

## **Seat belts, windows and the industry approach to escape from passenger trains**

The UK Rail Safety and Standards Board (RSSB) has carried out research into seat belts, windows and the industry approach to escape from passenger trains.

Analysis of seven train accidents in Great Britain going back to 1996 has highlighted that a number of passengers were ejected from vehicles, some of whom received fatal injuries. The research conducted shows the importance of containing passengers within vehicles during accidents. Keeping passengers within vehicles can be achieved through the use of seat belts or improved windows. Working with experts from a number of industries in a research programme lasting five years, the RSSB research looked at both these areas.

The aim of the research into seat belts was to assess the benefits and disadvantages in terms of passenger safety. The first part considered the use of two-point lap belts, as used in commercial aviation. The second looked at three-point lap and diagonal belts, as used in cars.

The evaluation of both types of seat belts involved a suite of full-scale “sled tests” with crash test dummies and computer modelling to evaluate the effect of different seat spacings and different sizes of passengers. The tests directly compared the use of seat belts against modern design crashworthy seats which deform to reduce injury during an accident. It found that fitting two-point or three-point belts would, overall, increase passenger injuries and fatalities in a crash situation.

The aim of the research into window requirements was to resolve the conflict between the need for windows to contain passengers during an accident and their potential role in emergency egress or rescue.

Industry and glass experts agreed that laminated glass provides significantly better passenger containment protection in accidents than toughened glass and the rescue services and paramedics consulted supported the fitment of laminated glass to reduce ejections. They confirmed that they could still access anyone trapped in a train through the new windows.

Britain’s railways are extremely safe and accidents are rare. The measures proposed will further improve passenger survivability on those rare occasions when accidents do happen.

## **Improvements to safety signage on passenger trains**

This research project dealt with passenger safety signage in respect of the Cullen Report recommendations 71, 72 & 73. Cullen’s recommendations addressed the need to make passenger safety signs easier to see and to understand, especially in conditions such as poor light and/or in the presence of smoke. The work was funded by RSSB. The project aimed to produce signage on photoluminescent material using pictograms to portray actions where appropriate. The signage design was also to be able to be applied in a consistent style across the range of fleets operating in the UK in order to promote familiarity.

Research into current best practices was carried out, followed by a rigorous development process. This process established the graphical limits of printing onto photoluminescent material, the different actions and objects that needed to be

represented by the symbols and developed symbols for each action or object as required through thorough human factors testing. A format for laying out signage, including the new symbols, was developed, based on best practice graphical principles and on new data gathered from testing of the photoluminescent material in various dark and smoke conditions. New signage designs were then tested under these conditions to verify that the guidance developed was sound.

To support future design of signage based on the symbols developed and the rules and techniques used by this work, Guidelines for the development of signage were produced. A set of common signs was designed using the new guidelines and incorporating applicable new symbols. In addition, a second set of Guidelines, for the development of new symbols, was produced to allow others to develop symbols to the same standard and format.

The testing carried out for the application of graphics onto the photoluminescent material took on board Cullen recommendation 71, by defining the limits for legibility of symbols and text over a range of viewing distances under various lighting and smoke conditions. The testing of the initial set of symbols has ensured that they have all reached an acceptable level of comprehension by the general public, acknowledging recommendation 72 for the reduced use of text. The testing of trial signs has enabled the rules for the graphical composition of signs to be defined and thus a 'common' system of design has been evolved as required by recommendation 73. This work has put in place the tools, required by the industry, to carry out those recommendations put forward by Lord Cullen.

The research recommends that the Guidelines for the development of signs and symbols are adopted into applicable industry standards and that future work should address the process by which vehicle signage requirements are assessed. Part of this work should look into ensuring the placement of photoluminescent materials in areas of sufficient illumination for optimum light absorbency.

### **Validation of emergency lighting specification**

This was phase 2 of a research project which, in phase 1, created a specification for true Emergency Lighting on passenger carrying rail vehicles.

The aim of phase 2 was to validate the lighting levels specified under Phase 1, in terms of appropriate passenger behaviour and suitability, whilst also considering the minimum level of lighting that would provide the desired passenger behaviour such that it may be applied to retrofit vehicles.

This phase of the project involved completely excluding all external light from a vehicle interior and fitting the vehicle with lighting systems to provide the illumination levels, at heights and locations, as described in a draft specification based on the findings of the Phase 1 work. Members of the RSSB stakeholder group were invited onto the vehicle and exposed to the illumination as detailed in the draft specification. Discussions and trials were held with the attendees to validate, or otherwise, the levels in the draft specification. Based on the testing and Human Factors input, a specification for Emergency Lighting Best Practice was developed and validated by the RSSB stakeholder group.

The second part of the Phase 2 work was undertaken by degrading the lighting conditions from those contained in the specification to a level where the desired passenger behaviour was thought to be retained, but allowing for a reduced

performance lighting system suitable for use in vehicles when they may fall due for refurbishment. Consideration was given to Human Factors aspects and probable passenger behaviour.

The principal outcomes of this work were:

- Validation of the final specification for Emergency Lighting in terms of encouraging the appropriate passenger behaviours.
- A suitable 'retrofit' emergency lighting level and specification was agreed.
- Uniformity is an important measure when considering Emergency Lighting and the ability to provide a good ambient light level whilst allowing provision for egress or escape if necessary.
- Photoluminescent material provided better than expected luminance levels and possible benefits to the passengers.
- Photoluminescent material would be beneficial in those vehicles approaching the end of their commercial lives and where expenditure on an active system would not be justifiable.

***It was noted that the work conducted would benefit from passenger trials to further validate the findings.***