The results from the Swedish METRO project on fire safety in underground rail mass transport systems
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)
WP1 + WP5 Large scale tests

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

Test 1

Test 3

Test 4

Photo: FOI

Photo: Anders Lönnermark

Photo: Johan Lindström
WP1 - Fire load in the test trains

Original X1

Refurbished X1 – C10 seat and interior lining

Photo: Per Rohlén
WP1 – Material in the floor and walls for X1

Floor
- 2mm pvc
- 12mm plywood
- 40 mm expanded polystyrene
- 36 mm cellulose
- 4 mm corrugated steel sheet
- Aluminium foil

Wall
- 3mm HPL
WP1 - Ignition and initial fire development

Films: Jari Antinlouma
WP1 - Flashover
WP1 - Backlayering
WP1 - Pulsations
WP1 - Heat release rate and ceiling temperature

![Graph showing heat release rate and temperature over time for Test 2 and Test 3.](image)

- **Test 2, HRR(T)**
- **Test 3, HRR(T)**
- **Test 3, HRR (O2)**

**Test 2: Temperature near ceiling**

0 10 20 30 40 50 60 70 80 90 100 110 120

0 200 400 600 800 1000 1200

0 10 20 30 40 50 60

0 200 400 600 800 1000 1200

SP Technical Research Institute of Sweden
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.
WP5 – Large scale explosion test
WP5 - Post test document

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WP5 - Full-Scale Test

Measurement Values

<table>
<thead>
<tr>
<th>Gauge:</th>
<th>A1</th>
<th>A2</th>
<th>A3</th>
<th>B4</th>
<th>O5</th>
<th>O6</th>
<th>O7</th>
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<tbody>
<tr>
<td>p:</td>
<td>550</td>
<td>200</td>
<td>170*</td>
<td>11</td>
<td>32</td>
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<td>34</td>
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<tr>
<td>(i_p):</td>
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<td>(i_t):</td>
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<td>1500</td>
<td>780</td>
<td>1100</td>
<td>960</td>
<td>1000</td>
</tr>
</tbody>
</table>

\(p\) = 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 need 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 causalities in case of an explosion.
Thank you!

- www.metroproject.se
  Go to webpage for publications

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