

The results from the Swedish METRO project on fire safety in underground rail mass transport systems



SP Technical Research Institute of Sweden

Haukur Ingason ITA-COSUF workshop Berlin 5 June 2014



The METRO project 2010-2012

WP1: Design fires (SP)

WP2: Evacuation (LTH)

WP3: Integrated fire control (SL)

WP4: Smoke control (MDH)

WP5: Extraordinary strain on constructions (FOI)

WP6: Rescue operations (MDH)



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Storstockholms
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WP1 + WP5 Large scale tests

- Test 1: Fire under the wagon
- **Test 2: Fire in an X1**
- **Test 3: Fire in a refurbished X1**
- Test 4: Explosion in an X1



Photo: Anders Lönnermark

Test 1



Test 3

Photo: Johan Lindström

Test 4



Photo: FOI



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WP1 - Fire load in the test trains

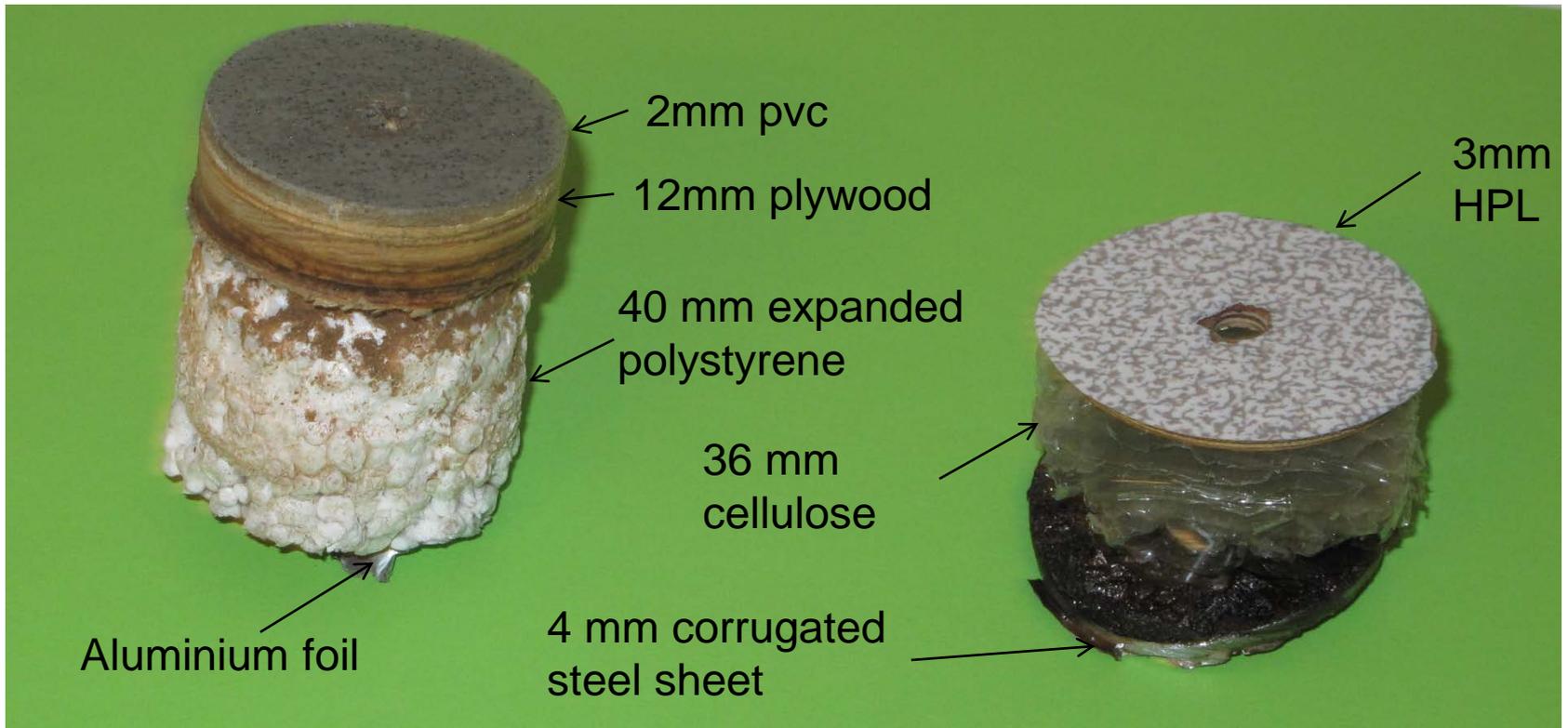
Original X1



Refurbished X1 – C10 seat and interior lining



WP1 – Material in the floor and walls for X1



Floor

Wall

WP1 - Ignition and initial fire development



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Films: Jari Antinlouma



WP1 - Flashover



WP1 - Backlayering



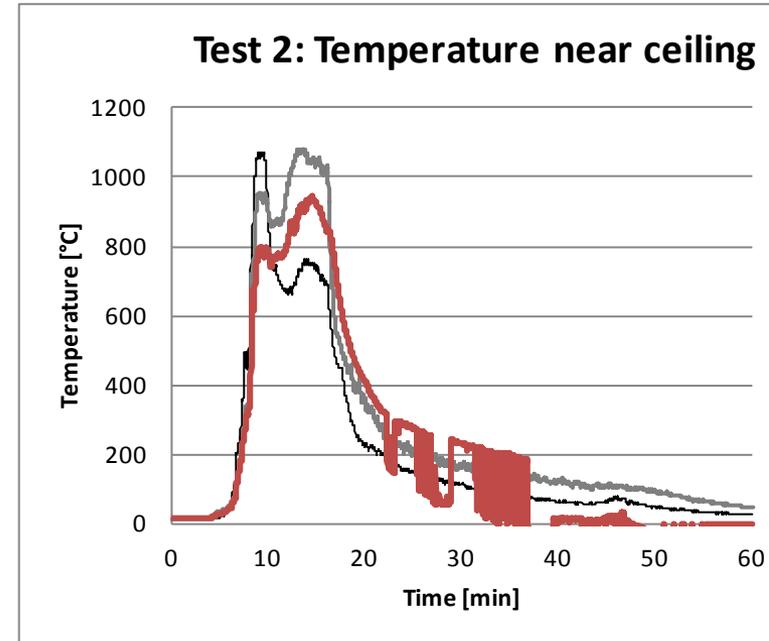
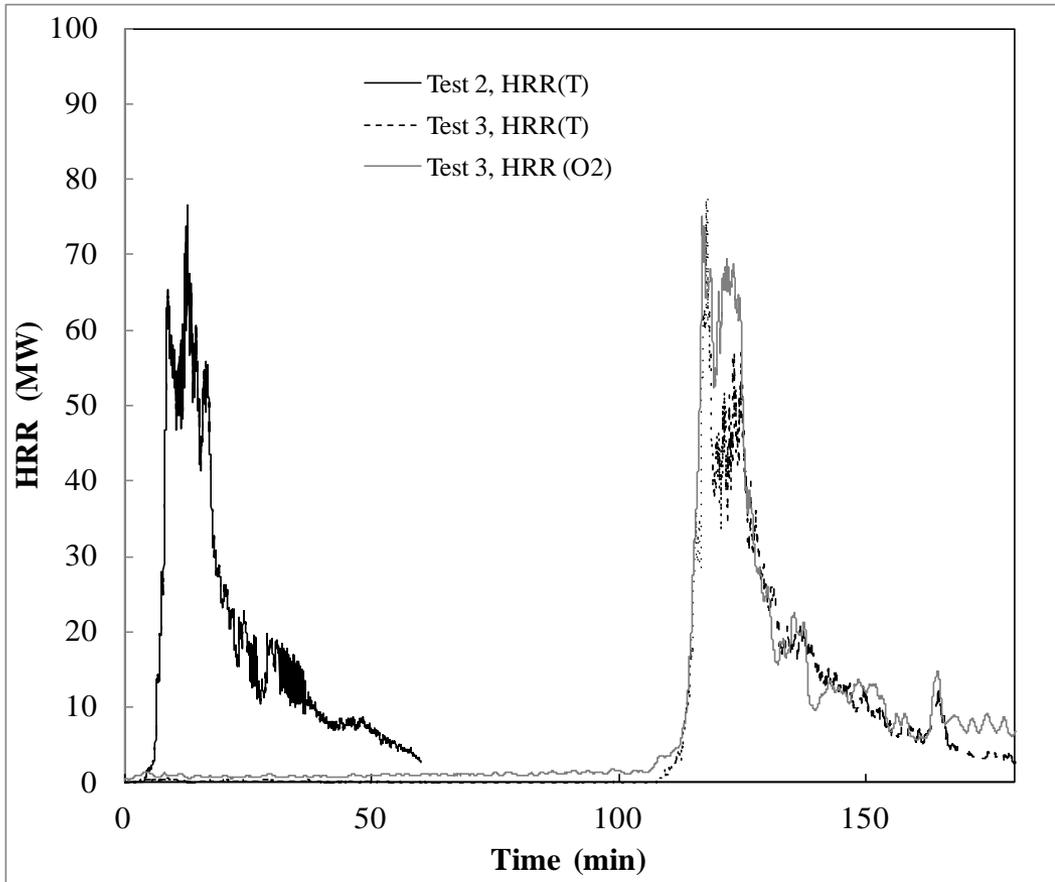
WP1 - Pulsations



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WP1 - Heat release rate and ceiling temperature



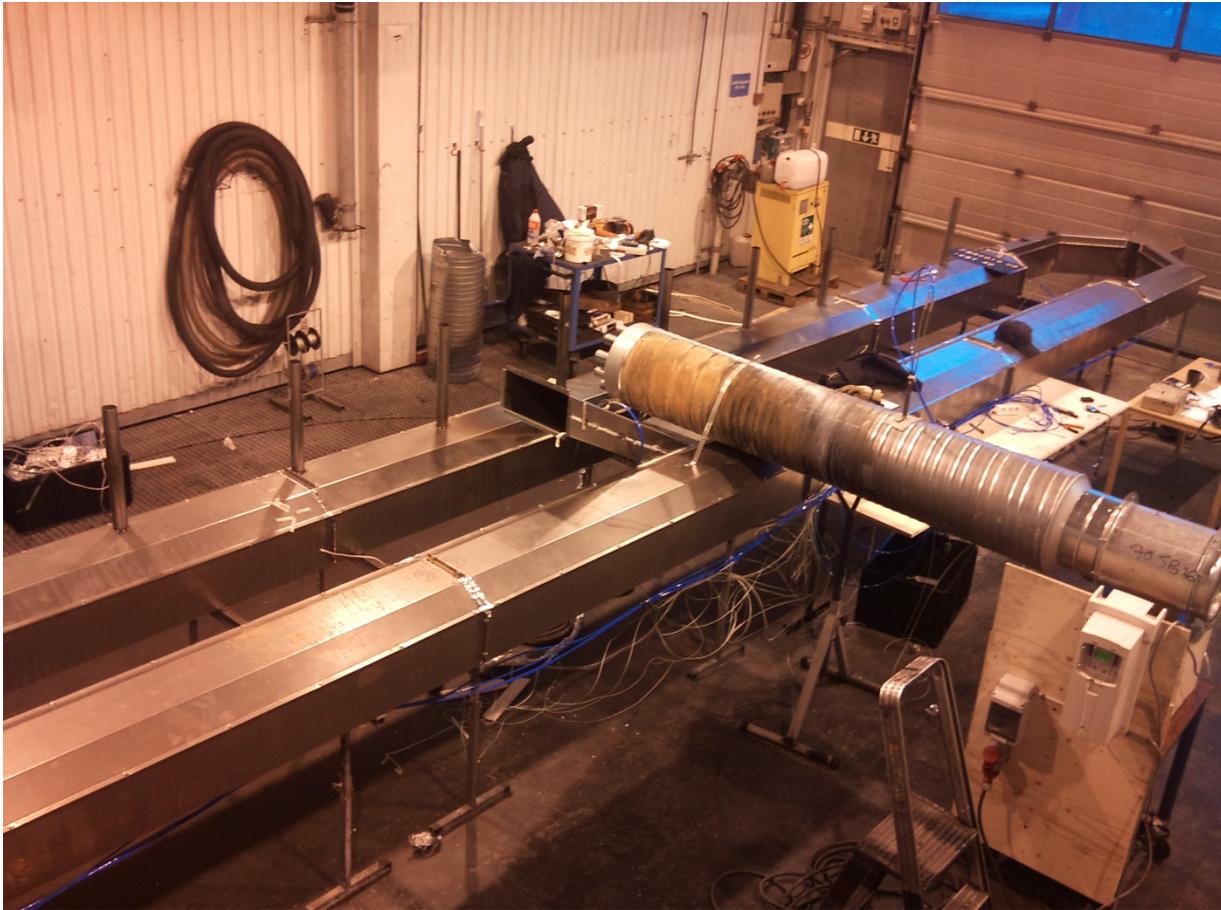
Recommendations WP1

- A Fast fire up to 60 MW (worst case arson scenario) for ventilation system at metro stations.
- A Fast fire up to 20 MW with interior lining material, seats and windows proven to be of high fire resistance quality.
- A Medium fire up to 20 MW for a tunnel system connected to a metro station.
- A time temperature curve using the European TSD curve in 2008/57/EG, alternatively a method presented by Li and Ingason (2012).



WP4 Smoke control

- Model scale test



WP4 Smoke control

- Results
 - supply air system
 - 20 MW: 20-40 m³/s
 - 60 MW: 40-80 m³/s
 - exhaust air system
 - 20 MW: 75-100 m³/s
 - 60 MW: 180 m³/s



WP4 Recommendations

- A positive-pressure supply air system or a mechanical exhaust system is recommended as a smoke control solution for single exit metro stations.
- Platform screen doors are recommended in one- tube underground stations as a part of a technical fire safety solution.



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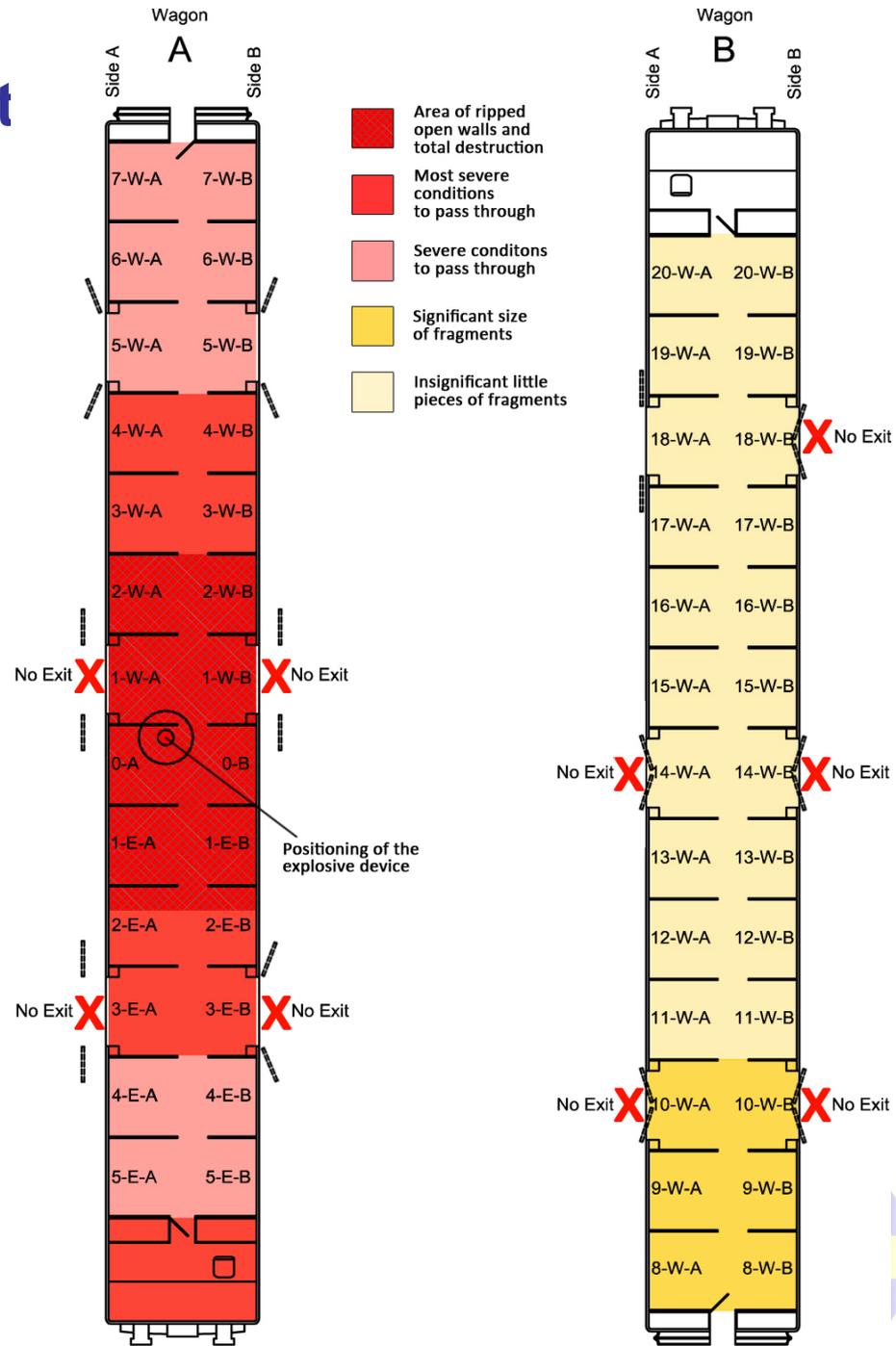
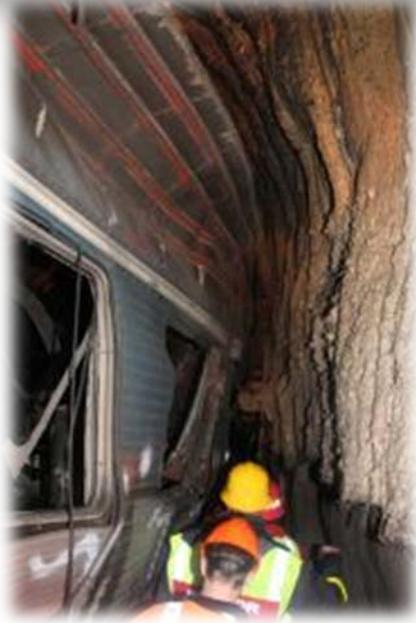
WP5 – Large scale explosion test



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WP5 - Post test document



WP5 - Full-Scale Test

Measurement Values

Gauge:	A1	A2	A3	B4	O5	O6	O7
p:	550	200	170*	11	32	32	34
i_p :	940	590	800	780	550	480	450
i_t :	940	1260	1500	780	1100	960	1000

p = peak-pressure (kPa),

i_p = first impulse plateau (Pas)

i_t = total impulse density (Pas)

*Gauge A3 is recording the reflected pressure and therefore supposed to be greater in value.



Recommendations WP5

- First responders needs to be aware and trained for the extreme environment after an explosion in a underground train carriage.
- The problem with doors that were jammed shut after explosion should be further investigated and solved.
- It should be further investigated how the interior design of train coaches can be improved to reduce casualties in case of an explosion.



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Thank you !

- www.metroproject.se
Go to webpage for publications

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