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Response to the RSSB recommendation for "Passenger containment" July 2007 – V2

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(Minor amendments – released as V2 - 17/09/2007)

Signed: ______________________________

Date: ______________________________

2) Index:

3) Introduction

This report has been compiled in response to the recommendation for “passenger containment” published by the Rail Safety and Standards Board (RSSB), on the 31st July 2007, and seeks to discover whether there is just cause for the RSSB to implement its recommendation for the removal of emergency egress windows and apply “passenger containment” as a means of improving safety in railway accidents.

Additional documentation has been utilised and referred to within this report therefore, it should be read in conjunction with the RSSB recommendation, Group Rail Standards, Industry Standards and research carried out by other organisations as listed in the bibliography.

In order to assist the reader; extracts have been taken from the documentation and applied to the report with comments added to the end of each section highlighting specific points of interest with regard to safety.

4) Extracts and comments relating to the RSSB recommendation and other related technical reports:

a) Rail Accidents General

Reference T424: Requirements for train windows on passenger carrying rail vehicles

Page 1 (P6)
As yet **►all vehicles involved in significant accidents in the UK pre date this standard (GM/RT2456) and were fitted with toughened glass

** ►Reference to rail carriages built prior to 1993 with all body side windows being made of toughened glass

Comments:
GM/TT0122 & GM/RT2456 (Group Standards) both refer to the introduction of laminated glass for all rail vehicles after 1993 with the introduction of egress windows made of toughened glass as standard.

The RSSB recommendation of 31st July 2007 referrers to "involuntary exit" by passengers through toughened glazing, more specifically, the core data used to recommend the change to laminated glass throughout rail vehicles appears to be centred on the Ufton Nervet and Potters Bar crashes (in which 15 passengers were involved in involuntary exits).

Through research it evolves both of the vehicles involved in these crashes were of the earlier type and built at the time when the earlier Group Standard GM/TT0122 (now withdrawn) was in place. Both types of vehicle having toughened glass the full length of each carriage (neither train conforming to the newer Group Standard).

More modern vehicles (1994 onwards) conform to Group Standard GM/RT2456 which states:
►All body side windows, except those designated for emergency egress, shall have at least one pane of laminated glass, or other material with similar structural properties, or better.

The accident data used by the RSSB to assist in reaching its conclusion "…breakable windows should cease to be recognised method of escape to passengers…" appears to be unsafe and seems to be based on rail accident data linked to vehicles that did not conform to the latest Group Standard GM/RT2456; therefore, any conclusions drawn from the data used can only be applied to the same type of vehicle (bodyside windows made of toughened glass the entire length of the vehicle) which complied to pre 1994 Group Standards..

►It is worth noting the Pendolino and Heathrow Express trains do not have toughened emergency egress windows installed and rely totally on the emergency exit doors for escape. Effectively this means "containment" has already been implemented ahead of formal approval and implementation of the RSSB recommendation, changes to Group Standards and the current ATOC Vehicle Standard (guidelines for Vehicle Interiors Design for Evacuation and Fire Safety).

b) Rail Accidents

Ufton Level Crossing

Reference: RSSB Final Report 21st June 2005
Train collision with a road vehicle and subsequent derailment 6th November 2004

Page 8
►The 1735 hrs London Paddington Plymouth train travelling at approximately 100mph struck a car on the level crossing killing the car driver and causing the train to derail. As a result of this derailment, six people on the train were killed (including the train driver) and a number received serious injuries.

7.5.8 **The role of windows in passenger containment**

7.5.8.1 Railway Group Standard Gm/RT2456, structural requirements for windscreens and windows on rail vehicles, requires bodyside windows which are not designated for emergency egress to have at least one pane of laminated glass. Emergency egress windows must have toughened safety ►glass to BS875. HST coaches pre date these requirements and all windows are made of toughened glass compliant to BS875, which breaks into non-aggressive pieces if it is shattered.

7.5.8.2 ►There were two and possibly four passenger fatalities as a result of being ejected through windows. Two persons who were ejected in this way survived. Others were injured as a result of limbs being trapped between the coach exterior and the track when the coach fell on its side or by being cut as they were thrown against the windows or by being hit by debris... All were the result of breakage of the glass. There was no evidence of failure either of the attachment of the window frames top the body side or of the fixing of the glass within the frames.

7.5.6.3 Significant amounts of ballast were found in the passenger saloons of some coaches, although it is not known if this contributed to passenger injury. However a number of passengers are known to have been cut by flying window glass.

7.5.8.4 **The principal engineer stated that if the windows had been to current standards, the number and severity of injuries would have been reduced…**

8.1 Actions of on-train staff

8.1.2 ►On arriving at his office situated at the trailing end of coach A, he collected a set of track circuit operating clips and a hang lamp, donned a high visibility jacket and climbed out of the train through a broken window on the cess side of the track. The coach was leaning at an angle of about 45 degrees towards the cess, consequent upon which he was not able to exit through the door which was being held shut by ballast….

9.6 Passenger 7

9.6.1 Passenger 7 was travelling in coach E in the company of his wife and sister…

9.6.5 ►His next action was to attempt to break a window on the upper side of the coach. In accordance with the instructions, he hit the window in the corner and although the inner pane cracked, it did not fall out. He made a second attempt at which point the hammer broke.

9.6.6 ►He referred to a smell of fuel in the coach and his suspicion that the couch could be foul of the adjoining line. He believed that there was urgency for the passengers to evacuate the coach. Moving with considerable difficulty towards the front end of the coach, he located a second hammer and two more light sticks. He made a second attempt to break the window at that end with the new hammer. This time the hammer broke on the first blow and the window stayed intact. In the case of both hammers, he recollected that the breakages had occurred in exactly the same place where the head of the shaft met the shaft…..

9.7 Passenger 8

9.7.1 He estimated that there were about thirty passengers in the coach and he believed that none had suffered injury as a result of the derailment.

9.7.3 He said there were some jagged pieces of glass around the frame, which caused minor cuts to some of the passengers during egress. He thought it took it took about 20 minutes to get all of the passengers out through the one window.

Potters Bar

Reference: HSE Interim Report - 14th May 2002
Train derailment at Potters Bar Friday 10 MAY 2002

Page 2 Sequence of Events

2. The incident involved a Class 365 electric multiple unit (EMU), comprising 4 carriages (head code 1T60) operated by West Anglia Great Northern (WAGN). This train left Kings Cross station, with between 130 and 150 passengers, at 12.45pm bound for Kings Lynn, Norfolk, via the East Coast Main Line (ECML). At the time of the incident, the train, which was not due to stop at Potters Bar, ►<u>was travelling up to 100mph</u>. The rear part of the train derailed at points 2182A located approximately 150 metres south of the station. The first 3 coaches remained upright and came to rest 400 metres north of the station, still on the down fast line. The rear bogie of the third coach had however derailed.

<u>Hatfield</u>

Reference: Office of Rail Regulation (ORR) Final Report – July 2006
Train Derailment at Hatfield

Page 3

1. On 17 October 2000 the 12.10 train travelling from London Kings Cross to Leeds derailed south of Hatfield station. The train was an intercity 225 Mark 4 express train operated by Great North Eastern Railway (GNER).

2. The location of the derailment was between Welham Green and Hatfield, approximately 16.7 miles (27 km) from Kings Cross. The left hand rail fractured on the down fast line1 (i.e. going ►North). At the time the train was travelling <u>between 115 and 117 mph</u> (185 and 188kph). There were 170 passengers and 12 GNER staff on the train.

<u>Reference:</u> RSSB recommendation for passenger containment 2007

Page 9

►The graph states 9 passengers were subject to involuntary exits at the Ufton Level Crossing Train collision, however, the final report for the accident by the RSSB states 2 or 4 passengers were subject to involuntary exit…

<u>Comment:</u>

The graph within this document appears to be misleading due to the high and conflicting numbers involved in involuntary exit. As a result this adds weight to the RSSB's recommendations for passenger containment. I am very concerned the data used for the Potters Bar accident may also be incorrect and misleading and ultimately adding further weight to the move for containment.

<u>Copmanthorpe</u>

Reference: Department for Transport (RAIB) Accident report – September 2006
Fatal collision between a Super Voyager train and a car at Copmanthorpe

Page 6

5 ►At 20:57 hrs on 25 September 2006 the 14:25 hrs Virgin train from Plymouth to Edinburgh struck a car on the site of the former Moor Lane level crossing at Copmanthorpe, south of York. The train was <u>travelling at approximately 100 mph</u> (161 km/h). The car driver was fatally injured.

Page 12

38 The derailed train did not obstruct the adjacent line. There was considerable damage on the ►underside of the vehicles (see paragraphs 90 to 105); as a result fuel leaked into the track ballast from three of the train's fuel tanks and the tilt system became completely unlocked on two of its five vehicles.

Page 25

94 **Performance of the train's fuel system**

Debris from the car smashed the plastic protective cover on four of the five diesel tanks' 'dead-space' drain valves, and damaged the valves and their protective brass covers to such an extent ►that a large quantity of diesel fuel, possibly up to 1,500 litres from each of the four vehicles affected, leaked out into the ballast (see Figures 11 and 12).

Comments:
Clearly the possibility of fire remains even when utilizing the more modern (Virgin) Super Voyager train. Punctured fuel tanks and the loss of thousands of litres of diesel fuel on to the ballast. Had it ignited the outcome may have been catastrophic.

►The RSSB recommendation for passenger containment suggests the possibility of fire is extremely small, however, the RSSB annual safety performance report 2006 clearly states (page 28) 139 train fires were recorded on passenger trains in 2006 with 141 train fires recorded in 2005. Far from being a minimal risk I would suggest there is an extremely high and significant risk to passengers.

c) Executive Summary

Reference: RSSB recommendation for Passenger Containment 2007

(V) (P2) The proposed strategy was subjected to risk assessment, both qualitative and quantitative. ►This identified that the immediate removal of hammers would cause a very modest increase in risk (relating to those very rare events where breaking a window would be beneficial to passengers). However the assessment concluded that the benefits of enabling operators to proceed with ad hoc and planned replacement of windows significantly exceeds this small increase, and therefore that this approach should be adopted

Comment:
►The report stated "a very modest increase in risk" seems incredible as the planned reduction of emergency exits (by 50% or more) must surely result in a dramatic increase in exit time and a heightened risk.

d) Fire and the use of windows for escape

Reference: RSSB recommendation for Passenger Containment 2007

Page 65
The review was then related to the situation at Ladbroke Grove. In that incident the vehicle most affected by fire was subjected to two distinct phases of fire. Firstly, the rupture and rapid crushing of a fuel tank produced an aerosol-like atomised spray of fuel into the vehicle which then ignited, causing a fire-ball to race through the vehicle within seconds. There was no time to begin the ►process of exiting via a window or other means. The major fire that finally engulfed the vehicle did not develop for approximately 7-10 minutes, during which time passengers were able to evacuate the vehicle, including via windows.

Comments:
►In a crash scenario where fire engulfs a vehicle containing 76 passengers (in an upright state) is it reasonable to suggest all 76 passengers could exit from the train through the exit doors alone? Further, in the event one or more exit doors become blocked by rollover, ballast or other material, I feel it is unlikely all passengers could exit with absolute certainty through the remaining exit doors. In addition, the likelihood of crushing occurring by passengers in their haste to exit the vehicles, will in all probability lead to blockage of the exits (as seen in other land based disasters where fire and blockage has been a major factor in the cause of deaths and injuries).

►The typical time taken for the emergency services to arrive at a rail accident once reported is 20 minutes. I have been advised by a serving fire brigade officer; due to the remoteness of many rail accidents a greater reliance is placed on retained fire fighters to attend the initial rescue operation as many fire stations in these remote areas are manned part time. As a result, approximately 5 additional minutes can be added to the total response time.

► In the event of a fire situation occurring at a rail accident (especially when carriages are in a roll over state), the length of time taken to reach the crash site by the emergency services, and initiate a rescue for "contained passengers", may leave passengers at greater risk than would otherwise be the case if they had alighted the vehicles through emergency exits (to include egress windows).

e) **Involuntary Exit**

Reference: RSSB recommendation for "Passenger Containment" 2007

Page 9
►Analysis of the evidence collected indicated that involuntary exit occurred in an accident when a vehicle was subjected to two events during the accident; namely, when vehicles separated and also overturned…

Comments:
The RSSB recommendation refers to involuntary exit through bodyside windows (Page 10**)** and bases its findings and recommendation for containment on this information, however, there appears to be a direct conflict with other information contained within the same recommendation whereby reference is made to "people who fell out" of the vehicle ►either through a window or through the vehicle end-connection (gangway) or through ruptures in the vehicle body shell, as illustrated at the Potters Bar and at Ufton Nervet accidents.

►The RSSB report appears to be flawed in that it bases it findings exclusively on involuntary exit through egress windows and excludes gangways and ruptures. As the argument for containment is mainly centred on the Potters Bar and at Ufton Nervet accident data (due to the high number of involuntary exits), the data has become disproportional and misleading in its findings which in turn has lead to a false impression of actual events (which has altered the critical decision making process). Further, the report does not appear to account for the numbers of travelling passengers involved in each accident. This critical data would give a clearer understanding of how many passengers were seated or standing and using the gangways at the time of the accidents.

If end gangways are being utilised by passengers and it's "standing room only" within the carriage, the number of injuries and fatalities due to involuntary exit could increase (the report does not appear to factor this into its analysis of the crash data). It is therefore entirely possible in both the Potters Bar and at Ufton Nervet crashes involuntary exit could have been partly attributed to overcrowding of the vehicles.

►Both the Potters Bar and at Ufton Nervet crash report data shows a high number of passengers using the emergency exit windows following the accident (far greater than other accidents) rather than the exit doors (this may be due to the end gangways being blocked). No explanation is given in the report. This information is therefore critical in determining whether there is a case for retaining emergency egress windows in current Group Standards.

►As far as I am aware there are no recorded incidents of involuntary exit from any modern rolling stock conforming to the latest Group Standard where emergency egress windows are incorporated in bodyside windows.

The most recent accident in Cumbria involved a Pendolino train in which laminated glass has been fitted throughout. The final crash analysis is not in the public domain at this time; therefore, it is difficult to comment on the difficulties passengers may have encountered when trying to escape. My thoughts are that the train design maintained its structural integrity during and after the accident, which in turn prevented involuntary exit, however, as the Pendolino design only incorporates one escape door per side of each carriage I would have expected a degree of panic when trying to exit the vehicles. In addition, it would appear all gangways were clear of passengers otherwise involuntary exit would have been a factor in the crash investigation.

f) **A changing pattern of injuries**

Reference: RSSB recommendation for "Passenger Containment" 2007

Page 10

Figure 2; **Accident casualty data 1973 – 1983**
The most significant cause of injury during the period of 1973 to 1983 was occupants being crushed as the vehicle body collapsed.

Page 11

Figure 4; **Accident Casualty Data, 1984-2004**
It is evident from Figure 4 that, with the increasing structural integrity of the vehicles, involuntary exit became a more significant cause of injury during the later period.

Comments:
►The incidence of involuntary exit (shown in the graphs contained in pages 10 and 11) has increased significantly over recent years, however, this does coincide with the increase in train speed form 80 mph in the late 1980's to over 115 mph in the late 1990's.

►As the vehicles involved in high speed accidents conform to pre 1994 Group Standards (toughened glass throughout) and are designed for use at approximately 80 mph, I wonder if there is some correlation between increased speed (in high speed rollover accidents) and risk of involuntary exit where toughened glass is installed throughout?

There does not appear to be any reference in the RSSB recommendation which relates to vehicles involved with high speed accidents and their link to operating under outdated Group Standards. This information is highly significant and may ultimately have a bearing on the outcome of crash analysis.

►It would be of great interest to know what proportion of the UK rolling stock are currently operating to outdated Group Standards, further, as Group Standards are updated year on year, and are not retrospective, what would the life expectancy be of a typical rail vehicle operating to these outdated Group Standards?

►It would also be of great interest to what approval process is in place that confirms rail vehicles which do not conform to current Group Standards are suitable for high speed use, and whether these vehicles are subject to inspection and certification as would be the case to land vehicles (MOT).

g) Escape and Rescue

Reference: RSSB recommendation for "Passenger Containment" 2007

Section 9 - Page 59

9.1 Escaping from a vehicle in an accident

In the aftermath of an accident passengers will react according to what, in their minds, is the perceived risk. This risk may result from the following:
• A rapid evaluation of the situation (which may be informed or not),
• Recollections of publicity surrounding previous accidents,
• Information communicated by fellow-passengers (informed or not),
• Formal instructions given at the time.

►The desire to escape is not related to the need to escape. The threat to life or of serious injury only arises when there is a need to escape, not when there is merely a desire to do so. Equally the risk to passengers remaining on board a rail vehicle after an accident is not primarily related to whether they are *capable* of getting out, but whether they *need* to get out. If there is no need to get out, then there is no risk of injury associated with being unable to get out unaided. Only when there is an urgent need to get out, such as in the event of fire, does the ability of people to escape from the vehicle become critical. There are two factors affecting the ability of people to escape from a vehicle: the incapacitation of people through injury and the incapacitation of the vehicle through damage. Both are significant in this consideration. A third, where the method of opening doors for escape is not understood in the aftermath of an accident, only becomes significant where the ability to escape is preserved.

Comment:
The comment within the report "The threat to life or of serious injury only arises when there is a need to escape, not when there is merely a desire to do so" is flawed in that it does not account for crowd dynamics in which the need to escape overcomes the desire to escape.

Passengers are not qualified, or trained to analyze an emergency train accident situation to determine whether there is or indeed will be a threat to life as a result. Therefore, determining if the situation is or will become critical can only be based on ones own instinct and level of fear. In the event one decides the situation is critical (whether real or not) the need to escape will without doubt override the desire to escape.

h) Crowd dynamics

Reference: Computational Modeling of Non-adaptive Crowd Behaviors for Egress Analysis CIFE Seed Research Proposal

1. Introduction
The objective of this research is to study human and social behavior for emergency exit in buildings and facilities. Among the numerous regulatory provisions governing a facility design, one of the key issues identified by facility managers and building inspectors is safe egress. Design of egress for places of public assembly is a formidable problem in facility and safety engineering.

►There have been numerous incidents reported regarding overcrowding and crushing during emergency situation. In addition to injuries and loss of lives, the accompanying post-disaster psychological suffering, financial loss, and adverse publicity have long-term negative effects on related individuals and organizations -- the survivors, the victims' families, and the local communities [14]. In a crowded environment, it has been observed that most victims were injured or killed by the so called "non-adaptive" behaviors of the crowd, rather than the actual cause (such as fire) of the disaster [1.8]. Non-adaptive crowd behaviors refer to the destructive actions that a crowd may experience during a disaster, such as stampede, pushing others out of the way, knocking others down, and trampling on others, etc.; these actions are responsible for a large number of injuries and, even, deaths in crowd disasters. To study the non-adaptive behavior in a crowded environment, we need to carefully study human and behavior in panic situation from both the psychological and sociological perspectives.

Comments:
►If crowd dynamics where applied to a crash situation involving the Pendolino train (in a roll over situation), I am sure serious problems would be exposed with regard to emergency exit through the single remaining exit door or end gangways. Further, in the event one or more gangways where to be blocked by debris or collision damage effectively up to 76 (or more) passengers would be forced to converge on the last remaining exit. Crushing could then become a major factor in the prevention of emergency egress via that exit.

As the Pendolino already operates without emergency egress windows the risk to passengers would appear to be significantly higher than would otherwise be the case with vehicles that incorporate egress windows and conform to current Group Standards.

►There does appear to be a question mark over whether the Pendolino trains actually conform to current Rail Standards…

i) Escape and Rescue

Reference: RSSB recommendation for "Passenger Containment" 2007

Page 60

9.2 **The Role of Emergency Lighting**
The failure of the lights to survive the impact resulted in passengers being suddenly plunged into darkness without any ability to comprehend what had happened, how serious the situation was, the extent of the damage to their vehicle or the threat to their life. Inevitably, in such a situation, **fear of**

the un-see able and unknowable is generated, followed by an overwhelming desire to escape the potentially threatening scene…

Page 62

9.3 **The use of windows for escape**

A significant number of passengers chose to exit through windows after an accident, particularly ►after the publicity surrounding the Ladbroke Grove accident. The research identified that there was no case discovered in numerous vehicle accidents reviewed, in which the lives of passengers were or could have been prejudiced if windows could not have been used for escape…

►**Exiting through bodyside windows**, whilst the rail vehicle remained vertical, was hazardous but not impossible. As can be seen from Figure 40, it represents a sheer drop with nothing to break the fall. <u>Exiting the vehicle in this way renders the passenger vulnerable to the often unpredictable conditions of the ground beneath the vehicle and to any passing trains (where still operating).</u> In some cases vehicles had remained upright after the accident but had been perched perilously in the air – a situation that may not be realised during the hours of darkness. In another recent accident, vehicles have formed a bridge between a steep embankment leaving passengers with a drop of over 4 metres onto a steeply inclined embankment of very slippery mud…

Page 63

►…the passengers would need to lift themselves up through the broken window, using other armrests to gain leverage, and exit onto what would have become the top surface of the overturned vehicle (see figure 42). Passengers would be liable to suffer laceration of their hands, due to jagged fragments of glass inevitably remaining in the window frame, whilst hauling them selves through the broken window aperture. In front of, and behind, may be further broken windows which, in the dark, would be potential hazards to be negotiated. Even discounting such hazards, descending from such a lofty position, probably in excess of 2.8m above the ground, would be extremely hazardous with a relatively smooth curved roof surface forming one vertical 'wall' and the other vertical 'wall' comprised of potentially damaged equipment or smooth equipment covers.

<u>Comments:</u>

Page 62 (P1) **The use of windows for escape**

"There has been no case discovered in numerous vehicle accidents reviewed, in which the lives of passengers were or could have been prejudiced if windows could not have been used for escape". This statement has clearly not taken into account the possibility (how ever small) of both end gangways and exit doors being effected by debris and damage which may ultimately lead to the entrapment of passengers and their possible exposure to smoke, fire or water…

Page 62 (P2) **Hazardous exit through body side windows.**

►I find this information highly biased in favour of the removal of emergency egress windows, however, <u>as the RSSB now recommends</u> <u>the use of</u> <u>exit doors as a primary means of escape surely the same difficulties in lowering oneself to the ground would be encountered</u>?

Page 63 - Exiting through body side windows

►The RSSB recommendation fails to adequately provide a clear and concise alternative method for passenger exit in an emergency situation when bodyside egress windows have been removed and replaced with laminated glass. In particular, in a rollover situation of 90 degrees how would passengers reach the exit door (that may be some 10ft overhead) as there does not appear to be any method or climbing apparatus available?

►The failure to provide clear and concise information, signage, and printed passenger documentation (advising the passenger how they should alight the vehicle in an emergency situation) prior to formal implementation of the change to laminated bodyside windows from current egress windows could in real terms create a serious and life threatening situation. With TOC's already implementing these changes to existing vehicles (prior to formal changes to Railway Group Standards) I am increasingly concerned with passenger safety.

j) <u>Hammers and hammerless window braking systems</u>

Reference: RSSB recommendation for Passenger Containment 2007

The use of windows for escape

Page 62
The situation of a vehicle on its side was reviewed by experiment on the industry's roll-over rig, which permitted a vehicle to be turned over on its side for evaluation and training purposes. In such a situation, exit via a bodyside window would require the use of seat armrests like rungs of a ladder to climb up to the window which must then be broken above the passenger's head. The situation is illustrated in Figure 41.

►Striking the window with a hammer from such a position results in a glancing blow, rather than a direct impact, reducing the effective blow to the window. **In order to offset this extra force must be applied with the increased risk of overloading the hammer and of the hammer breaking**. A successful strike of the window would then result in, or necessitate, the extraction of the glass panel directly above the head of the passenger seeking exit. It is unlikely that the glass would be removed in convenient small sized particles and the safety of the window-breaking passenger could be seriously prejudiced.

Page 64
Early research undertaken by RSSB's predecessor, Railway Safety Ltd included investigation of window breaking systems in current usage, including hammers and hammerless systems. The research undertaken represented an overview of systems in current usage in the UK. This work indicated that hammerless systems as already trailed in the UK were likely to be more consistent in operation because the successful operation was less dependent upon the passenger operating it. This work did not review the desirability of breaking windows for escape, but was extended by RSSB as indicated below.

In view of reports from a number of accidents indicating that some passengers had been unable ►to break windows and that, in other cases, the hammer itself had failed an investigation into hammer specification and performance was undertaken. Whilst at least one hammer design ►carried an indication that performance was proven for glass up to a thickness of 5mm compared with a glass thickness on rail vehicles of 6mm, this suitability depended equally on the type of ►glass used. Hammers used on rail vehicles had been subjected to tests in order to verify their suitability. Representatives of the hammer types used in the UK were subjected to a test of their ability to break standard type windows and to perform repeatedly. Hammer breakage occurred in some of the tests and, from those incidents, it was possible to identify the circumstances in which the hammers broke. It was evident that hammers impacting at 90° to the glass were effective but, **when impacting the glass with a glancing blow, such as would be the case in an overturned vehicle (see Figure 40); the stress pattern in the hammer changed significantly and could result in failure**. As a result of numerous tests covering the range of hammers available, it was possible to develop a specification identifying….

<u>Comments:</u>

Page 62
"In order to offset this extra force must be applied with the increased risk of overloading the hammer and of the hammer breaking…"

►Clearly the hammer in question could never have been designed, approved or passed as "fit for the purpose" for use at a varying range of strike angles. The most shocking realisation is these hammers are in current use on most of the UK rail network…

As the recommendation for "passenger containment" has not yet been accepted or formally implemented (Railway Group Standard), there is a strong likelihood of existing emergency hammers remaining in service in rail vehicles for many years until such a time as the vehicles are refurbished or removed from service.

► Lifeaxe emergency hammers
Despite being submitted for testing by AEA Technology Ltd (now Delta Rail Ltd) and conformation by the RSSB "they were the best of the bunch", there is no mention of the products within the report regarding performance. Clearly this would have a direct bearing on the ability of the user to actually break the glass even at the most extreme angles.

Requests have been made by Allan Rhodes to both Delta rail and the RSSB for formal release of the high speed photos; film and test data recorded by Delta Rail in order to examine and compare results with existing UK emergency hammers currently in use. It would appear from the lack of response the information is being withheld, despite its direct importance for passenger safety and survival.

In the interests of public safety I believe this information should be brought into the public domain for scrutiny at the earliest possible opportunity.

k) <u>Performance of windows</u>

Reference: RSSB recommendation for Passenger Containment 2007

7.11 **Toughened Window test results (new requirements)**
Figure 38 is the view taken from under the double-glazed unit (the passenger's side) showing the glass rapidly separating from the frame and being propelled into the vehicle interior. It can be clearly seen that, although the glass shatters into small dice, the impact is so rapid that the dice ►break away in large clusters which approximate to large shards of glass. The potential to injure passengers is thus even greater than was anticipated. Not only did the glass present a hazard to anyone on the inside of the vehicle, but in the midst of the large shards of glass seen in Figure 38

"It is unlikely that the glass would be removed in convenient small sized particles and the safety of the window-breaking passenger could be seriously prejudiced"…

<u>Comment:</u>
►This is in direct conflict with BS857 - Specification for safety glass for land transport.

Page 45

Protection from external objects:
As has been indicated above, a review of the accidents identified the need to protect passengers from external objects penetrating the windows during the course of an accident as well as the possibility of the window being penetrated from inside the vehicle. During the course of an accident, when the train is derailed, there is a potential danger that components may be displaced from the train or the object with which it has collided. Such components or other objects may become airborne and windows are the most potentially vulnerable area of the vehicle where penetration may occur. Equally, in the case of derailment without a collision, there is the possibility that smaller objects or ballast may impact the windows.

<u>Comment:</u>
► Although the concern for intrusion through glazing is of great importance, the image shown on the page clearly shows intrusion through the vehicle side wall. The likelihood of any of window, laminated or not, preventing intrusion from penetrating objects at speed will in my opinion be extremely limited if objects can penetrate side walling.

l) <u>Risk Scenarios</u>

Page 17
►Rail accidents are very rare and accident data is very limited. However, analysis of evidence from the accidents showed that passengers were injured as a result of what happened to their individual vehicle, not as a result of what happened to the train. Thus, even though the number of train accidents considered was relatively small (7), every vehicle within each train had its own accident with the vehicle in front and the vehicle behind it (52 vehicles).

Comment:
►The RSSB Annual Safety performance report hand book (page 28) clearly makes reference to a total of **823 train accidents in 2006 and 840 in 2005**. This information is in direct conflict with the information contained in the RSSB "Passenger Containment" recommendation 2007.

m) Risk Assessment Summary

Reference: RSSB recommendation for Passenger Containment 2007
Section 12 (Emergency hammers and the benefit of retaining egress windows)

Page 86
Finally, consideration was given to whether windows might provide an escape route for ►passengers who might otherwise be trapped. **It was decided that windows might be effective in the event that the train was upright or at around 45 degrees**, but if the train was on its side, evacuation via windows would be so slow and difficult that there would be a negligible benefit.

Comments:
►Clearly, the RSSB has decided egress windows might be effective in an upright or partial roll over situation, however, if it was on its side the benefit would be reduced. I suspect the reasoning for this relates to the test results of the existing emergency hammers and their subsequent failings when used at extreme impact angles (Delta Rail Ltd – On behalf of the RSSB).

►The Lifeaxe emergency hammers have been specifically engineered to perform at extreme angles (tested by Delta Rail and proven to be very effective) therefore; I can see no real reason why the Lifeaxe would have been dismissed when reviewing all egress situations to include 90 deg rollover situations.

n) Risk Assessment Summary (2)

Reference: RSSB recommendation for Passenger Containment 2007
Section 12

Page 94

12.9 **"Trapping" Internal doors**
One further issue involved trains with internal doors that could lead to trapping should the train roll over. This could occur if one-way sliding internal doors at opposite ends of a vehicle both slid closed in the same direction, as if the vehicle rolled onto its side in the direction that made both doors slide closed, they could trap the passengers between them (the doors were very difficult to open in this situation). Lord Cullen, in the Ladbroke Grove Inquiry Report, recommended that such doors be phased out, either by reversing the direction of slide of one of them, or fitting them with push-through panels. According to the information supplied, and used in the model, there were very few such vehicles with 'trapping' doors still in use on the network.

► Currently, no vehicles with end external doors and with 'trapping' internal doors were in use. On trains with one-third two-third external doors, only 0.15% of passenger miles were affected by 'trapping' internal doors. The risk model considered the impact of such doors, and estimated that trains with this type of door had a risk level which was about 70% greater for the key outcomes where evacuation via windows might have a beneficial impact. Whilst it was not considered that this difference was so large that it should delay implementation of Action 1 until the remaining trains with 'trapping' doors were modified, it was clear that the remaining modifications would need to be afforded greater priority if Action 1 were implemented.

Comments:
The introduction of internal doors closing opposite to each other seems sensible on the surface; however, this change does in fact create additional problems. When faced with a rollover scenario one or other of the internal doors will be in the closed position effectually "blocking" the exit at that particular end. In the event a removable panel is available additional problems may occur in that passengers will have little or no knowledge of how one should remove them.

►In the event "blocking" occurs at one end as a result of the internal door jamming, passengers could be left with a single internal door for emergency exit.

►In the event both internal doors become "blocked", and the ability to exit via the egress windows has been removed, passengers will effectively become entombed within the vehicle until such time as the emergency services arrive. Clearly in a fire situation this would be totally unacceptable.

►Pendolino trains operating with single doors to either side of the carriage will without doubt place passengers at great risk from entrapment if internal doors are installed that close to the same side as the external door.

o) **Fire Brigade**

Reference: Office of the Deputy Prime Minister 20 January 2004 – DCOL 2/2004

Dear Chief Officer Letter 2/2004

Item B Train Glazing
Over recent years the development of train glazing has evolved around the need to retain passengers within the compartment at the time of an incident. This coupled with the continual desire to improve passenger comfort has resulted in much stronger glazing being employed.

This item provides some practical guidance on how best to gain access/egress through train glazing if required.

Railways Train Glazing
Whilst participating in the production of the video FRS members became aware that the style of trains has hanged with one of the main areas being glazing. This is as a direct result of Public Enquiry Reports which emphasised that more needs to be done to contain passengers within the train following an accident. This coupled with the need to ensure passenger comfort, similar to that of an aeroplane, has resulted in different construction and much thicker glazing being used**.** As part of the video production the group experienced the difficulty in gaining access through a window. **Windows are not the first choice for access but with regard to the Pendolino' there is only one door on each side of every carriage**. Therefore if the train is on its side there is only access through one door. There may also be the need to secure alternative means of access/egress or to create space by glass removal.

►The group was concerned with the level of effort required to actually break through the glazing and therefore enquiries were made with some of the glass manufacturers and fitters. It became apparent that there is now a wide range of glazing types and thickness on current trains and these changes will continue to evolve in the future.

►It is therefore recommended that all personnel are advised that when attending train incidents the best method to employ, if access has to be made though the glass, is with a reciprocating saw. **Personnel need to be aware of the dust produced when cutting glass and appropriate respiratory protection (RP) used**.

►It should also be noted that until access can be gained it may not be possible to provide RP for passengers but the benefit of quickly gaining access has to be appreciated and this need will outweigh the problem.

Item E Methods of Forcible Entry

FIRE RESEARCH DIVISION, Gaining entry update

Windows
Windows may often look an easy option, but the trials clearly proved that this is not necessarily the case. They can take as long as a door to open and provide additional hazards to both fire fighters and any persons awaiting rescue. Broken glass needs careful management - sharp edges can cut both people and through hoses. **Dust masks are also essential for fire fighters to avoid damage to lungs (both short and long term)**. The laminated glass trials proved conclusively the usefulness of the Glass-Master tool (or equivalent) to all brigades, particularly at Road Traffic Accidents and incidents involving passenger transport, such as high speed trains.

►During forcible entry into an enclosed compartment, crews must be aware of possible fire development and ensure that, as far as possible, venting of the fire is controlled to reduce the risk of a flashover or back-draught.

Comments:
This document confirms my findings in that the "Pendolino" trains only have one exit door per side and no egress windows. In the event of a roll over scenario the problems (as previously mentioned) with passenger escape become clear and obvious.

The Heathrow express trains and the Euro trains do as far as I am aware offer the same limitations for passenger escape.

►Within this document there is mention of the dangers to fire fighters of the dust created when using a reciprocating saw on laminated glass. **The use of dust masks is essential to avoid damage to the lungs**. Further, the document states "it may not be possible to provide RP for passengers but the benefit of quickly gaining access has to be appreciated and this need will outweigh the problem". RP being as far as I am aware means "respiratory protection".

►The shocking admission there is further risk to passengers following and accident by inhalation of glass particles. This should be brought to both the public and Health and Safety executives' attention at the earliest opportunity as there does not appear to be any risk awareness, or Health and Safety Guidelines on this subject.

►Passenger awareness of this particular problem and the risks involved to them may be a determining factor as to whether laminated glass should be used for emergency egress by the Fire Brigade.

►It would be of interest to know what the long term effect would be to passengers who inhale glass particles. Other research suggests there is a possibility of tumours (cancer) developing as a result of particles lodging in the lungs…

p) **University of Greenwich**

Reference: Fire Safety Engineering Group

Evacuating and overturned smoke filled rail carriage

Page 1

(P1) Incidents requiring the rapid egress of passengers from trains are infrequent. However, there is an obvious requirement to ensure that rail vehicle design and crew procedures are adequate to allow the safe egress of passengers under a variety of conditions. Perhaps the most challenging scenario for passengers involves the evacuation from an overturned or partially overturned carriage resulting from a crash or derailment. In the most severe cases, fire/smoke may also be present. This report investigates the evacuation of passengers from rail carriages with a focus on ►overturned carriages. This is achieved through a study of passenger accounts from past accidents and two full-scale evacuation experiments involving an overturned carriage, in one of which the participants were subjected to non-toxic smoke. The carriage used in the experiments is a standard class Mark IID, which while an old design, shares many features with those carriages commonly found on the British rail network.

(P2) The first trial without smoke resulted in passengers evacuating from both ends of the carriage. The flow rate for a carriage end door lying on its side with people displaying non-competitive behaviour is between 8.2 and 9.2 persons/minute producing an average flow rate capacity of 8.7 persons/minute. Assuming this mean exit flow rate capacity, a full carriage load of 62 passengers would require approximately 3 minutes 43 seconds evacuating through both ends and 7 minutes 18 seconds through a single end. When smoke was introduced into the carriage, the flow rate capacity for the carriage end door lying on its side with people displaying non-competitive behaviour was found to be between 4.7 and 5.2 persons/minute producing an average flow rate ►capacity of 5.0 persons/minute. **It was further estimated that a full carriage load of 62 passengers would require approximately 13 minutes 19 seconds to evacuate through a single end. The presence of smoke tends to almost half the exit flow rate capacity and almost double the evacuation times.**

Page 3

(P1) While these times are considered optimistic, they suggest that the time required to evacuate a full load of passengers from an overturned carriage subjected to these types of conditions are excessive. This suggests that given this type of scenario, **only a handful of those passengers lucky enough to survive the impact would be likely to survive the subsequent evacuation**.

Comments:

►It is clear from this research the time required to exit through end gangways (being the primary route of escape) is insufficient to prevent further loss of life.

►Serious doubts must be cast over the recommendation by the RSSB for the removal of emergency egress windows (and associated emergency glass hammers) as a result of this research. Further, the suggestion "a very modest increase in risk" falls far short of the obvious danger and increased risk proven in this report.

5) Extracts and comments relating to Rail Standards and other official regulations governing the UK rail network:

a) **Performance of windows**

Reference: RSSB recommendation for Passenger Containment 2007
Section 7

Page 42 (P2)
Railway Group Standards do not as a matter of course mandate things retrospectively since, **in the case of the majority of updated requirements, the cost would be prohibitive and the benefit outweighed by the cost**. Standards only apply retrospectively where specifically stated in the individual standard concerned. The retrospective fitting of laminated glass was not mandated in the issue of GM/RT2456

Comments:
►The failure of the RSSB to mandate "things" retrospectively effectively means current rolling stock used on the UK rail network can be operating under several outdated Group Standards (by many years) until such a time as vehicles undergo refurbishment or are withdrawn from service
(cost cutting over absolute safety?).

b) **GM/RT2456 - 2002** (Current) Structural requirements for windscreens and windows on railway vehicles

Part B - Page 4

B1 **Purpose**
The purpose of this document is to mandate the structural requirements for windscreens and windows on railway vehicles, with the aim of ensuring safety under normal operation and minimising risks to passengers and train crew in the event of vandalism, collision or derailment.

B2 **Application of this document**

B2.1 **To whom the requirements apply**
This document contains requirements that are applicable to duty holders of the train operator category of Railway Safety Case. After the compliance date, or after the date by which ►compliance is achieved (if earlier), Railway Group members shall not deviate from the requirements set out in this document.

Page 7

C3 **Bodyside windows**
C3.2 ►All body side windows, except those designated for emergency egress, shall have at least one pane of laminated glass, or other material with similar structural properties, or better.

C3.3 ►All body side windows designated for emergency egress shall be of toughened glass or other transparent material of similar structural properties, or better. The requirements for toughened glass are contained in BS857.

C4 **Interior windows**

Page 8
C4.1 ►All interior windows shall be of toughened glass, or other material of similar structural properties, or better. The requirements for toughened glass are contained in BS857.

c) **GM/TT0122 - 1993** (Withdrawn) Structural requirements for windscreens and windows on railway vehicles

5.2 All windows, except those designated for emergency egress, shall have at least one pane of ►laminated glass, or other transparent material with similar structural properties, or better.

d) **<u>UIC Code 564 -1 1990</u>** (Current) Windows made from safety glass (Emergency hammers)

3 ►If double glazing is used, both panes must be made of safety glass… (Toughened) In coaches where windows cannot be opened wide enough for passengers to be able to climb out in case of absolute necessity, provision must be made for an emergency exit. If toughened glass is used, this quick exit can be arranged by providing a special hammer in coaches for breaking the window panes.

e) **<u>T424</u> Requirements for train windows on passenger carrying rail vehicles**

Page 1 (P6)
Subsequently laminated glass was introduced for body side windows on new trains. The standard GM/TT0122 stated that all windows that were not designated for escape should be made of laminated glass, which is stronger than toughened glass. This standard was introduced in 1993, before being superseded by standard GM/RT2456 in 2000 (these requirements remaining unchanged).
► As yet all vehicles involved in significant accidents in the UK pre date this standard and were fitted with toughened glass.

f) **<u>ATOC Vehicles Standard - AV/ST9002</u> - Issue One - December 2002**
Vehicle Interiors Design for Evacuation and Fire Safety

Page 6
6.1.1 ►Considerations for evacuation and escape to the vehicle side. No passenger seat in a passenger saloon or location at which a passenger may reasonably be expected to be in a side corridor shall be further than 12 m from a bodyside door or a bodyside emergency escape exit on both sides of the vehicle. In the case of dead ends the maximum distance shall be reduced to 6 m.

Where access to a bodyside door is not directly via an open, unhindered route, additional bodyside emergency escape exits or means to guarantee access via the designated route shall be provided.

►Where the risk of not being able to gain access through the passenger evacuation route, <u>or the risk of not being able to open an external bodyside door is considered high and no other means of direct access is available, then additional bodyside emergency escape exits shall be provided</u>.

Passenger and staff accommodation with a plan view of greater than 4 m2 shall have at least two separate exits, either directly through a bodyside door or bodyside escape exit or a way leading to such a door or exit on both sides of the vehicle.

Power operated bodyside doors and manually operated slam doors fitted with a secondary locking system shall have emergency door release facilities adjacent to each door. Where only selected windows are breakable or removable as a designated bodyside escape device, a suitable and ►easily accessible device for breaking or removing the window shall be provided locally at each such exit.

Access to the device shall adequately deter unauthorised use under normal conditions.

<u>Comments:</u>
►The ATOC Vehicle Standard shown is current; therefore, I am unable to see how the Pendolino trains currently in operation throughout the UK manage to operate within the Standard when only one exit door is available to either side of the train (two in total per carriage) and no emergency egress windows provided.

►Surely, this type of vehicle is contravening ATOC Safety Standards and placing passengers at risk, additionally, train operating companies knowingly operating these vehicles must in my opinion be liable under British Transport Law?

In a scenario where a Pendalino train was in a crash rollover situation only a single exit door would be available. Given there could be some 76 passengers within a carriage trying to exit, the probability of crushing would I suspect become a major factor when considering passenger survival. In the event this single door was blocked by debris or damage passenger escape routes would be removed completely.

g) Health and Safety Executive: INDG358 07/02 C50

Guidance on the provision of equipment and arrangements for evacuation and escape from trains in an emergency

HSE Safety case assessment criteria

31. ►It is important that the equipment to be used in the event of an incident **is available when needed and is fit for purpose.**

59. In the event of an accident it is foreseeable that both passengers and employees may have to escape/evacuate from damaged parts of the train. Unless the passengers' health and safety is at risk they should be encouraged to remain within the train until the emergency services arrive.

67. Provision should be made for the removal of glazing where it forms part of an escape route and this should be provided in each carriage with appropriate instructions for passengers.' Printed and published by the Health and Safety Executive.

Comments:

Clearly the emergency equipment supplied is not fit for the purpose, as confirmed by AEA Technology Rail Ltd (now Delta Rail Ltd). **As a mater of public safety it is vitally important the recorded test data held by the RSSB and Delta Rail Ltd is released into the public domain for analysis by the HSE.**

h) GM/RT2456

"All interior windows shall be of toughened glass…"

►This appears to be in direct conflict with the recommendation by the RSSB to change bodyside windows to laminated glass and retain the interior windows (interior doors using toughened glass). Reference made within the report to "people who fell out of the vehicle either through a window or through the vehicle end-connection (gangway) or through ruptures in the vehicle body shell" are at the same risk of injury and involuntary exit through the interior windows in a roll over or separation situation as they would be from bodyside windows exit. The report fails to make reference to this critical information.

i) UIC Code 564 -1

"Provision must be made for an emergency exit…"

This standard is still current until such time as the new Group Standard is introduced by the RSSB (passenger containment). Therefore, the move by TOC's to replace egress windows to laminated windows and remove emergency hammers for emergency escape is outside the requirement of current Group Standards (Pendalino, Heathrow Express etc). Further, it is my belief First Great Western Trains are already following suit and currently implementing the change to its fleet of rail vehicles and installing laminated glass (throughout).

►Although I have no knowledge of the way in which Railway Group Standards are implemented, as a layman, I would have thought any TOC operating outside current Group Standards is in some way committing an offence under British Transport law?

6) Summary:

a) The RSSB recommendation makes reference to the Potters Bar and Ufton Nervet rail accidents in which both show extremely high numbers of involuntary exits; however, when reading the final crash reports for both accidents the numbers of involuntary exits differ alarmingly to that which is found within the recommendation (graph on page 9). This clearly states nine involuntary exits occurred at the Ufton Nervet crash, however, the final published crash report states two or possibly four involuntary exits occurred. Further, there is no mention in either report as to whether these exits were via the toughened glass or end gangways. I suspect end gangway exit may be involved as both sets of crash information refer to carriages separating.

b) Two vitally important pieces of information were uncovered which relate directly to the major rail accidents used in the RSSB recommendation data. Firstly, all vehicles involved with rail accidents were of pre 1994 construction and adhered to outdated Rail Group Standards. In all cases toughened glazing was installed the full length of each vehicle and the glazing was in all probability 5/6 mm in thickness. This is vitally important when considering involuntary exit as all passengers were at risk (and still remain so) due to the glazing thickness and type being below current Group Standards. Secondly, the vehicles involved were built at a time when rail speeds were in the region of 80 mph. Vehicles involved with the accidents appear to have been in high-speed use and travelling at approximately 100 mph. This is a 25% speed increase over its intended use when first commissioned; therefore, I would suggest all vehicles of this type and in current use be restricted to their original maximum speed until such time as they meet fully the current UK rail Group Standards (in all aspects).

c) Although the RSSB recommends the removal of egress windows and emergency hammers there would be no safety benefit to current rail vehicles. With an estimated life span of 20 years it is difficult to see how passengers could benefit from the recommendations as the threat of involuntary exit would remain. Future rail accident data would only serve to complicate reports further as a mishmash of types of glazing would be utilised in a variety of vehicles. Further, rail passengers would in all likely be completely confused with escape generally as TOC's will operate vehicles without a clear and consistent exit strategy.

d) The RSSB recommendation fails to clearly explain what the new exit strategy is, further, it would appear there are no current clear and concise instructions available in any documentation or Group Standards on how one should exit a train through an exit door when the vehicle is at 45 degrees or beyond. With no obvious provision of a ladder or foothold for an individual to utilise when climbing up towards the door, it is difficult to see how the recommendation can be implemented. Much is made of the ability to exit through the gangways, as was confirmed at our recent meeting at Westminster by Ray Ford (RSSB), however, in the event rail vehicles are not separated at the time of the crash the same problems could be encountered in the next vehicle or beyond. This is extremely important when considering fire scenarios or vehicles coming to rest across adjacent tracks.

e) Two further areas of safety cause me concern and I feel both have not been answered fully in the recommendation; Fire and crowd dynamics.

The recommendation appears to suggest the likelihood of fire is extremely low and passengers are safer remaining within the vehicle than would other wise be the case if they evacuated. Further, the perception of danger when confronted with fire is based on the outcome of the Ladbroke Grove crash where fire played a major part in the loss of life. Reports of fire on rail vehicles throughout the world continue to be presented to the public via the media, therefore, any suggestion their fear is based solely on the Ladbroke Grove crash are unfounded. Further, there seems to be a failure by the RSSB to recognise the public have been indoctrinated since childhood into the belief danger can represent injury, to avoid injury one must remove oneself from the danger, fire being the most frightening and dangerous of all. Therefore, it is my belief the need to escape will rapidly overcome any desire to escape, whatever the circumstances.

f) A report by the University of Greenwich (Evacuating and overturned smoke filled rail carriage) clearly shows only a handful of passengers lucky enough to survive the impact would be likely to survive the subsequent evacuation. This further reinforces my belief egress windows play a major role in passenger escape and confirms my findings that crowd dynamics should be investigated to determine why so few passengers would survive the evacuation.

g) I am left somewhat confused by the RSSB recommendation “the risk of fire is extremely low” when the Annual Safety & Performance Report produced by the RSSB and released in 2007 clearly states: a total of 142 train fires occurred in 2006 and a further 174 fires occurred in 2005.

h) Crowd dynamics: Little is mentioned in the recommendation regarding crowd dynamics although there is mention of the “Stay or Go” report completed on behalf of the RSSB. This report is in-depth however; it does not appear to answer questions relating to the reduction of emergency exits by 50%, nor does it reference the Pendolino design of train and others operating already operating and utilising containment strategy for passengers. As this issue is of such importance I would request the RSSB responds to the two following questions (as an initial probe into their findings regarding the effect on passengers in an emergency):

1) How would 76 passengers escape in an emergency or crash rollover situation where only a single emergency exit remains?
2) What proportion of injuries and fatalities can be expected as a result of crushing when using a single exit?

j) **►The use and safety of Pendolino trains**
(Single exit door to either end on opposing sides of vehicles)

It would appear from my research Pendolino trains are operating outside current safety standards as laid down by ATOC (Association of train operating companies).

ATOC Vehicles Standard - AV/ST9002 – 2002 clearly states:
►Considerations for evacuation and escape to the vehicle side: No passenger seat in a passenger saloon or location at which a passenger may reasonably be expected to be in a side corridor shall be further than 12 m from a bodyside door or a bodyside emergency escape exit on both sides of the vehicle. In the case of dead ends the maximum distance shall be reduced to 6 m.

►Where the risk of not being able to gain access through the passenger evacuation route, or the risk of not being able to open an external bodyside door is considered high and no other means of direct access is available, then additional bodyside emergency escape exits shall be provided.

In a scenario where a Pendolino train was in a crash rollover situation only a single exit door would be available to the opposite end of the vehicle crash side. Given recent events I would suggest the probability of this re-occurring is high, therefore, additional bodyside emergency escape exits should be provided. As egress windows are not incorporated into this type of vehicle these vehicles do not conform to the current ATOC Standard and as a result should be immediately removed from service until such a time as they do conform. Effectively, they are a direct safety hazard to passengers.

Given there could be in the region of 76 passengers within a vehicle trying to exit, the probability of crushing would I suspect become a major factor when considering passenger survival. In the event this single door was blocked by debris or damage passenger escape routes would be removed completely and those within would remain entombed until rescue.

7) Conclusion:

a) As a result of my research I remain of the firm belief the recommendation published by the RSSB is flawed and has utilised data applicable to vehicles conforming to outdated standards in order to reach its conclusion, further, their conviction "no person that has ever escaped through a window would have lost their life if they had not been able to" is astonishing as I have been unable to find any information within their reports or industry documentation to support this, ►<u>I therefore, remain of the firm belief this is directly related to cost-cutting over and above absolute safety within the rail industry and make reference to the RSSB recommendation – Page 42 - Paragraph 2 "costs would be prohibitive…"</u>

b) Initial findings show the change recommendations proposed by the RSSB would not be retrospective (nor are any Rail Group Standards), therefore, the rail industry would only be obliged to remove the emergency hammers and refit new laminated glazing when replacing damaged egress panes or when vehicles undergo major refurbishment. Voluntarily implementation may be undertaken by individual train operating companies who prefer to adhere to new Group Standards however; I feel this is unlikely as this will require a considerable monetary investment, therefore, ►<u>there would be no direct and immediate cost to train operating companies (TOC's) who choose not to adhere to the changes recommended by the RSSB</u>.

c) In the event egress windows and emergency hammers were to remain, there would be an immediate cost implication to the TOC's in that all current emergency hammers (proven to be sub standard) will require replacement with a suitable and approved hammer that is capable of breaking current rail glazing (up to 8 mm in thickness). ►<u>A substantial investment will be required by each TOC to fund this change. The only possible way to avoid this investment is to recommend the removal of all emergency hammers.</u>

d) In the event TOC's decide not to remove emergency hammers from rail vehicles until such time as vehicles are due for refurbishment, which could be several years, existing emergency hammers will remain. This does cause me real concern as AEA Technology Ltd (now Delta Rail Ltd) confirmed to me all existing hammers have failed in one way or another during testing (with exception to the Lifeaxe), therefore, they are clearly "not fit for the purpose".

e) Several requests have been made directly to Delta Rail Ltd and the RSSB for the immediate release into the public domain information gained whilst testing all current emergency hammers. This work was completed by AEA Technology Rail Ltd (now Delta Rail) several months ago. Despite my repeated requests for the release of this information, to include high speed film and still images, it has been withheld. I believe this information is highly relevant to the safety of passengers and has a bearing on the recommended changes requested by the RSSB. In addition, I am of the firm belief it would be in the best interest of surviving passengers of recent rail accidents for the RSSB to explain why many of them were unable to break vehicle windows when using these hammers, and give clarification as to why an approved piece of emergency equipment repeatedly failed during use (reports of hammers breaking and bending).

f) I feel these highly important questions remain unanswered by the RSSB and would welcome their response:

- Has any loss of life been reported when using emergency egress windows as a means of escape?
- When involved in a rail accident how many passengers have chosen to remain in vehicles (rather than exit) until rescue by the emergency services?
- In a fire scenario how many passengers would choose to remain within the vehicles?
- What is the overall view of the public when requested to remain within the vehicle following a rail accident?
- What changes are to be made to the current emergency hammers to ensure they are fit for the purpose in the event TOC's choose not to remove them or they remain in service until the new RSSB recommendation has been implemented?
- The current emergency instruction leaflets and signage available on trains is in English, are there plans to change all signage to include the most common European languages?
- Has a risk assessment been undertaken by the HSE as to the effect of annealed glass particles being inhaled by surviving passengers when rescue services saw through the glazing?
- Why has toughened laminated egress windows not been evaluated within the RSSB report?

8) Recommendations:

a) Due to the serious implications to passenger safety, and as a result of this research, I am left in no doubt the recommendation by the RSSB for "passenger containment" should be withdrawn until such time as an independent review can be carried out to accurately determine if it's content is accurate and its recommendation is in the best interest and safety of the general public.

b) An urgent review be undertaken be ascertain whether Pendolino trains conform to current UK safety standards and regulations.

c) Emergency hammer testing and performance information requested from the RSSB and Delta Rail Ltd be released into the public domain immediately due to direct safety issues relating to their failure to break emergency egress windows in all types of accident.

d) An urgent review is undertaken to determine if there is any passenger safety issues regarding vehicles operating to pre 1994 Group Standards at high speed, and whether there is any correlation to the increase in speed and the accident data relating to involuntary exit (where toughened glass is utilised throughout bodyside windows).

e) The RSSB confirms in detail, and as a matter of urgency, what the exit strategy and method for escape is for vehicles already utilizing containment strategy.

f) The RSSB confirms the time scale for implementation of the removal of emergency hammers (to include changes to current regulations and standards) and whether TOC's have already as a result of the recommendation, started their removal ahead of formal changes being made to the relevant regulations and standards.

g) The RSSB advices, as a matter of urgency, whether TOC's have already implemented, or started to implement (in part or in whole) the change from toughened egress windows to laminated windows.

h) The RSSB responds to the many safety issues raised within the report and more specifically the summary and conclusions.

9) Bibliography

Reference	Description	Issued by	Issue date
AV/ST9002	Vehicles Standard **-** Vehicle Interiors Design for Evacuation and Fire Safety	ATOC	2002 Dec
T424	Requirements for train windows on passenger carrying rail vehicles	RSSB	-
BS857	Specification for safety glass for land transport	BSI	
UIC Code 564 -1	Windows made from safety glass (Emergency hammers)	IUR	1990 Jan
GM/TT0122 Withdrawn	Structural requirements for windscreens and windows on railway vehicles	RSSB	1993
GM/RT2456	Structural requirements for windscreens and windows on railway vehicles	RSSB	2002 April
DCOL 2/2004	Methods of forcible entry – Fire research Division – Gaining entry update	odpm.gsi.gov.uk	2004
INDG358 C50	Guidance on the provision of equipment and arrangements for evacuation and escape from trains in an emergency	HSE	1002 July
Research	Passenger containment – Rail industry recommendations	RSSB	2007 July
Research	Computational Modeling of Non-adaptive Crowd Behaviors for Egress Analysis CIFE Seed Research Proposal	CIFE	2003
Research	Paper No 00/IM/55, ISBN 1899991 56 5, 2000 Fire Safety Engineering Group – University of Greenwich	CMS PRESS	2000
RSSB	Annual Safety and performance report (blue handbook)	RSSB	2006
The Tech online	Washington post – Eight of 11 train crash victims died of fire	-	1996 Feb
Times online	Unbreakable windows “are a recipe for panic” rail crash survivors say	Times Newspaper	2007 Aug
Grayrigg	Train derailment Interim report, Cumbria 23 Feb 2007-09-04	RAIB	2007 Feb
Ufton Level	Train collision with a road vehicle and subsequent derailment - Final Report	RSSB	2004 Nov
Potters Bar	Train derailment Interim Report	HSE	2002 May
Hatfield	Train derailment final report (Office of Rail regulation)	ORR	2006 July
Copmanthorpe	Fatal collision between a Super Voyager train and a car	RAIB	2006 Sept
Chief Fire Officers	Office of the Deputy Prime Minister – DCOL 2/2004	Fire Brigade	2004 Jan
Letter	Martin Horwood MP – From Anson Jack Director of Policy	RSSB	2007 July

Abbreviations:

RSSB	Rail Safety & Standards Board
TOC	Train Operating Companies
ORR	Office of Rail Regulation
ATOC	Association of Train Operating Companies
BS	British Standards

10) Notes

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