



U.S. Department  
Of Transportation  
**Federal Railroad  
Administration**

# Research Results

RR06-07  
April 2006

---

## Passenger Rail Car Evacuation Simulator

### SUMMARY

The Office of Research and Development of the Federal Railroad Administration (FRA) is investigating how to improve rule provisions addressing the safe, timely, and effective emergency evacuation of occupants from rail passenger vehicles in various emergency scenarios. A variety of evacuation concepts, strategies, and techniques for applicability to U.S. rail passenger cars are being investigated and evaluated.

Under the sponsorship of the FRA, and with the partnership of the Washington Metropolitan Area Transit Authority (WMATA) and New Jersey Transit, an Emergency Evacuation Simulator (Rollover Rig) for passenger cars was constructed at the Carmen E. Turner Training Facility, located in Landover, MD. The original idea for this rotating rail car came from a British design built to evaluate evacuation equipment and scenarios. The FRA Simulator can “roll” the car “over” in 10-degree increments in place to simulate rail car positions after derailments or other rail accidents. The Simulator is intended for use as a training tool by emergency response organizations, and for equipment designers to evaluate different types of emergency equipment.



*Figure 1. Emergency Evacuation Simulator (Rollover Rig), WMATA, Landover, MD*



## BACKGROUND

The “Rollover Rig” or Emergency Evacuation Simulator was designed to assist passenger car designers to think realistically about how to improve the interior design to better protect occupants in an accident, and to provide a training tool for passenger railroad operating companies and emergency responders to improve response in emergencies.

Originally designed and built by Serco Rail Services, United Kingdom, the passenger car Evacuation Simulator won the prestigious British Railway Industry Innovation Award in 2003<sup>1</sup>. The UK Simulator consists of a Mark II passenger rail car body shell bolted onto a frame that can be “rolled over” in a controlled manner up to 100 degrees from the upright position, using steel cables linked to a portable diesel engine (Figure 1).



**Figure 1. UK Rollover Rig Simulator**

The UK Evacuation Simulator has been used to evaluate the effectiveness of various vehicle components during an emergency, including windows, lighting, and markings.

After reviewing the capabilities of the UK Rollover Rig, commuter railroad and rail transit system operators expressed interest to FRA in using it as a training facility for their train crews, as well as emergency responders. After an extensive search and evaluation, FRA and the Washington Metropolitan Area Transit Authority (WMATA) reached an agreement to locate the simulator at the Emergency Response Training Facility of WMATA in Landover, Maryland. WMATA also agreed to provide land for the Simulator site, as well as its operation and maintenance.

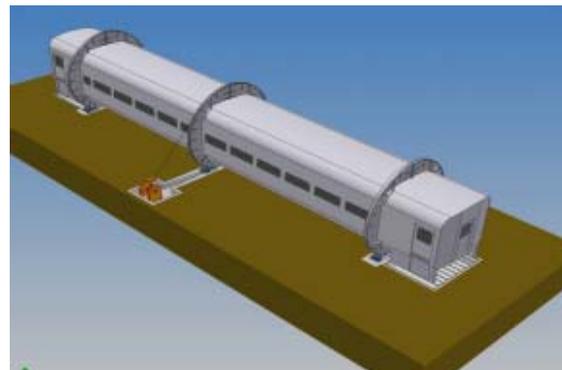
## DESIGN AND CONSTRUCTION

While the FRA-funded Evacuation Simulator is based on the design of the UK “roll-over rig,” it was not feasible for FRA to purchase the UK Evacuation Simulator “off the shelf” due to limited space and heavier U.S. rail car than British rail cars. Accordingly, FRA contracted with ENSCO Transportation Group to design and build a U.S. “roll-over rig” that addresses the weight and space issues and provides a safe environment for emergency responders to practice internal and external evacuation of a derailed rail car.

Working with WMATA, ENSCO completed the following work tasks:

- Detailed design, including:
  - associated rail car body shell modifications,
  - data-gathering instrumentation scheme,
  - control scheme,
  - safety features,
  - power supply; and
- Fabrication of Simulator and installation at WMATA Training Facility.

Preliminary design of the U.S. Simulator for the single-level coach car was completed in 2004 (see Figure 2). To accommodate the limited space requirements, ENSCO designed the Simulator to roll a rail car “in place,” versus rolling over to the side. Instead of steel “J” frames, the Simulator system uses 3 custom-made steel hoops that fit around the rail car body and specially designed polyurethane rollers mounted to custom foundations. The Simulator can be rotated in 10 degree increments up to 180 degrees.



**Figure 2. Preliminary Design – US Evacuation Simulator**



New Jersey Transit donated a retired Comet I commuter rail car built by Pullman Standard for the Simulator with 3 and 2 seating arrangement. (Figure 3).

Final assembly and testing of the Simulator was completed in April 2006 and a major demonstration to emergency responders was conducted on May 10, 2006.

Figures 4 and 5 show exterior and interior views of the Simulator rotated at an angle of 45°.



**Figure 5. Commuter Rail Car Interior: 45°**



**Figure 3. Donated Commuter Rail Car – Exterior**



**Figure 4. Evacuation Simulator: 45°**

### OPERATION AND MAINTENANCE

ENSCO prepared operating instructions and maintenance procedure manuals and provided training to WMATA staff in the normal and simulated emergency operations of the Simulator.

FRA and WMATA agreed to a Memorandum of Agreement for WMATA to maintain the Evacuation Simulator and to host training for emergency responders.

### FOR FURTHER RESEARCH

In addition to serving as a training tool for emergency responders, use of the Evacuation Simulator is planned as a tool to assist in evaluating the impact of passenger rail car design on emergency evacuation.

An on-going FRA study has evaluated the applicability of existing time-based egress computer models to passenger rail cars and the possible refinement of such models. Among the analytical models considered is the EXODUS model developed by Professor Ed Galea of the University of Greenwich, (UK), US, that has been used for various types of aircrafts, ships and buildings. Although the EXODUS model has been configured to evaluate evacuation of rail cars, the model has not been fully validated due to a lack of available experimental data. The Evacuation Simulator provides a “dedicated” means to verify the effect of different levels of emergency lighting, types of signs, etc. on the minimum available egress time.



## ACKNOWLEDGMENTS

The successful construction of the Evacuation Simulator was due to numerous organizations and individuals, e.g. the FRA Office of Research and Development funded the project, the FRA Office of Safety provided technical advices, the Washington Metropolitan Area Transit Authority (WMATA) provide the site, the New Jersey Transit provided the rail car, and ENSCO Corporation provided the technical support in design and construction.

## REFERENCES

1. *The Railway Industry Innovation Awards 2003*, March 2003, the Railway Forum, London, UK.

## CONTACT

Eloy Martinez  
Federal Railroad Administration  
Office of Research and Development  
1120 Vermont Avenue NW - Mail Stop 20  
Washington, DC 20590  
TEL: (202) 493-6348  
FAX: (202) 493-6333  
[eloy.martinez@dot.gov](mailto:eloy.martinez@dot.gov)

## KEYWORDS

Emergency evacuation, emergency egress, passenger train egress, passenger rail egress, computer egress models, rollover rig, simulator.

---

*Notice and Disclaimer: This document is disseminated under the sponsorship of the United States Department of Transportation in the interest of information exchange. Any opinions, findings and conclusions, or recommendations expressed in this material do not necessarily reflect the views or policies of the United States Government, nor does mention of trade names, commercial products, or organizations imply endorsement by the United States Government. The United States Government assumes no liability for the content or use of the material contained in this document.*

---