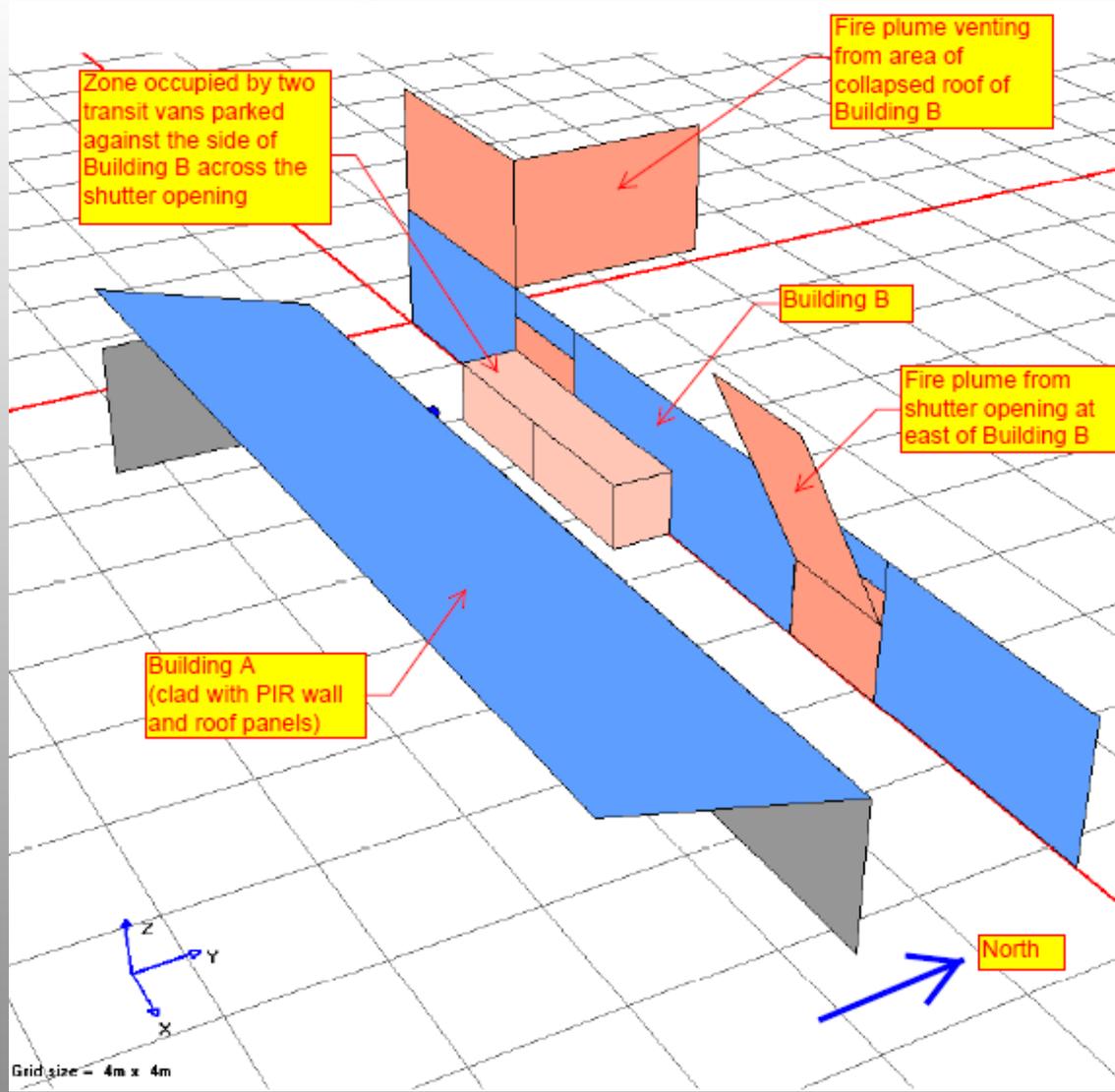
Heining, Netherlands - 2013



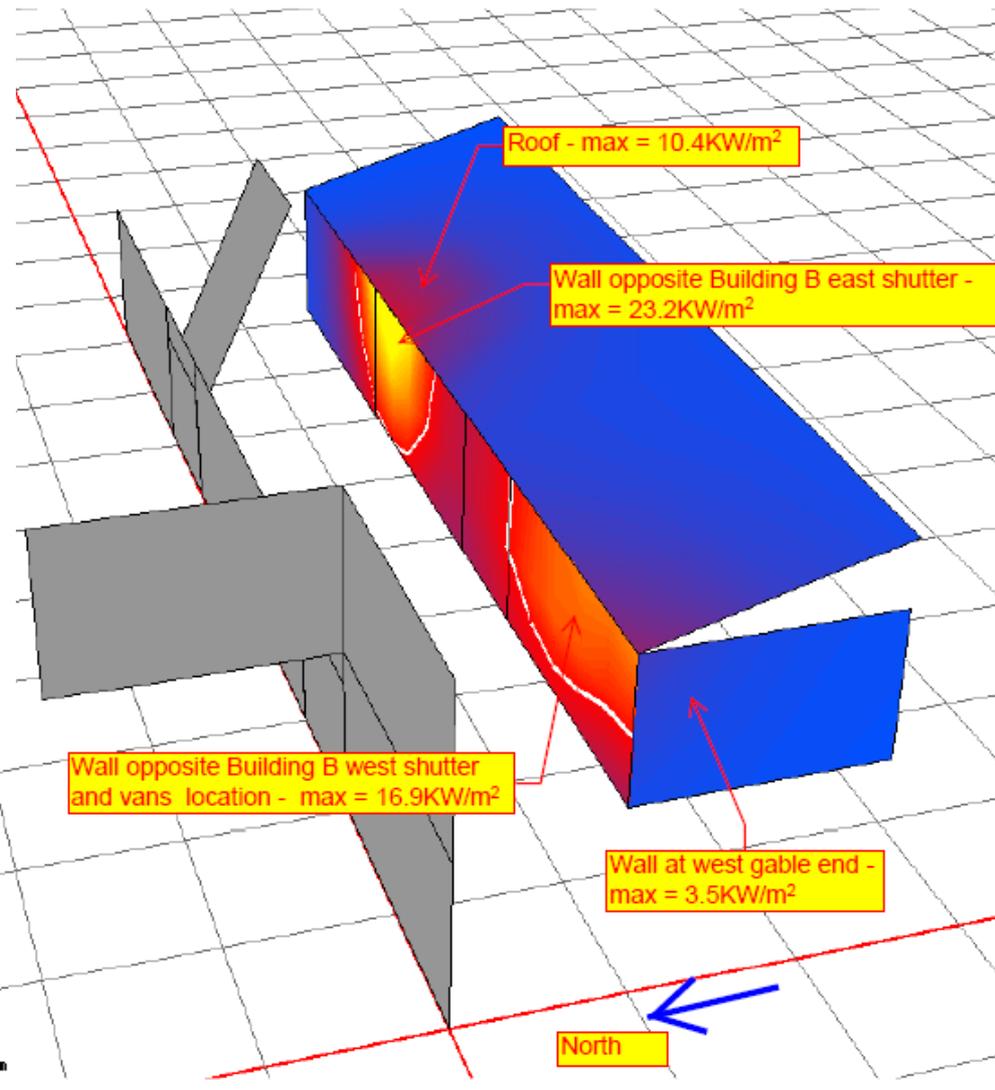
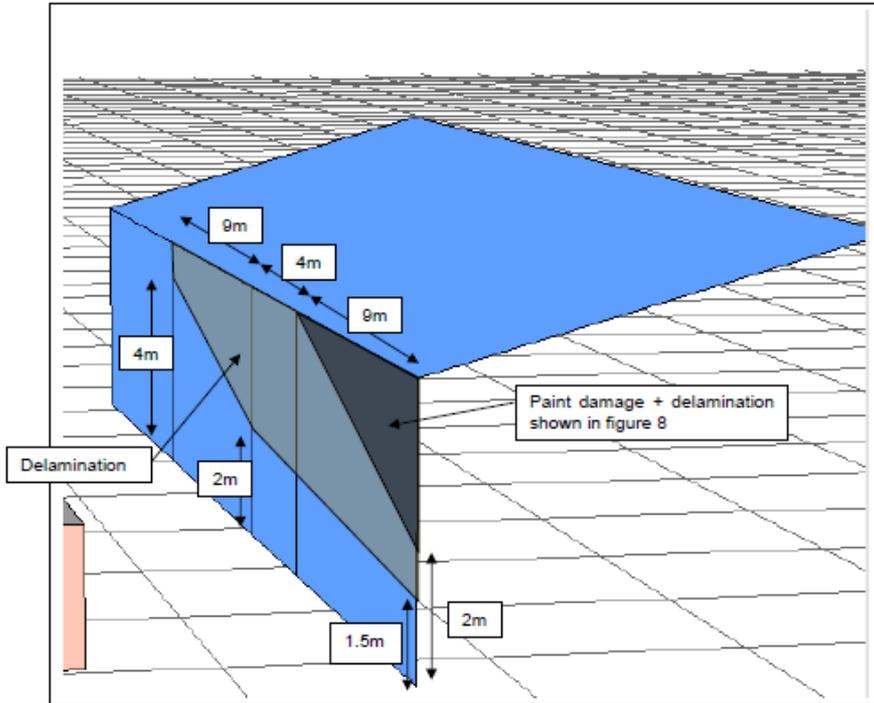
Wind direction



Heining, Netherlands - 2013



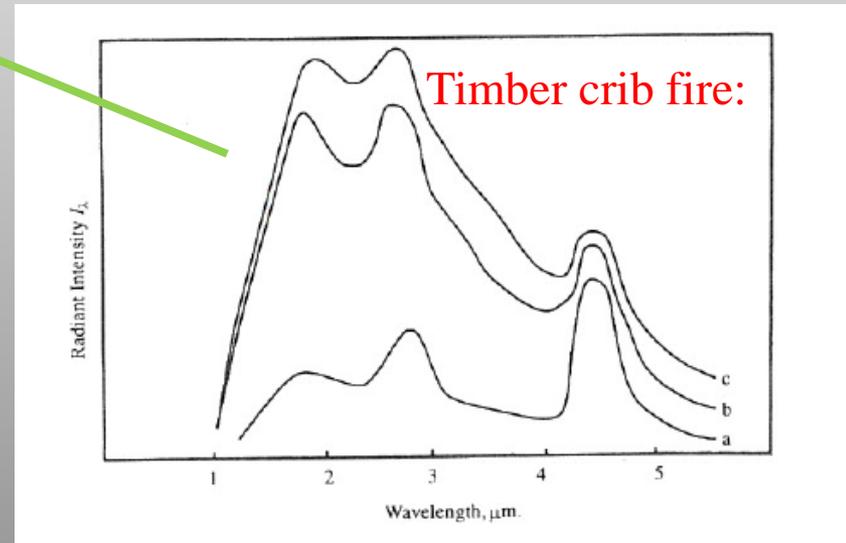
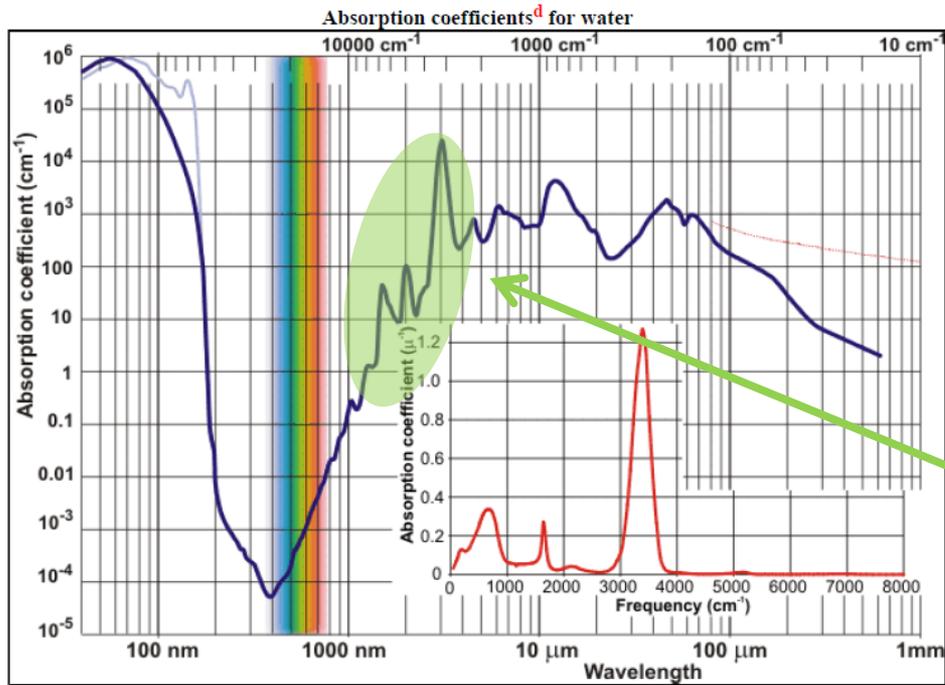
Heining, Netherlands - 2013



Heining, Netherlands - 2013



Heining, Netherlands - 2013



Heining, Netherlands - 2013



Assume water film spread evenly over wall surface = 0.0143cm/sec applied

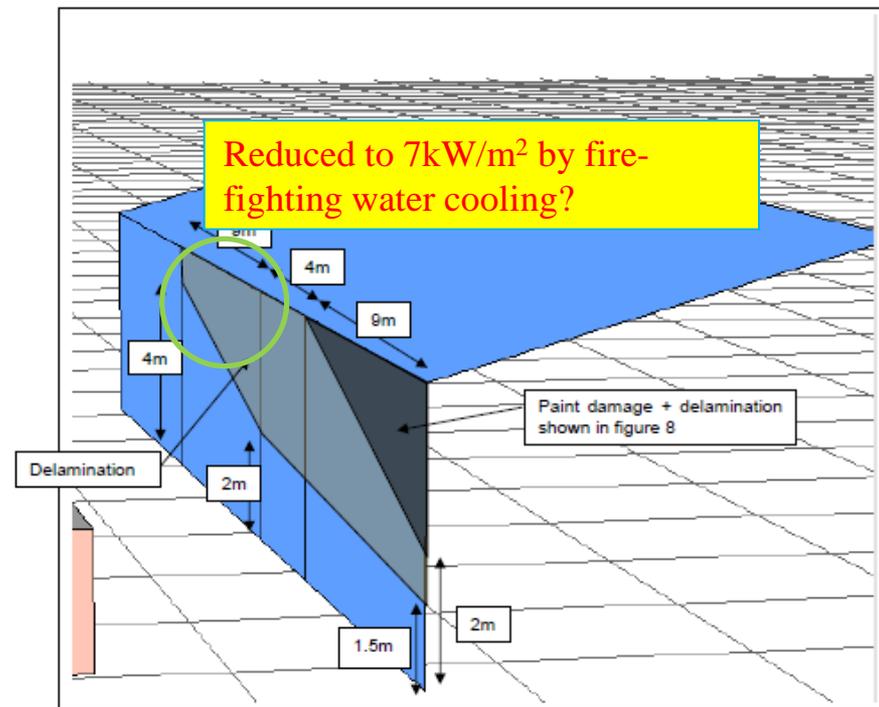
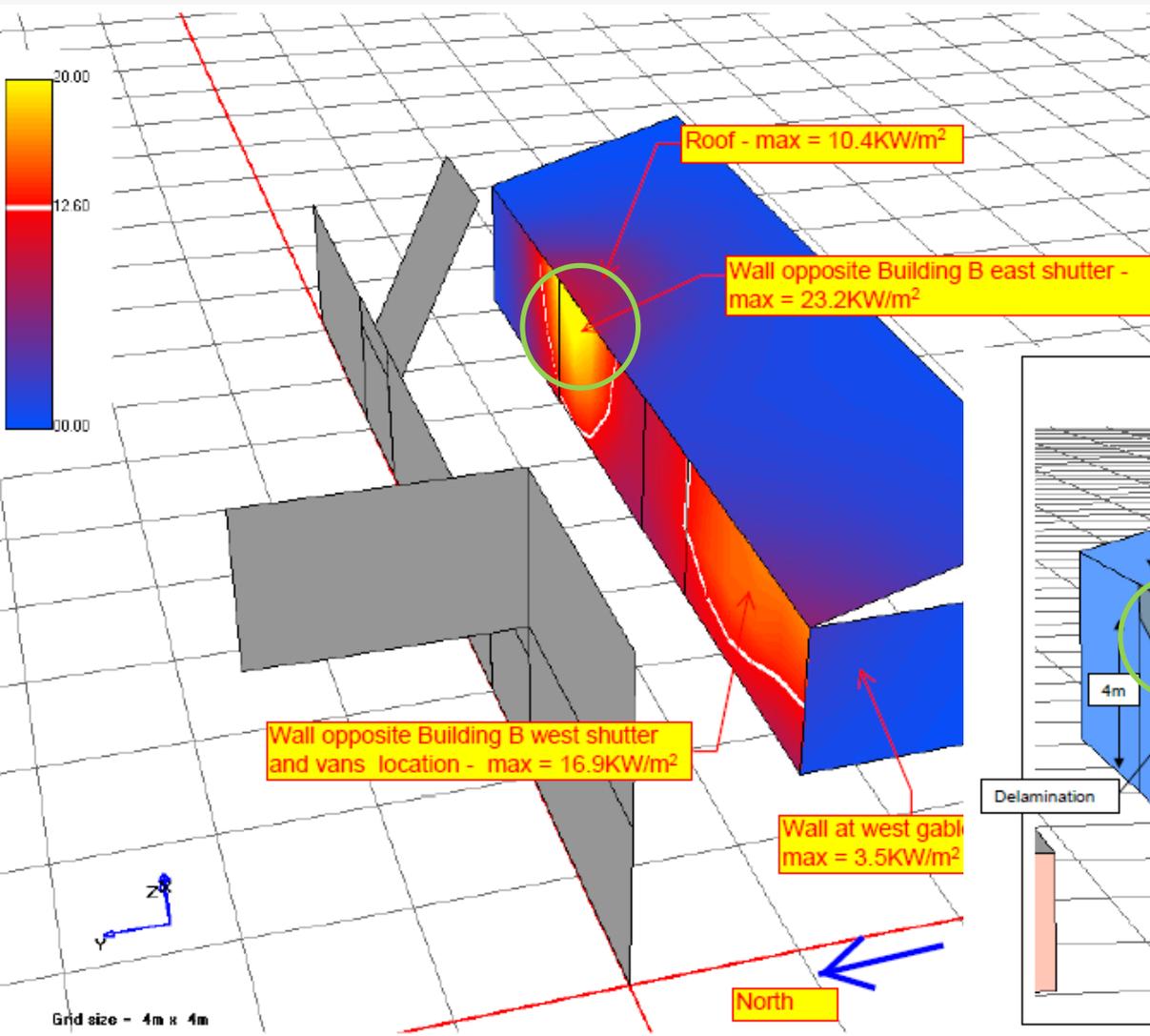
Wavelength	Relative % of R _e	Incident heat flux at this wavelength range, kW/m ²	Absorption coefficient, cm ⁻¹	Residual Heat Flux at water/surface interface, kW/m ²
1-2µm	25.2	5.85	1	5.07
2-3 µm	34.7	8.05	100	1.93
3-5 µm	40.1	9.30	1000	5.7 x 10 ⁻⁶
TOTAL Incident Heat Flux		23.2	TOTAL Residual Heat Flux 7.0	

Based on 4.5m wall height the flow time from top of wall to ground = 1 second (approx).

In this 1 second the water film absorbs:
 $23.2 - 7.0 = 16.2\text{KJ/m}^2$

Based on specific heat capacity of water:
 Temp rise = 27°C

Heining, Netherlands - 2013

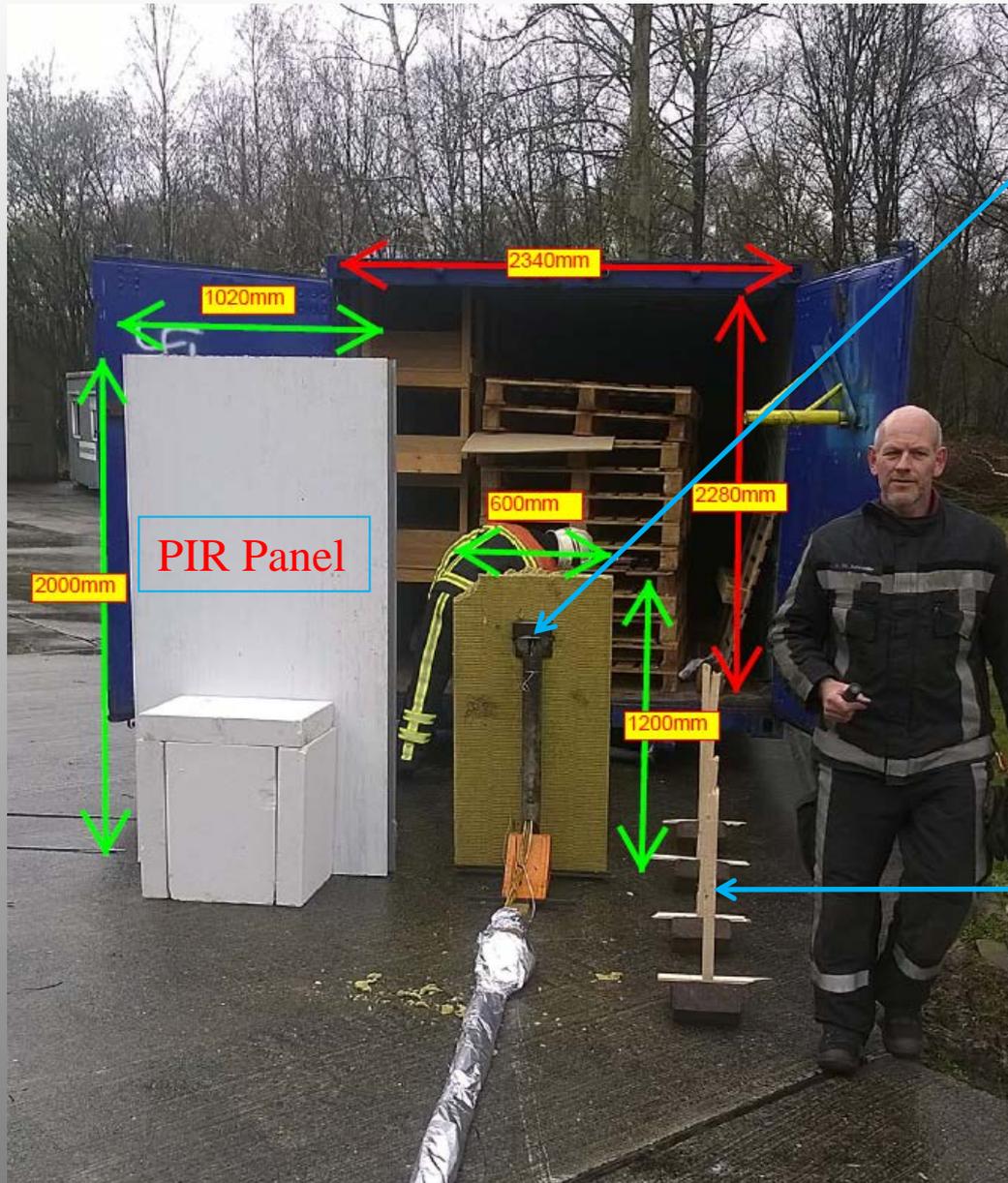


Heining, Netherlands - 2013



15 minute exposure ?
17kW/m² ?
Charring of PIR core?
(yet to be dismantled & inspected)

Troned – March 2014



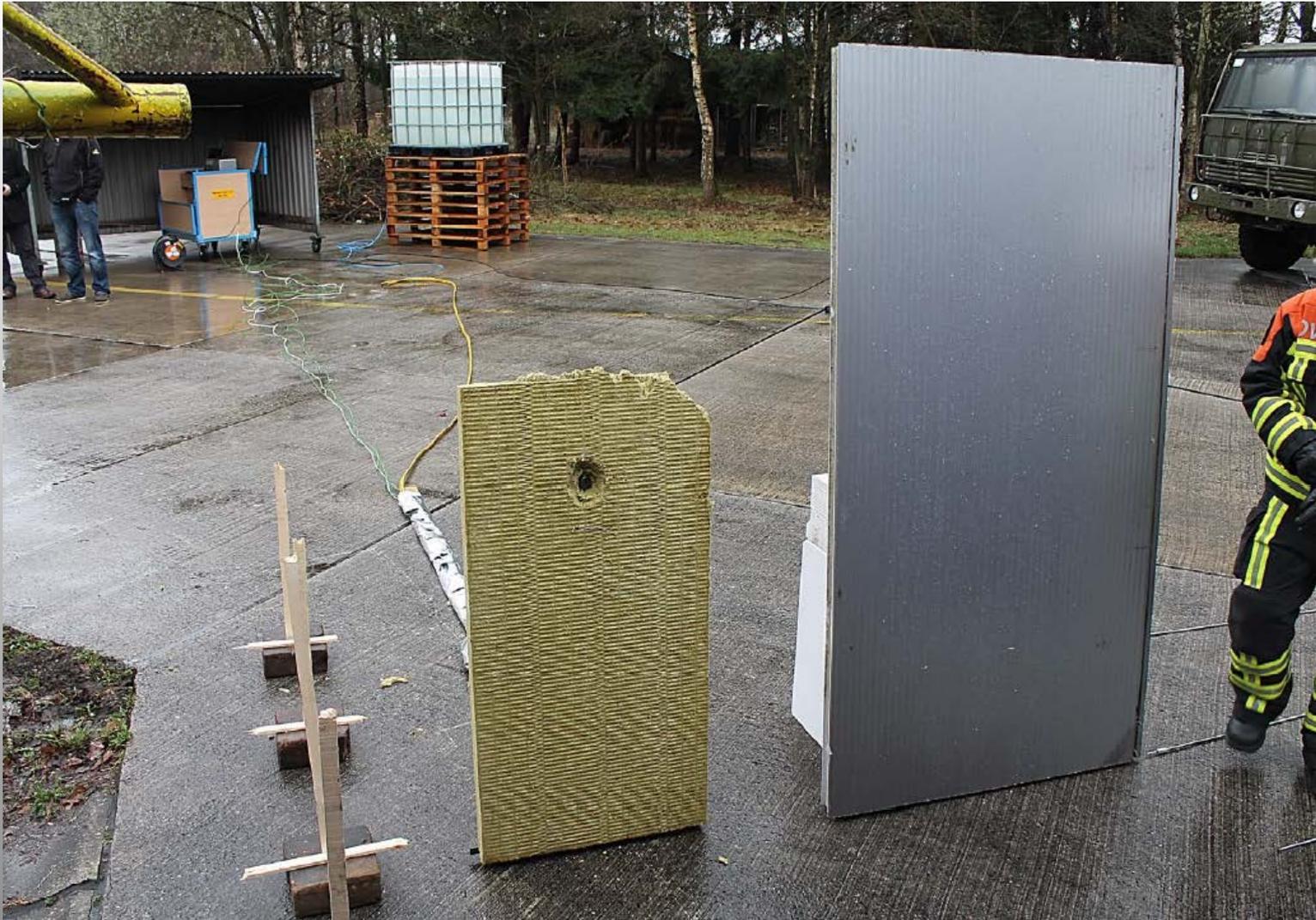
Radiometer
(Total Heat Flux type)

PIR Panel

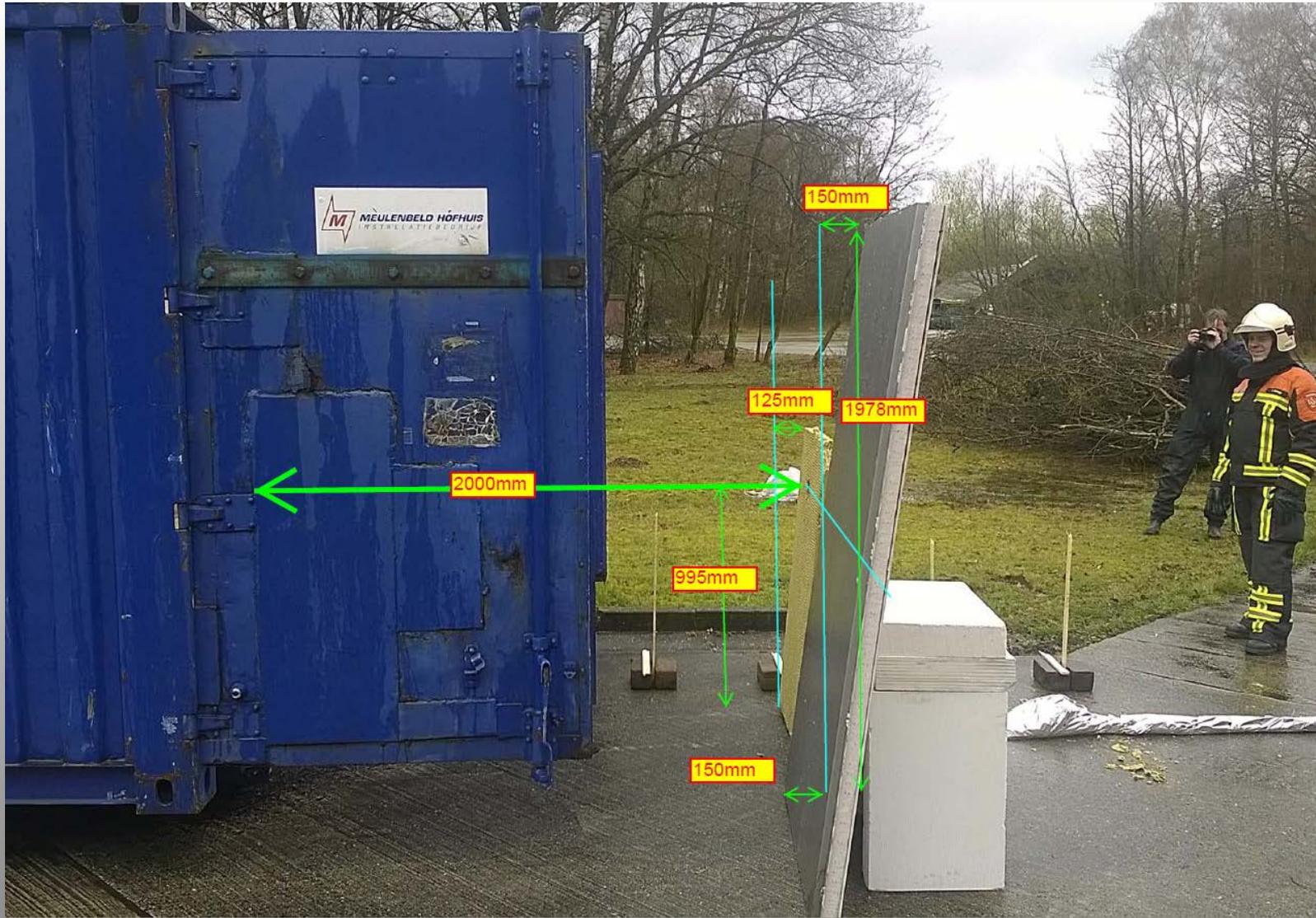
Timber stick targets

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Troned – March 2014



Troned – March 2014

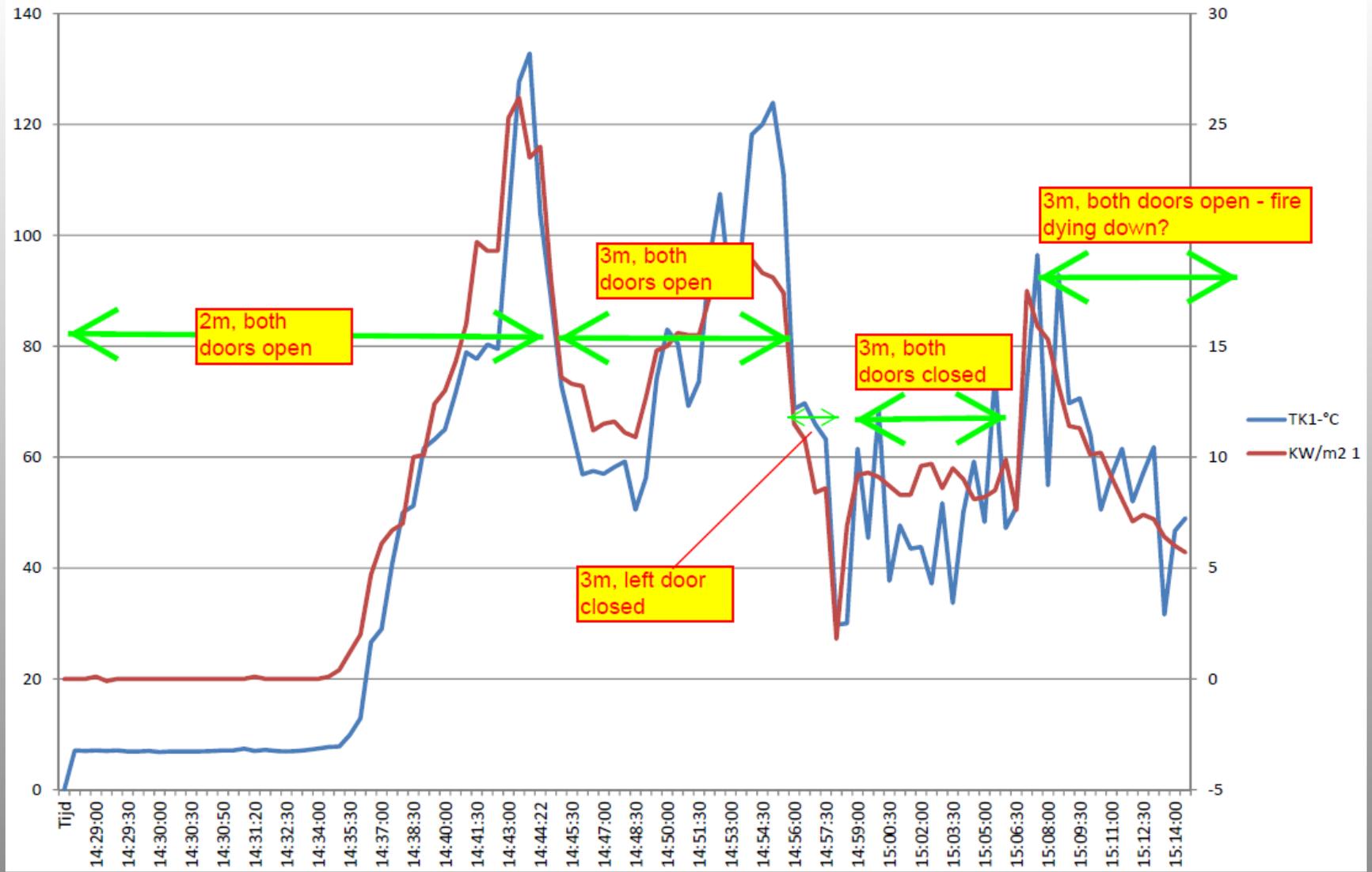


Troned – March 2014



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Troned – March 2014



Troned – March 2014



Plume:

Emissivity = 0.423

Heat Flux emitted = 34.5kW/m²

Opening:

Emissivity = 1.0

Heat Flux emitted = 84kW/m²

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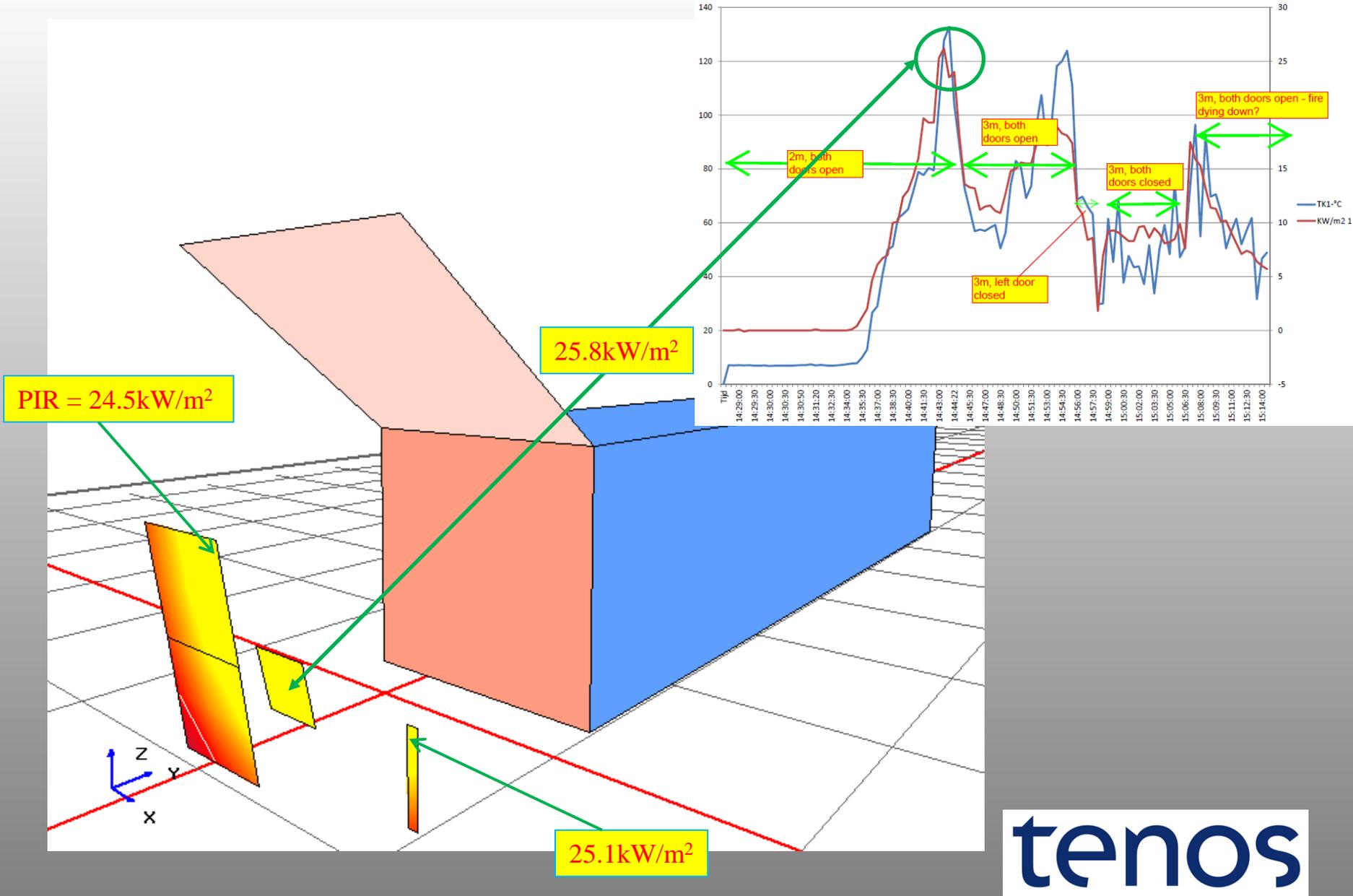
Troned – March 2014

Incident Heat Flux
on PIR Panel?

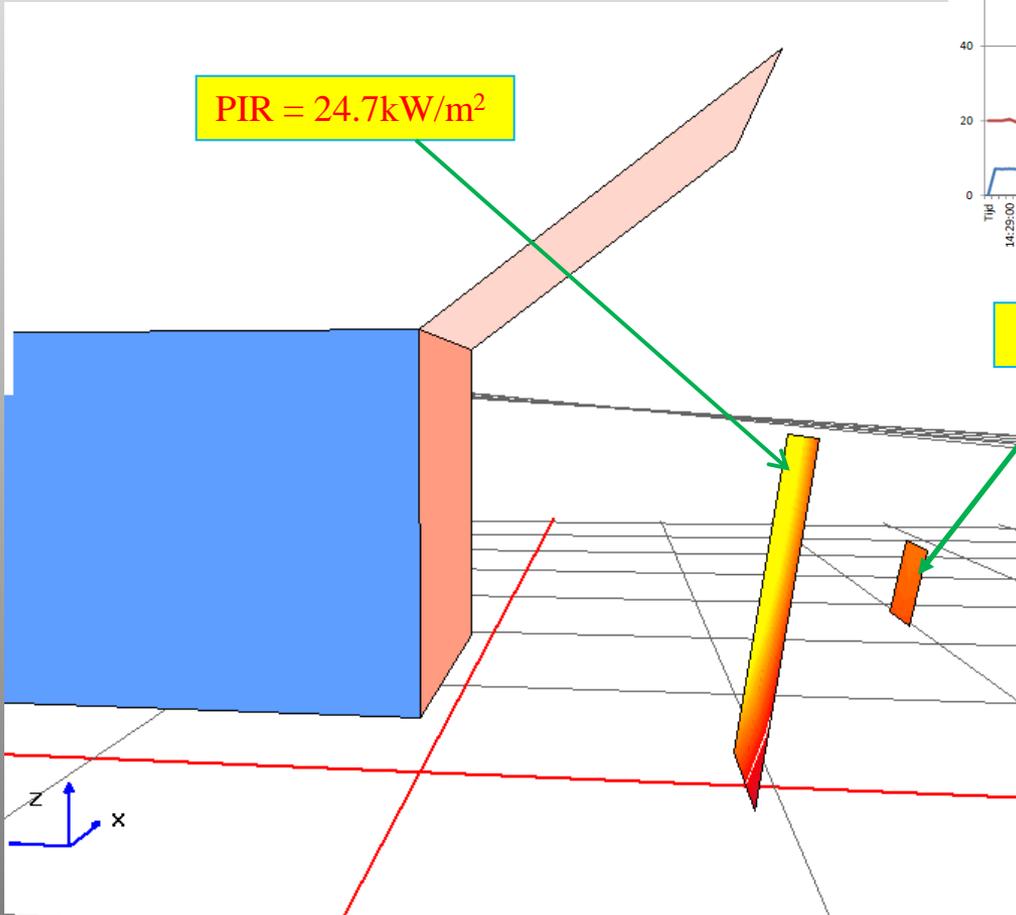
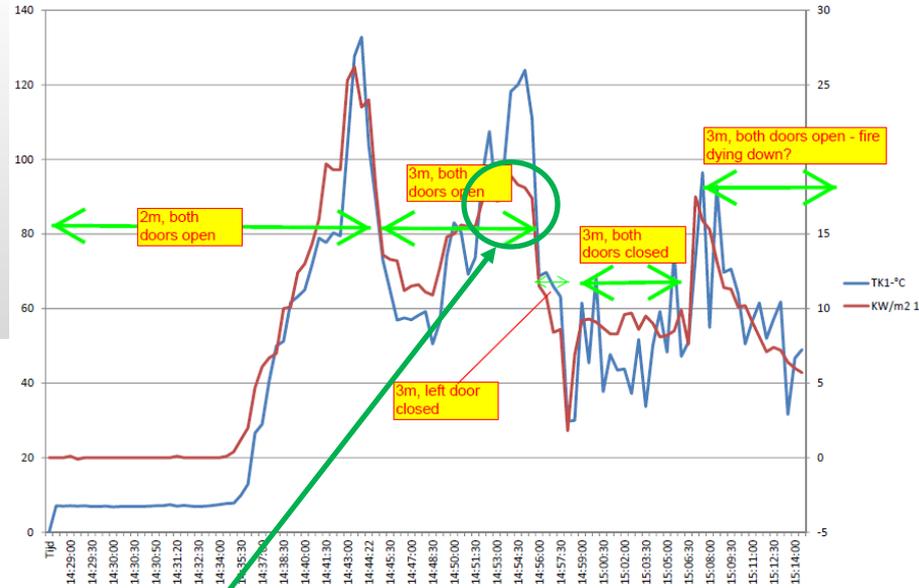


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Troned – March 2014

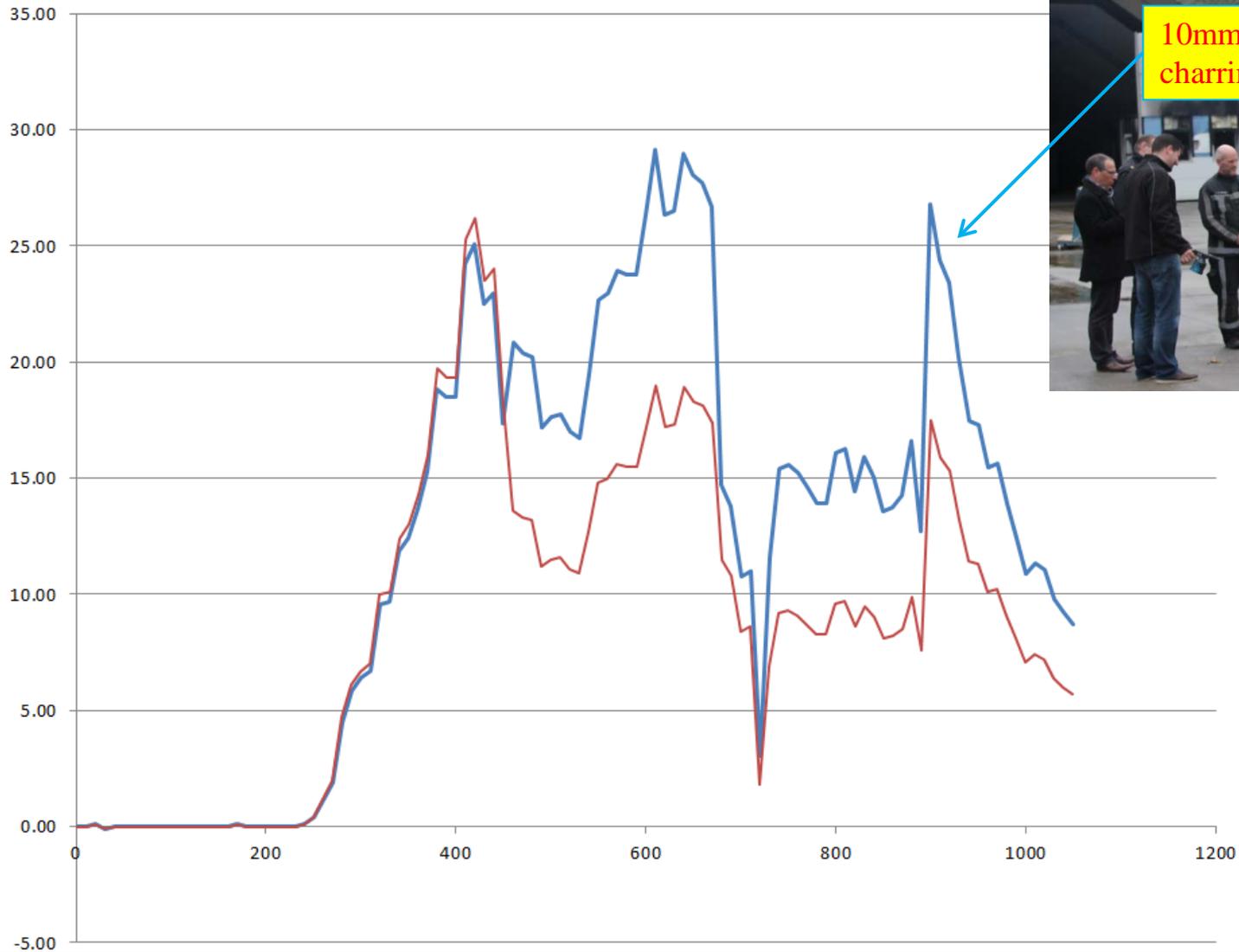


Troned – March 2014



kW/m²

Troned – March 2014



— PIR Panel heat flux
— Radiometer heat flux