



Mitigating the Effects of Firebomb and Blast Attacks on Metro Systems.

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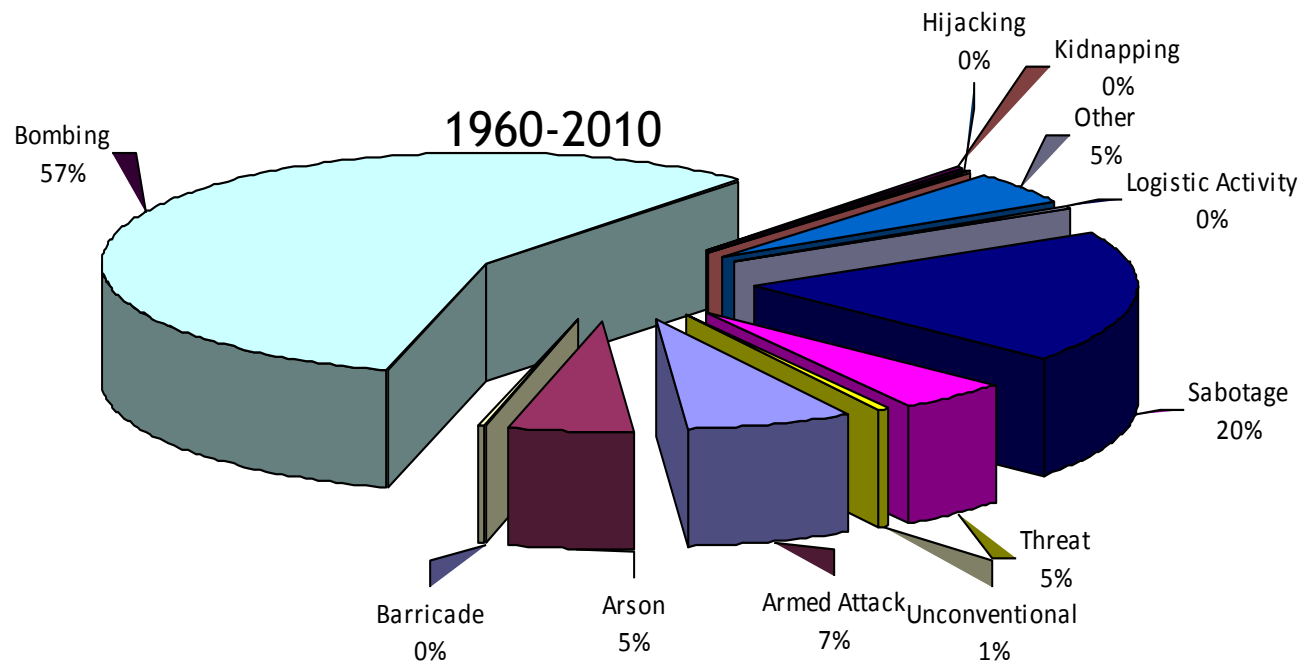
PROJECT AIMS

- ☐ To increase metro **vehicle resilience** to terrorist **bomb blast** through selection of vehicle **materials** and **structural design**.
- ☐ To **increase security** against a **firebomb attack** through design of **fire barriers** and fire **suppression technology**.
- ☐ To increase the **resilience** of vehicles to blasts in order to **speed up recovery** following attack to return to **normal operation**.
- ☐ To **reduce the attractiveness** of metro systems as a **target for attack** by reducing deaths and injuries and increased resilience.



THREATS

- ❑ Review of previous blast and incendiary attacks on metro systems.
- ❑ Analysis of potential future threats, risks and potential trends .
- ❑ Threat and attack scenarios to provide design approach.





THREATS

❑ Subway systems.

	Total Attacks	Attacks on Vehicles	% of Total	Fatalities on Vehicles	Injuries on Vehicles
Subway	82	29	35%	90%	67%
Subway EU	35	11	31%	100%	92%

❑ Future Threats.

Question posed	Highest ranking response
Most severe threat	Explosive device
Most probable threat	Explosive device
Most vulnerable target	Multi-modal terminals
Primary aim of attack	Loss of life
Device type	Improvised explosive device
Attack type	Multiple targets



SCENARIO DEFINITION



Vehicle



Setting



Infrastructure



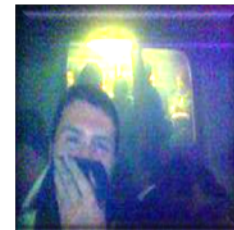
Device



Damage



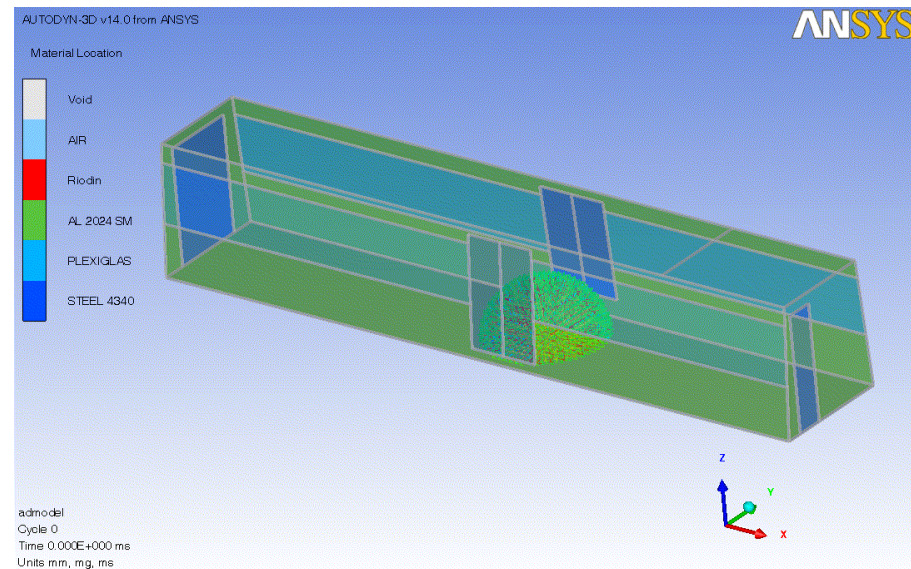
Response





BLAST SIMULATION

- ❑ Finite element modelling and simulation of blast conditions.
- ❑ Study of blast mechanics related to rail metro vehicles and systems.
- ❑ Small/large scale blast testing (correlation) components and vehicle.
- ❑ Evaluation of range of potential vehicle design improvements.





BLAST Testing

❑ Panel tests June 2012:

- 4 driver cabin panels (2 metres standoff).
- 4 carriage wall panels (3 at 2m, 1 at 1m).
- 2 ceiling panels (1 at 2m from "false" ceiling, 1 at 2m from steel structural ceiling).
- 2 windows (2 m).
- 2 floor panels (0,5 m standoff).
- 4 materials assessment tests (32 individual materials tested) .





BLAST Testing

❑ Panel tests:





BLAST Testing

- ❑ Full-scale test Aug 2012:
 - ❑ Decommissioned Metro de Madrid vehicle.
 - ❑ Tested at HSL (UK) for NewRail.
 - ❑ Evaluation of structural and equipment response.





BLAST Testing

❑ Delivery of metro!





BLAST Testing





BLAST Testing





AREAS OF INTEREST - Reduce Damage and Injury



- ☐ Glass fragmentation
- ☐ Door retention
- ☐ Structural deformation
- ☐ Equipment retention
- ☐ Vehicle derailment

- ☐ Interior components (floor/roof)
- ☐ Critical system protection
- ☐ Driver Protection
- ☐ Evacuation & egress
- ☐ Recovery (injured & system)



KEY SYSTEMS

☐ **Lighting:**

- Assess situation. Seek egress. Communication. Guidance.

☐ **Driver:**

- Knowledgeable person. Relay updates & commands. Focal point.

☐ **Radio communications:**

- Gather information from source. Co-ordinate evacuation. Link to outside world.

☐ **Door systems:**

- Operational post incident. Escape means. Useable if unpowered. Access for emergency response crew.

☐ **Surveillance data backup:**

- Forensic data. Understanding of events leading up to blast.



RESEARCH OUTPUT

- ❑ Appraisal of State-of-Art design practices (techniques).
- ❑ Specification of the desired vehicle performance.
- ❑ Design specification for blast and firebomb mitigation.
- ❑ Recommendations for future international standards.





THANK YOU!



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