Final Report

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Title:

Safety Consideration of Longitudinal Seating Arrangements in Buses and Coaches

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Contractor and Project Co-ordinator: Cranfield Impact Centre (CIC)

Project Manager: Dr S M R Hashemi
Project Engineers: Dr A C Walton and Dr S M Whayeb

Partner: Vehicle Safety Research Centre (VSRC)
at ICE Ergonomics Ltd
Represented by: S Cook

Project funded by the European Community under the Directorate-General ENTR/F/5
Mr Per-Ove Engelbrecht (Head of Unit)
AN 88: 2/53
Rue de la Loi, 200, B-1049 Brussels, Belgium

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EXECUTIVE SUMMARY

This document is prepared in response to the General Invitation to Tender No. ENTR/00/020 by the European Commission, ENTR/F/5 and is submitted in compliance with the administrative requirements and Terms of Reference accompanying the Invitation.

The aim of this investigation is to conduct a research of the safety of longitudinal seating configurations in buses and coaches. The study divided into five inter-linked investigations focussed on the side facing related issues. A thorough literature survey of the longitudinal seats in M2 and M3 vehicles together with inventory of the existing regulations for such vehicles enforced within and outside Europe was conducted. Accident research data were reviewed to assess, as far as possible, the safety implications for bus and coach passengers in side facing seats. The search also included views expressed by the organisations or operators of public transport regarding security of such seats. This was achieved through a questionnaire with targeted related issues. In addition, the effectiveness and implementation issues with regards to occupant safety of 2 and 3 point belt systems were investigated.

The outcome of the systematic approach from the five inter-linked investigations was an opinion as to whether longitudinal seating arrangements in class III and B of M2 and M3 vehicles should be permitted and also the nature and extent of any condition attached to the use of them. The results of the survey from soliciting relevant organisations with respect to various issues on side facing seats appear not to be in favour of the use of such seats in M2 and M3 vehicles. Whilst it has not been possible to make any recommendations based on real world accident data, information obtained in the course of this study suggests that longitudinal seating:

- Should NOT be permitted in those classes of vehicles where standees are not allowed.
- SHOULD be permitted in those classes of vehicles where standees are allowed subject to certain design considerations and the nature of operation of the vehicle e.g. whether it is local service, city bus, etc.

(1) INTRODUCTION

This report presents the results of an investigative research into the issues concerning safety of the longitudinal seats in M2 (minibuses) and M3 (buses and coaches) vehicles. A systematic approach to obtain information in order to look at the possibilities to further enhance the safety of passenger in motor vehicles equipped with such seats was adopted. The research was carried out by a consortium of two organisations with previous experience in the safety of road vehicles.

Both CIC, as the contractor and VSRC, as a partner, are currently involved in a 5th framework project, no 1999-RD.11130 funded by DG TREN, entitled Enhanced Coach and Bus Occupant Safety (ECBOS). In addition both organisations were involved in a European Commission backed programme Tender No. III/96/37 on " Study to Further Enhance the Safety of Passengers in Motor Vehicles" that was completed in 1997.

(2) OBJECTIVES

The objectives of this investigation were to enhance understanding of the safety of longitudinal seating in buses and coaches, with specific reference to:

(1) general overview of the literature survey;
(2) inventory of the existing regulations;
(3) accident data analysis;
(4) consultation with public and private interested parties;
(5) suitability of 2 and 3 point belt system configurations.

Although there is specific legal requirement or EC Directives, for side facing seats in M2 and M3 vehicles, it is expected that the outcome of this study, based on the above approach, will help to provide added value to establishing more appropriate safety standards.

The emphasis of the investigation, in relation to side facing seat regulations in buses and coaches, was on the issues concerning:

(a) construction characteristics;
(b) type approval testing procedures;
(c) seat positioning;
(d) seat mounting and fixation.

The M2 and M3 vehicles are divided into different classes. Both rear facing and side facing seats, sometimes with combination of the two, are still being used in the urban buses. These seats, due to either design constraints or for maximising space, are located over the wheel arch. The side facing seat passengers in such vehicles, albeit at low velocity impact, where no seat belts are fitted, are exposed to the effects of combined loading with either standees or those in rear facing seats and also impact with stanchions or bulkheads (glass panels).

Rear facing seats, although mentioned here, with appropriate floor attachment is considered safe in front impact. The fitting of rear and side facing seats in M2 and M3 can be divided into the following: -

Rear facing seat in minibuses⇨	not fitted
Rear facing seat in buses (city vehicles)⇨	usually fitted over wheel arch
Rear facing seat in coaches⇨	limited use
Side facing seat in minibuses⇨	limited use due to EEC regulation on carrying of Children (Advice to users and operators of minibuses and coaches carrying children, DETR VSE 1/96)
Side facing seat in buses (city vehicles)⇨	fitted over wheel arch and near exit doors
Side facing seat in coaches⇨	not fitted

This investigation is mainly focussed on the effects of side facing seats in M2 and M3 for class III (***vehicles constructed exclusively for the carriage of seated passengers***) and class B (***vehicles not designed to carry standing passengers; a vehicle of this class has no provision***

for standing passengers) vehicles. The following outlines the definition of the vehicle classification.

(2.1) *VEHICLE CLASSIFICATION*

The following definitions for M2 and M3 vehicles were extracted from EU web page.

M2 and M3 (Class III and Class B)

- M2 is a bus with more than 9 seats for passengers and driver and weighs less than 5t.
- M3 is a bus with more than 9 seats for passengers and driver and weighs more than 5t.

Motor vehicles of category M2 or M3:

- ***'Bus or coach` means a vehicle of category M2 or M3 designed and constructed for the carriage of seated, or seated and standing passengers.***
- 'Articulated bus or coach` means a bus or coach which consists of two or more rigid sections which articulate relative to one another, the passenger compartments of each section intercommunicating so that passengers can move freely between them; the rigid sections are permanently connected so that they can only be separated by an operation involving facilities which are normally found only in a workshop.
- 'Double-deck bus or coach` means a bus or coach where the spaces provided for passengers are arranged, at least in one part, on two superimposed levels, and space for standing passengers is not provided on the upper deck.

'Class` of a bus or coach means:

- For vehicles having a capacity exceeding 22 passengers in addition to the driver:
  - 'Class I`: vehicles constructed with areas for standing passengers, to allow frequent movement of the passengers,
  - 'Class II`: vehicles constructed principally for the carriage of seated passengers, and designed to allow the carriage of standing passengers in the gangway and, if provided, in an area which does not exceed the space provided for two double seats,
  - ***'Class III`: vehicles constructed exclusively for the carriage of seated passengers.***
- For vehicles having a capacity not exceeding 22 passengers in addition to the driver:
  - 'Class A`: vehicles designed to carry standing passengers; a vehicle of this class has seats and may have provision for standing passengers,
  - ***'Class B`: vehicles not designed to carry standing passengers; a vehicle of this class has no provision for standing passengers.***
  - A vehicle may be regarded as belonging to more than one class. In such a case it must comply with all the corresponding requirements of this Directive.
  - Vehicles of category M2 or M3 other than buses or coaches are considered to be special purpose vehicles (e.g.: ambulances).

Whilst these definitions exist, it was not always possible to obtain information directly relevant to Class III and Class B vehicles in the sections below. Much of the information discussed therefore can only be generalised at the M2 and M3 level of definition.

(3) LITERATURE RESEARCH

A comprehensive perusal of the work conducted in the area of side facing seats in M2 and M3 vehicles, both within and outside the EC, was carried out. This information was in terms of field tests, controlled laboratory tests and numerical analysis performed to ascertain design feasibility of seat/floor issues and occupant protection.

(3.1) *CONSULTED DATABASES*

The following databases were consulted to obtain relevant information for this study: -

- Society of Automotive Engineers (SAE) – Global Mobility Database;
- National Technical Information Services (NTIS);
- Compendex;
- Motor Industry Research Association (MIRA) – Automotive Abstracts;
- NASA Star;
- International Transport Research Documentation (ITRD)
- Global and US Patent plus Trademark Office

(3.2) *REVIEW OF RELEVANT CONSULTED DOCUMENTS*

Kecman (1997) examined the issue of side facing and rear facing seats in coaches, buses and minibuses as part of a wider study looking at the safety of seats in Public Service Vehicles. This document contains an extensive reference to the issue of side and rear facing seats and occupant injuries in class M2 and M3 vehicles

With regard to minibuses with side facing ('crew') seats, five accidents involving such vehicles were identified from an on-going study of UK vehicle accidents. The five cases varied in severity from minor to multiple-fatal (due principally to the onset of fire). None of the rear occupants seated on side facing seats were wearing seat belts. Kecman noted that the occupants were thrown against a range of objects within the vehicles (principally, other forwards facing seats and their occupants, including the driver) and also against the rear doors of the vehicle. However, the sample was too small for estimates to be made regarding the injury reducing potential of seat belts in these particular cases.

The author observed that seat belts would eliminate the hazardous movement of unrestrained side facing occupants during impact and would also prevent possible ejection. On the limited accident evidence available, it could not be concluded whether lap-only belts, or lap and shoulder belts ('3-point') would be most beneficial. Whilst a 3-point belt is most effective for front facing occupants, it was noted that for side facing occupants, the shoulder strap can be arranged to pass over the 'leading' or the 'trailing' shoulder. If the 'leading' shoulder option is chosen, this may result in the belt applying forces across the occupants' neck in a frontal crash. If the 'trailing' option is chosen, the upper torso may simply slide out of the upper strap. The reverse situation, in terms of occupant-seatbelt interaction, would occur if the vehicle were impacted from the rear instead of from the front.

Kecman concluded that it was preferable for the side facing occupant to be restrained rather than be unrestrained. However, due to the issue of possible neck loading by the belt, he could not determine whether lap-only belts or 3-point belts would be the most effective. To further

explore this question, a computer model of a side facing seated occupant was developed. Various seat belt configurations were tested along with different dummy types and crash signals. In addition, a number of full-scale sled tests of side facing minibus seats, both with and without a 3-point restraint system, were conducted.

For side facing seats, the authors' conclusions from the simulation and tests were as follows:

- The full-scale sled tests of 3-point belted dummies on side facing seats indicated 'the effectiveness of belts in terms of restraining the occupants in the seats'. No injury data were measured in these tests.

- Side facing seats in M2 and M3 vehicles 'create an accident environment and possible body kinematics which are significantly different from the car side impacts'. Consequently, the technology which is used to evaluate side impacts into cars (specifically, the side impact dummy 'EuroSID'), can not be directly transferred to this minibus and bus occupants.

- The main areas of injury protection to be considered with side facing seats are;
  - the head (using the standard Head Injury Criterion injury measure)
  - the neck (no neck lateral bending injury criterion exists but it was observed that, as a first approximation, a limit of 54 to 57 Nm could be used from data defining neck extension limits in the fore-aft plane)
  - the rib cage (a lateral rib compression not exceeding 42 mm is required in car side impact tests, for example)
  - the abdomen and pelvis (EuroSID injury parameters could be adopted for these areas)

- Using the M2 deceleration signal sled test with a Hybrid III dummy fitted with a 3-point belt, (the diagonal belt being over the forward shoulder), the bending moment of 61.9 Nm was slightly above the adopted lateral bending criteria.

- For side facing seats, Kecman observed that suitable panelling immediately in front of the seat to restrain the occupant, offered 'a truly safe' solution. He noted that a 'compartmentalised' seat layout was used in some Australian off-road vehicles but that this approach was not feasible in M2 and M3 vehicles. The author did note that this approach would be suitable for medical personnel in ambulances who have to use side facing seats.

- The author recommended that in M2 and M3 vehicles where standees are prohibited, then side facing seats should also be prohibited

For M2 and M3 vehicles with rear facing seats, Kecman's study could find no instance of an impact involving an M2 or M3 vehicle with rear facing seats. The conclusions reached on rear facing seats are summarised as follows:

- In frontal vehicle impacts, rear facing seats are subject to loading from the forward inertia of each occupant in the seat. This places a bending moment in the seat back and at the attachment points of the seat to the bus floor and side structure.

- Conventional forward facing seats to which 3-point belts are attached would have to be reinforced to maintain their integrity in a rear facing location.

- An effective head restraint is essential for each rear facing seat.

- In tests on conventional M3 seats with 3-point belts in a rear facing mode, the seat back was found to fail. In such cases, the belt restraint remained intact and the injury levels were acceptable provided that the space immediately behind the tested seat was unobstructed. Obstacles in this area would have had some effect on the injuries received to the occupant in the failed seat.

- Computer simulation was used to explore the effect of an unrestrained forward facing occupant striking an unrestrained rear facing occupant – this simulated a 'bay seating' arrangement. It was found that the impact of the forward facing occupant on the rear facing occupant caused 'significantly higher' loads on the rear facing seat than was experienced from the rear facing occupant alone. This result was also dependent upon minor variations between the seating position of both dummies **(Ref. 3.2.1)**.

Schneider et al (1979) conducted a series of sixteen sled tests on bus restraint systems for handicapped children. These involved tests of wheelchairs oriented in the forwards facing and side facing mode, restrained by wheel clamps and supplemented by various seat belt systems. Tests were also conducted on various forward facing standard bus seats (but not side facing seats), supplemented by seat belt systems. A nominal sled pulse of 16g applied for 0.6 seconds was applied in all cases. Rear facing seats were not considered in these tests.

The authors noted that for side facing wheelchairs attached to the floor by wheel locks, whilst the locks did not fail, they did not prevent the wheelchair from rotating sideways. The dummies were seen to flail sideways during impact, into and over the armrests, with lateral head displacements of 0.96-0.99 metres. Damage to the chairs was substantial.

Schneider observed that the majority of school bus accidents involved frontal or rear end collisions. He also noted that Federal Motor Vehicle Safety Standard 222 required that all school buses made after April 1978 should be fitted with forward facing seats only. He recommended, on the findings of this study, that this forward facing only requirement should also be applied to wheelchairs and all bus seats used by handicapped children **(Ref. 3.2.2)**.

Dickison et al (1997) looked at the fitment of seat belts to minibuses. The minibuses examined were those used primarily for private hire and not those used for stage carriage bus services. These vehicles were of unitary construction and did not have a separate chassis. Consequently, seats and seat belt anchorages were attached to thin-wall floor structure that was reinforced at the attachment points by washers or similar spreader plates. Under static pull tests specified by ECE Regulation 14 (seat belt anchorages), these attachment systems were seen to fail by pulling the attachment bolts through the floor structure. Similarly, the floor track attachment rails commonly used for wheelchair attachment in these vehicles were also seen to fail under this test. The solution proposed and tested by the authors consisted of an additional tubular frame fixed underneath the vehicle floor to which the seat belt anchorage, seat and wheelchair restraint systems could be directly fixed. Side facing seats were not considered **(Ref. 3.2.3)**.

Millar (1996) reported on the anticipated effects of the UK introduction of the compulsory fitting of seatbelts in all minibuses and coaches carrying children on school journeys, from 10th February 1988. He noted that from that time, all belt anchorages must comply with EU Directive EEC/76/115 or ECE Regulation 14 and that all belts must comply with EU Directive EEC/77/541 or ECE Regulation 16. Millar noted that the regulations did not apply to side facing seats and, (at that time), they did not apply to any other bus journeys other than those connected with school **(Ref. 3.2.4)**.

Dusseau et al (1995) used a Finite Element model of a typical US school bus structure, complete with seats, to predict the loads generated during braking. The authors noted their constraint at being able to use only static and linear-elastic modelling assumptions (as opposed to dynamic and non-linear assumptions). They observed that a dynamic, non-linear analysis 'might have been a more accurate method' but it was 'deemed to be far beyond the scope and budget of this analysis'. This paper considered the stress distribution within the vehicle framework under emergency braking, (represented by variations in pitch angle of the vehicle chassis plane). Impact load cases were not discussed. Reference was not made to side facing seats **(Ref. 3.2.5)**.

The Department of the Environment, Transport and the Regions (1998) published a document that requested public response to the UK Government's proposals for public service vehicle accessibility regulations. Amongst other issues concerning access to buses and minibuses for disabled users, this document outlined suggested installations for forwards and rearwards facing wheelchairs. The document recommended that for low-floor buses, wheelchairs could be carried without the need for a rigidly fixing the chair to the vehicle structure within areas of suitable design. In addition, the document suggested the preferred layout of 'Priority Seats' for the ambulant disabled. It recommended that these should be located near doorways and that these could be forward or rearward facing, within specified design parameters **(Ref. 3.2.6)**.

Khalidar at al (1980) considered bus crash protection for the handicapped in terms of ordinary 'transit' (stage carriage) buses and also school buses in the US. The authors examined a wide range of design features relating to safety of these vehicles for disabled users. In this, they noted that the ambulant disabled find the provision of side facing seats near the front entrance to be of benefit; forward facing seats would otherwise physically restrict their use. However, they added that the use of seat belts on side facing seats would be beneficial, as would additional crash protective padding.

Based on their investigation of bus accidents, the authors noted that the primary features of bus interiors that cause injury are the seat backs, stanchions, windows and those areas of the bus that are deformed when impacted by another vehicle. In the latter case, they observed that injuries caused by an impact with another vehicle are concentrated in the area of the bus where the impact occurred **(Ref. 3.2.7)**.

Petzall (1993) conducted a series of trials using ambulant disabled participants. This tested the suitability of a number of bus entrance designs and seats for these users. Variations in step heights, hand hold type and position and seat spacing were studied. No reference was made to side facing seats **(Ref. 3.2.8)**.

Thornthwaite (1990), in a review of the current literature, discussed the issues concerned with the mandatory fitment and use of seat belts in school buses. The author noted that Canadian studies had found that lap-only belts, in forward facing seats, may serve to increase head injuries by causing the belted occupant to rotate about the waist in a frontal impact. The author also noted that in the US and Europe, that more children were injured by being struck by the bus itself, or by other vehicles, when getting on or off, than were injured within the bus. The authors did not address the issue of side facing seats **(Ref. 3.2.9)**.

Siegal et al (1971) conducted a detailed study of US bus accidents based on 1960's data. The study was wide ranging in that it considered the significance of driver selection and training, vehicle maintenance, crashworthy design and fire hardening, in relation to overall bus safety. This study focused on severe type impacts where extensive structural damage was done to the vehicle. None of the vehicles studied appears to have been fitted with side facing seats and the authors did not consider this subject **(Ref. 3.2.10)**.

In a study of newly-introduced low floor buses in New York, **(Schaller et al, 1998)** noted, *'In general, bus designers can fit more side facing seats than single forward facing seats into a bus. However, customers strongly prefer forward facing seats because they are more comfortable when the bus stops quickly (customers do not like to slide sideways). They also provide better sight lines out of the windows to see the bus' location, and they help customers avoid disconcerting eye contact with strangers sitting across the aisle'* **(Ref. 3.2.11)**.

(4) REVIEW OF REGULATIONS AND LEGISLATION

There are a wide variety of accident scenarios in various modes of transport. They involve vehicles of different sizes and impact speeds. Despite such large variations in accidents, which are very dynamic phenomena and involve a range of influencing factors, various regulations are being introduced to enhance the safety aspects of various types of private and public transport.

Safety standards were initially introduced to cover automobile crashes (**Ref. 4.29)**. These standards specify test conditions under which injury indices must be met. These indices are based on NHTSA (National Highways Traffic Safety Administration) and EEVC (European Experimental Vehicle Committee) standards (**Refs. 4.28 and 4.29)**. They are being introduced and enforced in private and public modes of transport. Both aircraft and coach industries also have to comply with extensive regulations. The former ones are universally accepted, but the latter standards are only enforced in some of the European member states.

In relation to the occupant safety, the standards define test pulses, also used in analytical simulations of the occupant response, to establish the injury indices. An outline of the laboratory test pulses used universally or across Europe in automotive, aircraft and coach industries is given in Table 1. Both pulse and seat pitch must be defined in the HyGe Sled tests. The aim must be to make the test conditions as sever as possible to represent the 'worst case', while operating within the bounds of the regulations on accelerations and total velocity change. The deceleration pulse corridor for the ECE80 regulations, for instance, has a 90 ms of plateau between 8g and 12g levels. The test pulse, for possible worst case scenario, therefore, must be tailored to be very close to 12g approximately and also remain within the corridor. The shape and spread of the test pulse are influenced by the distribution of the masses and whether they remained coupled during declaration.

Figure 1 shows the pulse envelopes used in the HyGe sled test for different public service road vehicles, such as cars, coaches and minibuses. The ECE80 requirements of the European Standard are defined to regulate the provision of the seating in road passenger vehicles. It requires a sled-test with an acceleration pulse that lies within the corridors.

(4.1) *AVIATION INDUSTRY*

Most of the survivable air crashes are in and around airports during initial take-off or final lading approach. Air safety regulations such as JAR 25 (Joint Airworthiness Requirements) and FAR25 (Federal Aviation Requirements) and their derivatives for non-transport category are becoming more stringent in order to improve passenger survivability **(Ref. 4.23)**. In June 1988 new performance standards for transport aircraft seats were introduced by the FAA (Federal Aviation Administration). These included two dynamic tests for the assessment of the seat structural performance and the occupant restraint systems, FAR 25.561/562, **(Ref. 4.24 and 4.25)**. The European Joint Aviation Authorities adopted these standards shortly after for the type approval of aeroplanes manufactured for commercial operation. The aim was to improve passive protection provided to the passengers and consequently reduced the risk of injury and fatality in emergency crash conditions. These standards in aviation were the first requirements demanding a quantitative evaluation of the potential for human impact injury.

However, so far, these standards for forward and rearward facing seats are being used for side facing seats or couches on aircraft such as executive jets. Attempts in the aviation sector are also underway to address this issue.

(4.2) *COACH INDUSTRY*

There are a number of safety regulations in the ECE directives on many aspects of passenger safety in coaches and minibuses. These standards are for seat tests, and consequently occupant response, for vehicles of different size and weight, referred to as M1 for cars and M3 for coaches **(Ref. 4.26)**. Whereas ECE66 deals with the rollover strength of the coach structure to absorb the required energy before the occupant survival space is compromised, other regulations such as ECE80 are used, for seat strength in coach industries for M3 vehicles and ECE44 child restraint in cars, for the protection of the passenger in public transport.

The M2 proposed corridor, shown in Figure 1 is for lighter M2 vehicles (minibuses). These corridors are based on the accident research data collected over many years from the inspection of the crashed vehicles, collection of data related to occupant injuries, accident reconstruction and assessment of the sources of injuries **(Refs. 4.26 and 4.27)**. The current safety testing approach as defined by these pulse corridors, is to identify typical accident scenarios for which it makes sense to legislate and also to develop a simplified and standardised test procedure aimed at reflecting the main features of the representative accident scenarios **(Refs. 4.26-and 4.29)**.

In the HyGe sled test, the following criteria must be satisfied: -

- Seat and belts resist the loads and remain attached at all points of attachment.
- Loads in the belts stay below set limits.
- Maximum value of the head injury criteria (HIC) is not exceeded. Note that special tests have to be performed to prove the HIC criterion is met for different seat types and configurations.

These criteria are being updated to include load limits to other parts of the human body, such as neck, tibia and spine loads.

Breaking Velocity for the Pulse Corridors in Various Modes of Transport (Figures 52 to 54)	HyGe Sled Test Velocity Change (km/h)
ECE 80 Lower Boundary (M3 Vehicle Pulse, Coaches) ECE 80 Upper Boundary (M3 Vehicle Pulse, Coaches)	30 +2 -0
ECE 44 Lower Boundary (M1 Vehicle Pulse, Cars) ECE 44 Upper Boundary (M1 Vehicle Pulse, Cars)	48 +2 -0
Lower Boundary (M2 Vehicle Pulse, Minibuses) Upper Boundary (M2 Vehicle Pulse, Minibuses)	50 +2 -2
Aircraft Dynamic Certification, Seat Test 1 Aircraft Dynamic Certification, Seat Test 2	38.4 48.3
Lower Boundary (BRR Proposed, Rail Vehicles) Upper Boundary (BRR Proposed, Rail Vehicles)	30 +2 -0

Table 1 HyGe Sled Test Velocity Change for Various Modes of Transport

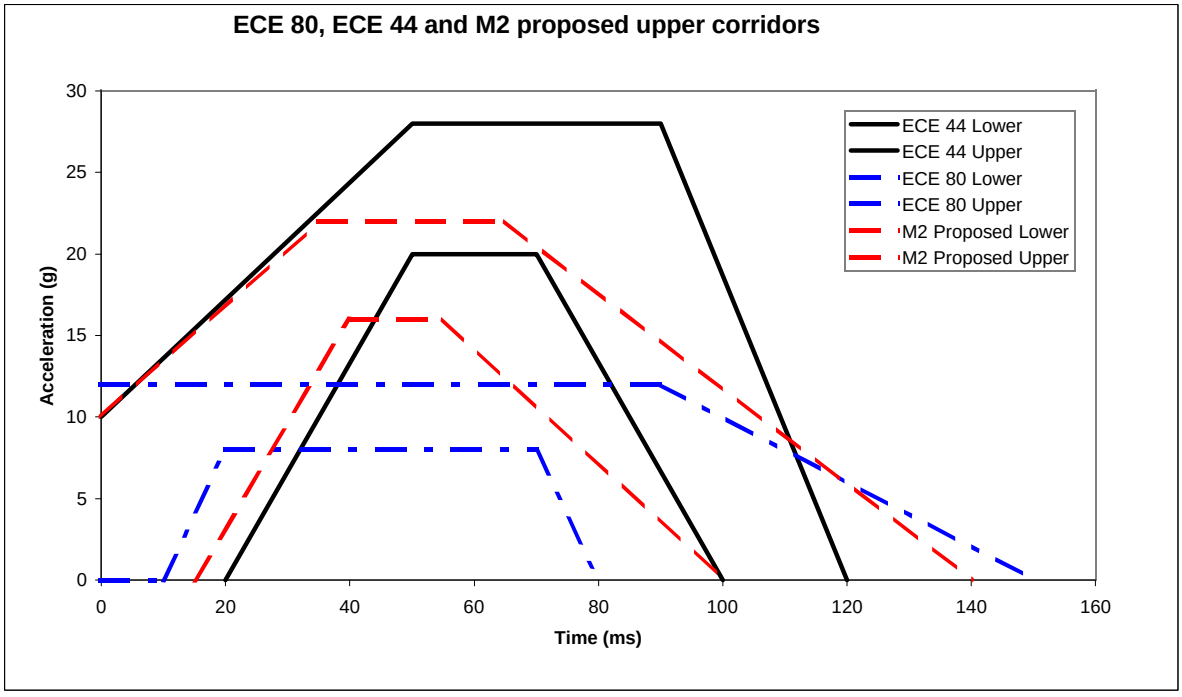

Figure 1 HyGe Sled Test Pulse Corridors for Various Modes of Transport (Refs. 4.27 ,4.29)

(4.3) *INVENTORY OF RELATED REGULATIONS*

The aim of the review of regulations is to provide an inventory of regulations governing the use, construction characteristics, positioning, fixation and type approval testing procedures for longitudinal seating including, where appropriate, 2 and 3 point belts.

Appropriate authorities and databases were consulted in order to obtain sufficient information on the existing standards for the concerned categories of the vehicles e.g. side facing seats in M2 and M3. A thorough review of the European standards was carried out to establish the commonality between them and other global standards. The evaluation of this phase may assist possibility of defining a minimum common standard for protection of occupants in the vehicles equipped with side facing seats.

As part of the regulation review advice and consultation was sought with:

- ILI, specialists in worldwide hardcopy Standards and Specifications and publishers of engineering, technical and regulatory. Whilst some assistance was given regarding European regulations, they could not provide guidance on regulations in this area pertaining to United States, Canada, Japan and Korea,

- Europa, the portal site of the European Union (http://europa.eu.int/), which provides up-to-date coverage of European Union affairs and essential information on European integration. Using this site it is possible to consult all legislation currently in force or under discussion,

- SAE, the Society of Automotive Engineers, concerning any vehicular requirements which they had which may be relevant to this work.

4.3.1 EC and UK

ECE Regulation 80 **(E/ECE/324, E/ECE Trans/505)** relates to uniform provisions concerning the approval of seats of large passenger vehicles and of these vehicles with regards to the strength of the seats and their anchorages. It applies to vehicles constructed for the carriage of more than sixteen passengers in forward facing configuration, in addition to the driver and crew.

Both dynamic and static R-80 seat test requirements are applicable to the side facing seats in a vehicle when involved in side impact situation. The R-80 static test for seat back break-over strength requires simultaneous load application via special devices pressing the seat back from behind at approximately knee and upper torso impact levels by using two different former sizes.

The following text is taken from the UK's Department of the Environment, Transport and the Regions web site **(DETR 2000)** and relates to the fitment of seat belts in minibuses and coaches:

'The new seat belt requirements for children are contained in The Road Vehicles (Construction and Use) (Amendment) (No.2) Regulations 1996, Statutory Instrument (S.I,)

No. 163. This S.I. further amends Regulation 47, and adds Regulation 48A to The Road Vehicles (Construction And Use) Regulations 1986, S.I. No. 1078.

The change to the "3 for 2" concession is contained in The Public Service Vehicles (Carrying Capacity) (Amendment) Regulations 1996, S.I. No. 167. This S.I. further amends The Public Service Vehicles (Carrying Capacity) (Amendment) Regulations 1984, S.I. No. 1406.

Regulations 46, 47 & 48 (as amended) of The Road Vehicles (Construction And Use) Regulations 1986, S.I. No. 1078 define the statutory requirements for seat belt anchorages, seat belts and their maintenance respectively. They refer to technical standards in United Nations Economic Commission for Europe (UNECE) Regulations, European Community Directives (EC), and British Standards (BS).

Technical standards for seat belt anchorages are contained in:

- *UNECE Regulation 14, latest revision 03. This specifies position and strength requirements for seat belt anchorages, whether or not incorporated into a seat.*
- *EC Directive 76/115/EEC (with amending Directives 81/575/EEC, 82/318/EEC, 90/629/EEC and 96/38/EEC). Generally equivalent to UNECE Regulation 14.*

Technical standards for seat belts are contained in:

- *UNECE Regulation 16, latest revision 04. This specifies technical requirements for adult seat belts.*
- *EC Directive 77/541/EEC (with amending Directives 82/319/EEC, 90/628/EEC and 96/36/EEC). Generally equivalent to Regulation 16, but also covers requirements for installation into the vehicle.*
- *BS3254: 1960 (no longer issued for new approvals) or BS 3254: Part 1: 1988. The latter is usually only used for retrofit seat belts.*

Technical standards for child restraints are contained in:

- *UNECE Regulation 44, latest revision 03.*
- *BS3254: 1960 (no longer issued for new approvals) or BS 3254: 1960 as amended by Amendment No. 16 published on 31 July 1986 under the number AMD 5210, BS 3254: Part 2: 1988 or BS3254: Part 2 1991, BS AU 202, BS AU 202a or BSAU202b.*

Seat belt wearing requirements are contained in:

- *The Road Traffic Act 1988 (Amendment) Regulations 1992, S.I. No 3105;*
- *The Motor Vehicles (Wearing of Seat Belts by Children in Front Seats) Regulations 1993, S.I. No. 31; and*
- *The Motor Vehicles (Wearing of Seat Belts) Regulations 1993, S.I. No. 176'.*

Note that in the UK, the effect of 'The Road Vehicles (Construction and Use) (Amendment) (No.2) Regulations 1996, Statutory Instrument (S.I,) No. 163' is that it requires every forward facing seat to be fitted with a seat belt in a minibus or coach that is used for carrying children. Vehicles with side facing and rear facing seats can be used, but children can not occupy these seats **(Ref. 4.1)**.

European Commission Directive 96/37/EC **(Eur-Lex 1996)** specifies requirements for vehicles *'of category M or N with regard to their seats, seat anchorages and their head restraints, or of a vehicle of category M2 or M3 with regard to their anchorages'* **(Ref. 4.2)**.

4.3.2 USA

In the USA, Federal vehicle construction standards are governed by the Federal Motor Vehicle Safety Standards **(NHTSA 2000)**. In relation to bus and coach design, only FMVSS Standard No 222 is applicable, as at end of year 2000. This standard *'establishes occupant protection requirements for school bus passenger seating and restraining barriers. The purpose of this standard is to reduce the number of deaths and the severity of injuries that result from the impact of school bus occupants against structures within the vehicle'* **(Ref. 4.3)**.

4.3.3 AUSTRALIA

A report by Transport Canada **(Transport Canada 1998)** noted that *'Australia's Design Rule 68 requires, since 1994, three-point seat belts in "heavy omnibuses" and has its own accompanying seat tests. Australia acted before an international standard was in effect as a result of a series of tragic fatal collisions involving violent bus impacts with other heavy vehicles. There was indication of seat failure contributing to injury in those crashes. Australia designed-in, and maintains the need for, a higher dynamic force requirement than in the ECE standard. Verbal reports on crashes with more recent coaches suggest that the Australian standard is successful at addressing seat failure and retaining passengers. Fatalities have occurred only among non-belted passengers'* **(Ref. 4.4)**.

(Henderson et al 1994) considered the fitment, effectiveness and cost of seat belts in school buses in New South Wales, Australia. The authors made no reference to the subject of side facing seats. However, they did observe from US studies that *'the overwhelming cause of injury in a school bus collision is the seat. In most US school buses made before 1977 there was exposed steel tubing on the tops of seat backs, and the backs of the seats were unpadded'*. The authors went on to point out that the use of a lap belt only in this situation *'could increase the risk of injury because 'the lap belted passengre pivots about the belt and slams the head, face and, if tall enough, chest into the seat back ahead'* **(Ref. 4.5)**.

(4.4) *SUMMARY OF LEGISLATION*

The status of the review of regulations to date is given in table below. Those items of legislation which have been highlighted indicate requirements which may pertain to longitudinal (sideways facing) seating.

LEGISLATION	APPLICABILITY	CONSTRUCTION	POSITIONING	FIXATION	TYPE APPROVAL TESTING	SEAT-BELTS	USE
European Union							
2000/0315 (COD) Proposal for a Directive of the European Parliament and of the Council ***amending*** **Council Directive 91/671/EEC** on the approximation of the laws of the Members States relating to compulsory use of safety belts in vehicles of less than 3.5 tonnes	Amend Article 1: to include all M2 and M3 vehicles, to include rearward facing seats *by implication sideways facing seats are excluded* Amend Article 2: all occupants to wear safety belts.	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Commission Directive 00/3/EC of 22 February 2000 ***adapting*** to technical progress **Council Directive 77/541/EEC** relating to safety belts and restraint systems of motor vehicles	No amendments to Article 9 or Annex 1 of Directive 77/541/EEC suggesting that this Directive is not applicable to M2 and M3 vehicles. However Article 2 indicates that this Directive and Directive 77/541/EEC are applicable to M2 no greater than 3,5 tonnes.	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Enforcable with respect to child restraint systems	Not Applicable
Commission Directive 96/38/EC of 17 June 1996 adapting to technical progress Council Directive 76/115/EEC relating to anchorages for motor vehicle safety belts	Article 1: applies to forward or rearward facing seats only. Annex I: Refers to the minimum number of safety belt anchorages for forward and rearward directed seating positions only.	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Commission Directive 96/37/EC of 17 June	Annex III, 1.1.1: Applies to M2 and M3 vehicle						

LEGISLATION	APPLICABILITY	CONSTRUCTION	POSITIONING	FIXATION	TYPE APPROVAL TESTING	SEAT-BELTS	USE
1996 adapting to technical progress Council Directive 74/408/EEC relating to the interior fittings of motor vehicles (strength of seats and of their anchorages)	categories (except those for both urban use and standing passengers) and to forward facing seats only.	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Commission Directive 96/36/EC of 17 June 1996 adapting to technical progress Council Directive 77/541/EEC relating to safety belts and restraint systems of motor vehicles	Annex I: Applies to forward and rearward facing seats only.	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Council Directive 91/671/EEC on the approximation of the laws of the Members States relating to compulsory use of safety belts in vehicles of less than 3.5 tonnes	Article 1: Applies to M2 vehicles except rear seats, vehicles with a maximum permissible weight exceeding 3,5 tonnes and places for standing passengers) *by implication sideways facing seats are included.*	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Article 2: Passengers must wear safety belt/restraint system where supplied	Not Applicable
Commission Directive 1990/629/EEC of 30 October 1990 ***adapting*** to technical progress **Council Directive 1976/115/EEC** on the approximation of the laws of the Member States relating to anchorages for motor vehicle safety belts	Annex I: Applicable to M2 and M3 vehicles. The minimum number of safety belt anchorages for each forward directed seating position shall be as specified in Appendix 1 *by implication this is not applicable to sideways facing seats.*	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Commission Directive 1990/628/EEC of 30 October 1990 ***adapting*** to technical progress **Council Directive 77/541/EEC** on the approximation of the laws of the Member States relating to safety belts and restraint systems of motor	Annex I: Applies to M2 and M3 vehicles (but no amendment to forward facing seats only).	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable

LEGISLATION	APPLICABILITY	CONSTRUCTION	POSITIONING	FIXATION	TYPE APPROVAL TESTING	SEAT-BELTS	USE
vehicles							
Commission Directive 82/319/EEC of 2 April 1982 ***adapting*** to technical progress **Council Directive 77/541/EEC** on the approximation of the laws of the Member States relating to safety belts and restraint systems of motor vehicles	Article 9: Applies to M1 vehicles only. Annex 1: Applies to forward facing seats only.	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Commission Directive 82/318/EEC of 2 April 1982 ***adapting*** to technical progress **Council Directive 76/115/EEC** on the approximation of the laws of the Member States relating to anchorages for motor vehicle safety belts	Article 1: Applies to forward facing seats – No change from Directive 76/115. Article 2: Applies to M2 and M3	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Council Directive 81/577/EEC of 20 July 1981 ***amending*** **Council Directive 74/408** on the approximation of the laws of the Member States relating to the interior fittings of motor vehicles (strength of seats and of their anchorages)	Article 1: Not applicable to side-facing seats	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Council Directive 81/576/EEC of 20 July 1981 ***amending*** **Council Directive 77/541** on the approximation of the laws of the Member States relating to safety belts and restraint systems of motor vehicles	Article 1: Applies to M2 and M3 vehicles (but no amendment to forward facing seats only)	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable

Council Directive 81/575/EEC of 20 July 1981 ***amending*** **Council Directive 76/115** on the approximation of the laws of the Member States relating to anchorages for motor vehicle safety belts	Article 1: Applies to forward facing seats – No change from Directive 76/115. Article 2: Applies to M2 and M3	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
80/1267 relating to **Type Approval of motor vehicles and their trailers**	Not available in English						
Commission Directive 78/632 EEC of 19 May 1978 ***adapting*** to technical progress **Council Directive 74/60/EEC** on the approximation of the laws of the Member States relating to the interior fittings of motor vehicles	Article 1: Applies to M1 vehicles only – No change from Directive 74/60.	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Commission Directive 77/541 EEC of 28 June 1977 on the approximation of the laws of the Member States relating to safety belts and restraint systems of motor vehicles	Article 9: Applies to M1 vehicles only. Annex 1: Applies to forward facing seats only.	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable

Council Directive 76/115/EEC of 18 December 1975 on the approximation of the laws of the Member States relating to anchorages for motor vehicle safety belts	Article 1: Applies to forward facing seats only. Article 2: Applies to M1 vehicles only.	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Council Directive 74/408/EEC of 22 July 1974 on the approximation of the laws of the Member States	Article 1: Not applicable to sideways facing seats	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable

relating to the interior fittings of motor vehicles (strength of seats and of their anchorages)							
Council Directive 74/60/EEC of 17 December 1973 on the approximation of the laws of the Member States relating to the interior fittings of motor vehicles	Article 1: Applies to M1 vehicles only	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Council Directive 70/156/EEC of 6 February 1970 on the approximation of the laws of the Member States relating to the type approval of motor vehicles and their trailers	Article 1 and Annex 1: Applies to M2 and M3 vehicles	Not Applicable	Not Applicable	Not Applicable	Article 3 and Annex 1 specify that an information document describing: seats (number, position, characteristics); safety belts and other retention devices (number and position) and safety belt anchorages (number and position), be submitted with the application for type approval.	Not Applicable	Not Applicable
ECE Regulation 14, Revision 2, Amendment 2 Uniform provisions concerning the approval of vehicles with regard to safety belt anchorages	1: Applies to M2 and M3 vehicles 1: Applies to forward-facing and rearward facing seats only – No change from Amendment 1	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable

ECE Regulation 14, Revision 2, Amendment 1 Uniform provisions concerning the approval of vehicles with regard to safety belt anchorages	1: Applies to M2 and M3 vehicles 1: Applies to forward-facing and rearward facing seats only	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
ECE Regulation 14, Revision 2 Uniform provisions concerning the approval of vehicles with regard to safety belt anchorages	1: Applies to M2 and M3 vehicles 1: Applies to forward-facing seats only	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
ECE Regulation 16, Revision 4 Uniform provisions concerning the approval of: I) Safety	1: Applies to M2 and M3 vehicles 1: Applies to forward-facing and rearward	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable

belts and restraint systems for occupants of power driven vehicles and II) Vehicles equipped with safety belts	facing seats only						
ECE Regulation 16, Revision 3, Amendment 4 Uniform provisions concerning the approval of: I) Safety belts and restraint systems for occupants of power driven vehicles and II) Vehicles equipped with safety belts	1: Applies to M2 and M3 vehicles 1: Applies to forward-facing and rearward facing seats only	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
ECE Regulation 16, Revision 3, Corrigendum 1 Uniform provisions concerning the approval of: I) Safety belts and restraint systems for occupants of power driven vehicles and II) Vehicles equipped with safety belts	Application not specified but superseded by above	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable

ECE Regulation 17, Revision 3, Amendment 3, Corrigendum 1 Uniform provisions concerning the approval of vehicles with regard to the seats, their anchorages and any head restraints	1: Applies to M2 and M3 vehicles 1: Does not apply to side-facing seats	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
ECE Regulation 17, Revision 4 Uniform provisions concerning the approval of vehicles with regard to the seats, their anchorages and any head restraints	1: Applies to M2 and M3 vehicles 1: Does not apply to side-facing seats – No change from previous version	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
ECE Regulation 17, Revision 3, Amendment 3, Corrigendum 1 Uniform provisions concerning the approval	1: Applies to M2 and M3 vehicles 1: Does not apply to side-facing seats	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable

of vehicles with regard to the seats, their anchorages and any head restraints							
ECE Regulation 17, Revision 3, Amendment 3 Uniform provisions concerning the approval of vehicles with regard to the seats, their anchorages and any head restraints	1: Applies to M1 vehicles only 1: Does not apply to side-facing seats	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
ECE Regulation 17, Revision 3, Amendment 2 Uniform provisions concerning the approval of vehicles with regard to the seats, their anchorages and any head restraints	No change to previous but superseded by above	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable

TRANS/WP.29/597 Draft Regulation**:** Uniform provisions concerning the approval of large passenger vehicles with regard to their general construction	1: Applies to M2 & M3 vehicles	5.13.: Guarding of stepwells	5.7.1.6-8: Access to service doors 5.7.2.3: Access to emergency door 5.7.5: Gangways 5.7.9: Passenger seats and space for seated passengers	Not Applicable	Not Applicable	Not Applicable	5.2.2.2, 5.2.2.5.: Area available for passengers 5.7.9.5.2.: Forward or rearward seats only to be provided for specific use by disabled
ECE Regulation 36, Revision 1, Amendment 1, Corrigendum 3 Uniform provisions concerning the approval of large passenger vehicles with regard to their general construction	No relevant change to ECE Regulation 36, Revision 1	Refer to ECE Regulation 36, Revision 1	Refer to ECE Regulation 36, Revision 1	Refer to ECE Regulation 36, Revision 1	Refer to ECE Regulation 36, Revision 1	Refer to ECE Regulation 36, Revision 1	Refer to ECE Regulation 36, Revision 1
ECE Regulation 36, Revision 1, Amendment 1, Corrigendum 1 Uniform provisions concerning the approval of large passenger vehicles with regard to their general construction	No relevant change to ECE Regulation 36, Revision 1	Refer to ECE Regulation 36, Revision 1	Refer to ECE Regulation 36, Revision 1	Refer to ECE Regulation 36, Revision 1	Refer to ECE Regulation 36, Revision 1	Refer to ECE Regulation 36, Revision 1	Refer to ECE Regulation 36, Revision 1
ECE Regulation 36,	No relevant change to						

Revision 1, Amendment 1 Uniform provisions concerning the approval of large passenger vehicles with regard to their general construction	ECE Regulation 36, Revision 1	Refer to ECE Regulation 36, Revision 1	Refer to ECE Regulation 36, Revision 1	Refer to ECE Regulation 36, Revision 1	Refer to ECE Regulation 36, Revision 1	Refer to ECE Regulation 36, Revision 1	Refer to ECE Regulation 36, Revision 1
ECE Regulation 36, Revision 1, Corrigendum 1 Uniform provisions concerning the approval of large passenger vehicles with regard to their general construction	No relevant change to ECE Regulation 36, Revision 1	Refer to ECE Regulation 36, Revision 1	Refer to ECE Regulation 36, Revision 1	Refer to ECE Regulation 36, Revision 1	Refer to ECE Regulation 36, Revision 1	Refer to ECE Regulation 36, Revision 1	Refer to ECE Regulation 36, Revision 1

ECE Regulation 36, Revision 1 Uniform provisions concerning the approval of large passenger vehicles with regard to their general construction	1: Applies to M2 & M3 vehicles	5.13.: Guarding of stepwells	5.7.1.6-8: Access to service doors 5.7.2.3: Access to emergency door 5.7.5: Gangways 5.7.8: Passenger seats and space for seated passengers	Not Applicable	Not Applicable	Not Applicable	5.7.8.5.2.: Forward or rearward seats only to be provided for specific use by disabled
ECE Regulation 52, Revision 1, Amendment 1 Uniform provisions concerning the construction of small capacity public service vehicles	1: Applies to M2 and M3 vehicles	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	5.2.2.2.&5.: Area available for passengers
ECE Regulation 52, Revision 1 Uniform provisions concerning the construction of small capacity public service vehicles	1: Applies to M2 and M3 vehicles	Not Applicable	5.7.1.6. & 7.: Access to service doors 5.7.2.3: Access to emergency doors 5.7.5.3.: Gangways	Not Applicable	Not Applicable	Not Applicable	5.2.2.2.&5.: Area available for passengers 5.7.8.: Passenger seats 5.9.1.4.: Handrails and handholds
ECE Regulation 80, Amendment 2 Uniform provisions concerning the approval of seats of large passenger vehicles and of these vehicles with regard to the strength of the seats and their anchorages	1: Applies to M2 and M3 vehicles 1: Forward facing seats only - No change to previous version	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
ECE Regulation 80,	1: Applies to M2 and M3						

Amendment 1 Uniform provisions concerning the approval of seats of large passenger vehicles and of these vehicles with regard to the strength of the seats and their anchorages	vehicles 1: Forward facing seats only	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
JAPAN							
JIS-D4610 Seats and seat anchorages for passenger cars	Defines strength of seats and seat anchorages for passenger cars. Does not apply to side-facing seats.	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable

UK							
Disability Discrimination Act 1995 for public servuce vehicles	Applies to M2 and M3 vehicles	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Annex A 2.4: Folding seats permitted in area provided for wheelchair use Annex A 3.2: Removable seats permitted in area provided for wheelchairs Annex B 3.1: Priority seats can only be forward or rearward facing Annex C 3.6: Removable seats permitted in area provided for wheelchairs Annex D 3.1: Priority seats can only be forward or rearward facing	Not Applicable
Statutory Instrument No 981 The Motor Vehicles (Type Approval) (Great Britian) Regulations	Not applicable to M2 & M3 vehicles	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Statutory Instrument No 737 The Road Vehicles (Construction and Use) (Amendment) (No.2) Regulations 1995	No relevant change to Statutory Instrument No 1078	Refer to Statutory Instrument No 1078	Refer to Statutory Instrument No 1078	Refer to Statutory Instrument No 1078	Refer to Statutory Instrument No 1078	Refer to Statutory Instrument No 1078	Refer to Statutory Instrument No 1078
Statutory Instrument No 551 The Road Vehicles (Construction and Use) Regulations 1995	No relevant change to Statutory Instrument No 1078	Refer to Statutory Instrument No 1078	Refer to Statutory Instrument No 1078	Refer to Statutory Instrument No 1078	Refer to Statutory Instrument No 1078	Refer to Statutory Instrument No 1078	Refer to Statutory Instrument No 1078
Statutory Instrument	Applies to M2 & M3		Schedule 6, Regulation 7:			Part I.46.2.b.: Seat belt	

No 1078 The Road Vehicles (Construction and Use) Regulations 1986	vehicles	Not Applicable	Access to doors Schedule 6, Regulation 9: Seats	Not Applicable	Not Applicable	anchorage points requirements are not applicable to vehicles carrying 12+ passengers Part I.46.4.a.ii.: Seat belt anchorage points only required for forward-facing seats	Not Applicable

Statutory Instrument No 257 The Public Service Vehicles (Conditions of Fitness, Equipment, Use and Certification) Regulations 1981	Sideways facing seats are not specifically excluded	28 1 b & c: Seat design	25 1 & 2: Access to exits 26: Width of gangways 28 1 d-i: Fitting clearances	28 1 a: All seat supports to be securely fixed	Not Applicable	Not Applicable	Not Applicable
USA							
SAE J1834 Seat belt comfort, fit and convenience	*Awaiting confirmation from SAE as to applicability*	*Awaiting confirmation from SAE as to applicability*	*Awaiting confirmation from SAE as to applicability*	*Awaiting confirmation from SAE as to applicability*	*Awaiting confirmation from SAE as to applicability*	*Awaiting confirmation from SAE as to applicability*	*Awaiting confirmation from SAE as to applicability*
SAE J879b Motor vehicle seating systems	*Awaiting confirmation from SAE as to applicability*	*Awaiting confirmation from SAE as to applicability*	*Awaiting confirmation from SAE as to applicability*	*Awaiting confirmation from SAE as to applicability*	*Awaiting confirmation from SAE as to applicability*	*Awaiting confirmation from SAE as to applicability*	*Awaiting confirmation from SAE as to applicability*
SAE J782 Ground Vehicle Standards: Comprehensive specificatins for vehicle design, manufacturing, testing and perfromance	*Awaiting confirmation from SAE as to applicability*	*Awaiting confirmation from SAE as to applicability*	*Awaiting confirmation from SAE as to applicability*	*Awaiting confirmation from SAE as to applicability*	*Awaiting confirmation from SAE as to applicability*	*Awaiting confirmation from SAE as to applicability*	*Awaiting confirmation from SAE as to applicability*
SAE J385 Motor vehicle seat belt anchorages – Performance requirements	*Awaiting confirmation from SAE as to applicability*	*Awaiting confirmation from SAE as to applicability*	*Awaiting confirmation from SAE as to applicability*	*Awaiting confirmation from SAE as to applicability*	*Awaiting confirmation from SAE as to applicability*	*Awaiting confirmation from SAE as to applicability*	*Awaiting confirmation from SAE as to applicability*
SAE J384 Motor vehicle seat belt anchorages – Test procedure	*Awaiting confirmation from SAE as to applicability*	*Awaiting confirmation from SAE as to applicability*	*Awaiting confirmation from SAE as to applicability*	*Awaiting confirmation from SAE as to applicability*	*Awaiting confirmation from SAE as to applicability*	*Awaiting confirmation from SAE as to applicability*	*Awaiting confirmation from SAE as to applicability*
SAE J383 Motor vehicle seat belt anchorages – Design recommendations	*Awaiting confirmation from SAE as to applicability*	*Awaiting confirmation from SAE as to applicability*	*Awaiting confirmation from SAE as to applicability*	*Awaiting confirmation from SAE as to applicability*	*Awaiting confirmation from SAE as to applicability*	*Awaiting confirmation from SAE as to applicability*	*Awaiting confirmation from SAE as to applicability*

(5) ACCIDENT DATA ANALYSIS

Knowledge and experience of the collection and analysis of bus accident statistics has been gained in the course of two research projects undertaken recently involving ICE. The first study 'Assessment of Passenger Safety in Local Service PSVs' (Public Service Vehicles), was undertaken on behalf of the UK's Department for the Environment, Transport and the Regions (DETR) and was completed in 1999. The second is the ECBOS project (Enhanced Coach and Bus Occupant Safety) which is funded by the European Commission under the Competitive and Sustainable Growth Program of the 5th Framework (project number 1999-RD.11130). This project started in January 2000 and is due to being completed in December 2002. Workpackage 1 involved analysis of accident statistics and Task 1.1, Statistical Collection (for which the VSRC was Task Co-ordinator) was completed in March 2001.

In this previous work the issue of longitudinal seating had not been specifically addressed and during the course of the research it did not become an issue requiring investigation. Indeed there was (very) little reference to the circumstances of longitudinal seating and the effectiveness of restraints in that seating orientation. It has been possible to revisit the data of the two research programmes referred to above, in order to confirm that this is the case. The various data sources are addressed below; all of which are from within Great Britain unless otherwise stated.

(5.1) *NATIONAL DATA – STATS19*

British national accident data are commonly called 'STATS 19' due to the name of the form that the Police complete for every road traffic accident involving an injury on a public highway. The fields used for analysis in this report are those that are generally available to the research community. The accident forms are submitted to the Department of the Environment, Transport and the Regions by each police force in Great Britain, some 50 forces in total. These data are available approximately 14 months after the year of collection in a form ready for electronic analysis. Data are available for Great Britain, which includes England, Scotland and Wales. Information for the United Kingdom (UK), which includes Northern Ireland, the Channel Islands and the Isle of Man, is not available.

For each accident there are 3 types of records: accident, vehicle and casualty. The overall criteria for an accident to be included in the STATS 19 records are that a person must have been injured in an accident on a public highway. An accident record is completed for each accident. A vehicle record is completed for every vehicle involved in the accident, even if that vehicle doesn't have an injured person in it. A casualty record is completed for every injured person in the accident.

Whilst a separate vehicle type code is given to buses and coaches (code 11), unfortunately there is no way to distinguish between a 'city' bus or coach and a 'touring' bus or coach.

Buses or coaches are defined as vehicles equipped to carry 17 or more seated passengers, regardless of whether or not they are being used in stage operation. Minibuses are defined as vehicles equipped to carry less than 17 seated passengers (and more than 8). Unfortunately the minibus category also includes motor caravans (code 10). This means that minibuses can never be separated from motor caravans in the vehicle type category. Unfortunately these national data records give no indication at all of the orientation of the seat, i.e. whether a

casualty was sitting in a forward facing or longitudinal seat, or whether a restraint was being used.

It appears that the reporting of injuries to bus and coach occupants in Great Britain is high at all injury levels. This is due to the responsibility of the driver to report incidents to the operator and a legal obligation to report incidents to the Vehicle Inspectorate, which is that part of the DETR responsible for assessing and ensuring vehicle roadworthiness. However, because of the way the accident information is recorded it is not possible to make any analysis of the presence or role of longitudinal seating in injury causation.

The results of the 'STATS 19' British national accident data for the period between 1990 and 1998 are tabulated in Tables 2 and 3. Graphical presentation of the data is given in Figures 2 and 3, **(Ref. 5.1)**. They are categorised in terms of the number of casualties and vehicles (buses, coaches and minibuses) in relation to areas. The areas are defined as either built up or non-built up including motorways.

Area	Killed	Killed/Seriously Injured	All
Built up	101 (51.27%)	4 893 (75.31%)	67 758 (82.48%)
Non-built up and Motorways	96 (48.73%)	1 604 (24.69%)	14 385 (17.52%)
All Roads	197 (100%)	6 497 (100%)	82 143 (100%)

Table 2 M2 and M3 Vehicles Road Accident Casualties – Great Britain (Ref. 5.1)

Area	Fatal	Serious	Slight	All
Built up	960 (69.76%)	11 527 (86.13%)	80 915 (92.35%)	93 402 (91.30%)
Non-built up and Motorways	416 (30.24%)	1 856 (13.87%)	6 654 (7.65%)	8 926 (8.70%)
All Roads	1 376 (100%)	13 383 (100%)	87 569 (100%)	102 328 (100%)

Table 3 M2 and M3 Vehicles Road Accident Number of Vehicles – Great Britain (Ref. 5.1)

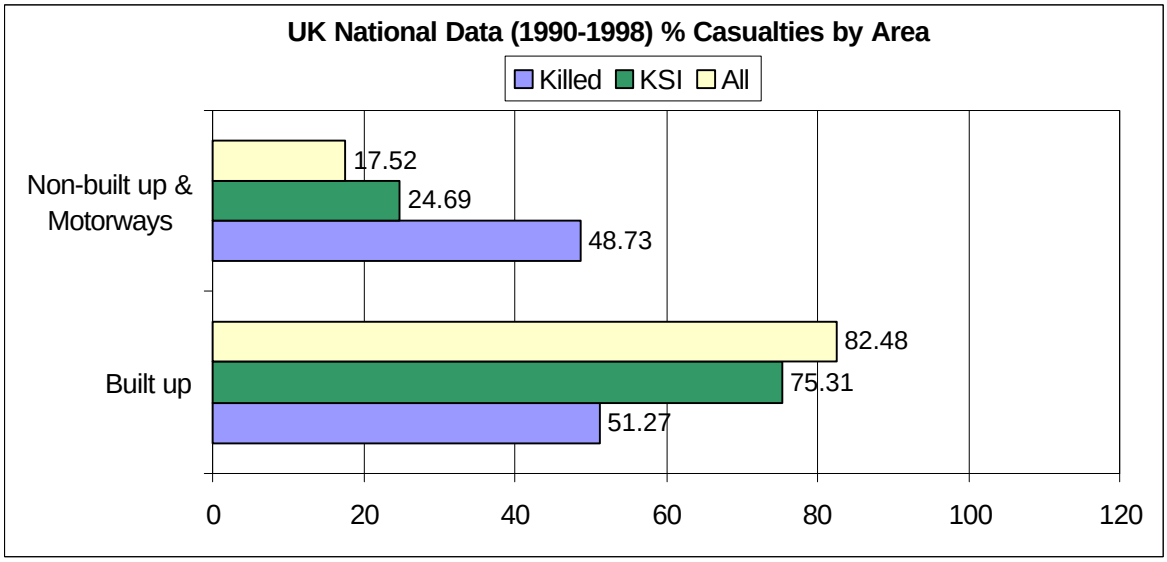

Figure 2 M2 and M3 Vehicles Road Accident Casualties – Great Britain (Ref. 5.1)

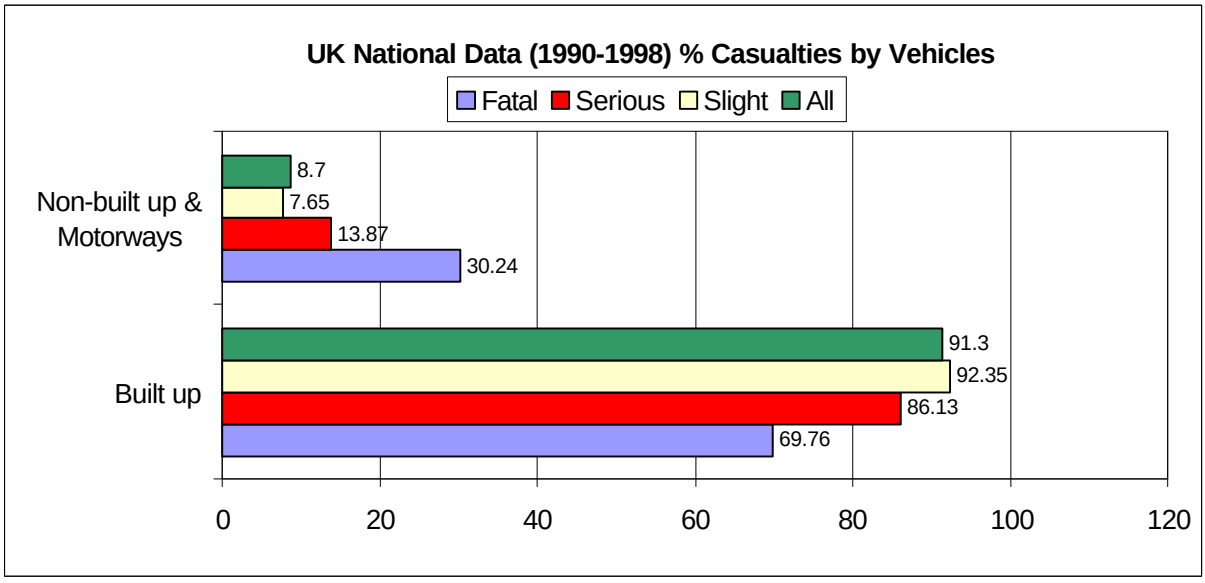

Figure 3 M2 and M3 Vehicles Road Accident Number of Vehicles – Great Britain (Ref. 5.1)

(5.2) *NATIONAL FATALS DATABASE (held and managed at the Transport Research Laboratory (TRL) on behalf of the DETR)*

In the period from 1994 to 1998 there were 99 fatal cases involving occupants of buses and coaches in Great Britain. Some of these fatal cases are on the fatals database but this resource has been exhaustively investigated for both the DETR and the ECBOS projects. No cases were found that made direct reference to the casualty being in a longitudinal seat.

(5.3) *UK CO-OPERATIVE CRASH INJURY STUDY (CCIS) DATABASE*

CCIS is funded by the DETR and several motor manufacturers. The study commenced in 1983 and the ongoing programme of research involves the in-depth investigation of real world car crashes. The aim of the study is to provide government and industry with crash injury data to assist in the development of regulations and improvements in secondary safety design features to help mitigate injuries to car occupants.

Although the circumstances associated with car crashes are not directly comparable with bus and coach crashes it was considered that any information about occupants injured in side facing seats might be of interest. Unfortunately analyses of cases over the last 5 years have found examples of this to be extremely sparse, with these seats generally being unoccupied in the accident. Only one example was found involving a severe rollover, the circumstances of which were such that it bears little comparison with longitudinal seats in buses.

(5.4) *POLICE ROAD TRAFFIC NOTIFICATIONS*

Police notifications of road traffic accidents are monitored during the course of the VSRC's ongoing research. These notifications are received from the Police areas of Nottinghamshire and Leicestershire in Great Britain.

As part of the Assessment of Passenger Safety in Local Service PSVs project approximately 130 notifications (with reference to the specific objectives of that study) were monitored during a 2-year period (1997-1998). There was no reporting of the presence of, occupants in, or injuries occurring in, longitudinal seats.

Similarly, as part of the ECBOS project an estimated 450 notifications of all incidents involving buses or coaches (both injury accidents and damage only) were received during a fifteen month period covering February 2000 to March 2001. In all these notifications there was no mention of whether an injured occupant was in a side facing seat.

(5.5) *ACCIDENT REPORTS FROM THE VEHICLE INSPECTORATE (VI)*

The Vehicle Inspectorate was able to supply bus and coach accident files to the ECBOS project. The cases supplied covered the majority of large bus and coach accidents during recent years. In these cases no information was evident concerning longitudinal seating.

(5.6) *OPERATORS' RECORDS*

In previous work by ICE, bus operators were asked to provide detailed

information about their accident and incident records. A sample of cases was selected from each operator generally covering the years 1997-1998 resulting in 245 cases. This information has been revisited and reviewed with specific reference to longitudinal seating.

All operator accident records are normally held by the insurance departments within the bus companies. All give differing amounts of detail, depending upon the operator requirements, but generally, they do not state where the occupant was sitting at the time of the incident. Out of the 245 cases examined there was only one case where it was reasonably clear that an injury had occurred as a result of an incident involving a side facing seat. Details of this incident are shown below.

The incident occurred on a single deck bus; No further details are known about the vehicle regarding body type/seating arrangement. The injury occurred when, according to the operator's own record an 'elderly lady stood up to get off and realised that it was not her stop. She went to sit down again and the seat squab which is moveable for buggies had shot upwards'.

Of the operators that were contacted again in order ask specifically about the issue of longitudinal seating the only one that offered any information suggested that fixed seating was not a problem but flip up seating was. The operator's representative was aware of two cases where people had been injured as a result of the seats springing up. In one case the bus was moving and in another the bus was stationary, and in both cases the occupants received bruising. The operator subsequently removed the springs from one specific type of seating in order to avoid this situation reoccurring, but had later been instructed to replace them by the VI.

(5.7) *OTHER INTERNATIONAL DATA*

The overall objective of the European funded ECBOS project (Enhanced Coach and Bus Occupant Safety) is to generate new knowledge to minimise the incidence and cost of injuries caused by bus and coach accidents. A review of the number and type of bus and coach accidents in several European countries was the starting point of this research program.

Task 1.1, Statistical Collection, involved the collection of accident statistics from each of 8 European countries: Austria, France, Germany, Great Britain, Italy, the Netherlands, Spain and Sweden. As Task Co-ordinator the VSRC was responsible for reviewing and compiling the data which were collected. As a result of the volume of information and the differences between the datasets, the output of the accident statistics review is in the form of an overview document and 8 National reports. This review of European bus and coach accident statistics is believed to be the most comprehensive to date.

The detail of the data from the different countries varies. However, there is consistency between all 8 countries in that the issue of longitudinal seating is not referred to. The seating position of occupants, whether uninjured or injured, is not recorded and the presence of longitudinal seating in the vehicle is also not recorded. Thus it is not possible to draw any conclusions about injuries to the occupants of longitudinal seating. Further the ECBOS partners were asked if they were aware of, and could provide, any specific data relating to the presence of longitudinal seating. As had been anticipated all of the partners confirmed that they were not aware of cases where longitudinal seating were reported.

(6) SOLICITING ADVICE AND RECOMMENDATIONS

The aim of this sub-task is to ensure that relevant organisations are given the opportunity to impart their knowledge, expertise and experience to this study and so contribute to the foundations upon which recommendations may be made.

An extensive consultation with the users, in general, of the M2 and M3 vehicles incorporating side facing seats was undertaken. It included both private (e.g. fleet operators) and state owned (local and national government) bodies representing the interest of the operator, regarding litigation, and safety of the users of vehicles with side facing seats.

Various issues, through consultation and recommendations from the interested bodies, were addressed and, where possible, supported by objective scientific data. Broad EU opinion was sought and the established network of UK contacts with manufacturers and operators were exploited.

The results of the replies to questionnaire are presented in bar chart format in Appendix A.

(6.1) *COVERING LETTER AND QUESTIONNAIRE*

28th February 2001

Dear Sir/Madam,

Re: Longitudinal Seating: Safety Study

Cranfield Impact Centre (CIC) of Cranfield University and Vehicle Safety Research Centre (VSRC) of Loughborough University have been contracted by the European Commission to look into issues regarding safety considerations of side facing (inward-facing or longitudinal) seating arrangements in buses/coaches (M3) and minibuses (M2) particularly in Class III and B vehicles.

As part of the brief, the European Commission has requested that the views, recommendations and advice of interested bodies and organisations concerned in enhancing the safety aspects of non-forward facing seats in M2 and M3 vehicles, be solicited.

Views regarding safety, design issues and certification of side facing and rear facing seats in buses and minibuses with regard to construction characteristics, positioning/spacing, attachment, type approval testing and the suitability of use of 2-point and 3-point seatbelts will be welcomed. The information collected will be of use to the European Commission in formulating future proposals in the area of motor vehicle type-approval for M2 and M3 vehicles.

Due to the limited time scale for the study, prompt responses will be much appreciated. Provision of any statistical evidence as requested by the EC, if at all possible, in support of your views on the raised issues will be extremely helpful. All information provided will be treated with utmost confidentiality.

The **deadline** for making effective use of information is **23rd March 2001**.
The extended **deadline** for making possible use of information is **27th April 2001**.

Please return your completed questionnaire and any supporting documents in the enclosed envelope.

If you have any questions please feel free to contact me.

Dr R Hashemi
Senior Project Engineer

Tel: +44 (0)1234-756514
Fax: +44(0)1234-750944
e-mail: s.m.r.hashemi@cranfield.ac.uk

Cranfield Impact Centre Ltd (CIC)
Vehicle Safety Research Centre (VSRC)
Questionnaire
Confidential

Safety Considerations of Side Facing (inward facing or longitudinal) Seating Arrangements in Buses/Coaches (M3) and Minibuses (M2) Particularly in 'Class III' and 'B' Vehicles

This questionnaire asks a few questions about safety issues of side facing seats (SFS).

Your answers will be treated in confidence.

Please tick <u>one</u> box only.

1. Organisation Function

(a) How would you describe your organisation:?

1. Manufacture of M2 or M3 vehicles ☐
2. Seat manufacture for M2 or M3 vehicles ☐
3. Converter of M2 or possibly M3 vehicles ☐
4. Government related or regulatory body ☐
5. Fleet or bus/minibus operator ☐
6. Transport association/Licensing body ☐
7. Other (please specify) ----------

2. Safety Record of Side-Facing Seats

(a) In your experience, how do you rate the safety (in terms of injury) record of side facing seats as compared with forward or rear facing seats?

Much Worse ☐ Worse ☐ Better ☐ Much Better ☐

(b) In your experience, do you feel it is necessary to fit seat belts to side facing seats?

Yes ☐ No ☐

If 'Yes' which of the two options would you prefer:
A lap belt (2-point) belt only ☐
A lap/shoulder belt (3-point) belt only ☐

(c) Do you think that side facing seats presents any safety problems?

Yes ☐ No ☐

If 'Yes', what are they (in brief)?

_____

_____

(d) Does your organisation accident records identify the seated position of any injured passenger?

Yes ☐ No ☐

(e) There is a concern that in a crash, passengers on side facing seats may slide and contact objects next to the seat. Do you think that any of the following presents an injury hazard to side facing passengers?

	Yes	No	Don't Know
Rearward facing seats	☐	☐	☐
Forward facing seats	☐	☐	☐
Panels/Bulkheads	☐	☐	☐
Clear space / Standing area	☐	☐	☐
Standing passengers	☐	☐	☐
Any others	☐	☐	☐

(f) In your experience, has any part of a side facing seat ever broken in an accident or emergency stop?

Yes ☐ No ☐

If 'Yes', please comment in brief

3. Construction and Configuration

The EU Commission is concerned with the strength of the attachment of side facing seats in M2 and M3 vehicles.

(a) Do you see this issue as a problem? Yes ☐ No ☐

(b) Which of these side facing seat (SFS) mounting options would you consider safer?

Floor ☐ Side Wall ☐ Both ☐

(c) Would you consider SFS, compared with forward facing seat (FFS) or rear facing seat (RFS), a safe option for disabled passengers?

Yes ☐ No ☐

(d) Given the choice of a side facing seat (SFS) or a Rear facing seat (RFS) for disabled passengers, which would you consider more:

Practical, in terms of space/design? SFS ☐ RFS ☐

Safe, in terms of injury? SFS ☐ RFS ☐

4. Manufacturing Issues

This section is intended for manufacturers of M2 and M3 vehicles and seats, as well as vehicle converters (if not relevant to your organisation, go to Section 5).

(a) In your opinion are the use of side facing seats in M2 and M3 vehicles (specifically class III and B types) for providing maximum possible number of seats?

Yes ☐ No ☐

If 'No' please state your reasons in brief:

_____

_____

_____

(b) What proportion of vehicles you produce have side facing seats? Please specify.

_____ %

(c) What proportion of seats in vehicles you produce have side facing seats? Please specify.

_____ %

(d) Given the associated design/cost implications, would you consider fitting seatbelts to SFS?

Yes ☐ No ☐

(e) Given the option of a lap (2-point) or a lap/shoulder (3-point) seatbelts, which would you consider more practical in terms of:

	2-point	3-point
Design implications?	☐	☐
Passenger safety?	☐	☐

(f) Do you regard the ECE 14:03 and EEC/76/115 for the seatbelt anchorages equally applicable to seats mounted in side facing configuration? Yes ☐ No ☐

If 'No' please state your views in brief:

_____

_____

_____

(g) Do you regard the ECE 16:04 and EEC/77/541 for the seatbelts equally applicable to seats mounted in side facing configuration? Yes ☐ No ☐

If 'No' please state your views in brief:

5. Supporting Information

(a) Are the views you expressed in this survey based on Scientific/Statistical data?

Yes ☐ No ☐

(b) Would you be prepared to provide any data (in confidence) in support of this research?

Yes ☐ No ☐

If 'Yes' please provide us with your details and/or supporting data:

Name:

Position:

Organisation:

Tel No.:

E-mail:

THANK YOU for your support with this research

(6.2) *SPECIFIC COMMENTS ARISING FROM QUESTIONNAIRE*

This section contains comments from the information received and processed to date.

Total number of distributed questionnaires: - 250.
Total number of positive replies: - 77
Response rate: - 30.8%

These specific comments relate to the feedback from the recipients of the questionnaire sent to various organisations concerned with the safety of the side facing seats in M2 and M3 vehicles. They are for the following sections in the questionnaire: -

- Safety Record of Side-Facing Seats Q2(c), Q2(f)
- Manufacturing Issues Q4(a), Q4(f), Q4(g)

The following numbers in the questionnaire identify the organisation functions: -

1 Manufacture of M2 and M3 vehicles
2 Seat manufacture for M2 and M3 vehicles
3 Converter of M2 or possibly M3 vehicles
4 Government related or regulatory body
5 Fleet or bus/minibus operator
6 Transport association/Licensing body
7 Other

Note: - Each completed returned questionnaire was identified by a number. The numbers next to the (*) refers to the questionnaire and the related comments.

Q2(c) – Do you think that side facing seats presents any safety problems – If Yes?

(1*)Much greater risk to personal injury especially on a side impact collision. (organisation function 5).
(4*)Sliding along bench seats. Cannot safely fit seat belts. Apparently the brain cannot withstand impacts to the side to the same degree as front or back impact. (organisation function 6).
(5*)Sliding problem. (organisation function 5).
(10*)Less to hold on to in an emergency. Inclination for accompanied luggage to be placed in front and therefore obstruct the gangway. (organisation function 7 – organisation representing bus passengers).
(11*)Most accidents are front or rear. 2 and 3 point belts could cause injury to wearer. If belts not fitted this equally is bad. (organisation function 3).
(12*)The diagonal belt will only work in one direction, if the occupant is thrown into the diagonal belt the result would be severe neck injury. Another problem is that the inertia reels might not work. There are possibly other potential problems. (organisation function 7 – manufacturer of removable seat fittings and wheelchair/occupant restraint systems).
(13*)Trip hazards. (organisation function 5).
(14*)Less support when accident. (organisation function 1).

(16*)Less satisfactory to passenger comfort. Higher accident risk. Side facing seats should not be in use. (organisation function 7 – local authority supporting community transport).
(18*)Passenger impacting upon each other in hard braking or accident situation, and/or sliding along seats. (organisation function 5).
(19*)They do not restrain occupants as effectively as forward/rearward facing seats during sudden or extreme deceleration or acceleration. (organisation function 5).
(20*)Passenger stability. Weight distribution. Seat security and seat types. (organisation function 5).
(23*)No direct knowledge but common sense dictates that if no restraint worst injuries will occur as sideways movement more extreme than forward facing impacts. (organisation function 4).
(24*)Domino effect. (organisation function 3).
(25*)In an accident the passengers could receive very serious injuries due to the 'domino' effect in a head on crash. (organisation function 1 and 3).
(26*)Passengers are never securely seated, especially if driving is erratic. (organisation function 4).
(27*)Seating position gives way to unnatural balance position versus direction of travel. (organisation function 5).
(28*)Use of lap and diagonal seat belts of side facing seat would only be effective in either a front or rear collision due to the diagonal belt position. An harness type belt would be best. (organisation function 2).
(30*)If a seat belt is worn it will injure the passenger (in an accident). If not, the passenger will injure others. (organisation function 1).
(31*)When you have to brake hard there is nothing to stop the forward moving of the person. (organisation function 5).
(32*)Unable to correctly use seat belts. Side ways movement when involved in an accident. (organisation function 4).
(33*)Yes, can allow passengers to slide but not necessarily any worse than forward facing where can be thrown forward. (organisation function 5).
(37*)In brief sliding across seat in accidents and damage to head, rib-cage, kidneys and shoulders. (organisation function 3).
(40*)Occupant restraint (M40 motorway type accident) normal 2/3 point belts do not perform its function on inward facing seats – seat belts would cause significant injuries to the wearer. (organisation function 1).
(41*)In an impact, occupants are thrown along the seat, into each other, - cannot be properly retained by a seat belt. (organisation function 1).
(42*)There is risk of injury in the event of an accident from being thrown out of the seat. It is felt that 2/3 point belts would not offer sufficient protection. This authority does not operate this type of vehicle neither would it allow their use on its contracts. (organisation function 7).
(43*)Not easy to securely hold seat occupant in seat during front or rear impact. High risk of head to head impact with occupant in adjacent seat. (organisation function 4).
(44*)Seat belts are not designed or tested to protect the occupant from heavy side loads, and could conceivably cause serious injuries. (organisation function 4).
(46*)Either in a crash or during intensive braking passengers on multiple-position sideways facing seats are thrown forward, hitting each other, themselves and others, causing injury and even death. (organisation function 4).
(47*)Inward facing seats are quite often "tip up" seats. Sometimes this seat tips up and the person seats on the floor. Normally there is no problem – but in a crash this person is more

likely to be thrown down the gangway. Armrest restraints are likely to break ribs. (organisation function 1).
(48*)Stability problems for passengers. (organisation function 5).
(50*)It depends on the layout of the vehicle and the use to which it is put. Whilst warming in popularity, SFS on local services bus is not a problem. (organisation function 6).
(53*)Problem passengers stability by acceleration and deceleration, full contact among passengers, more dangerous for passenger in case of car accident. (organisation function 1).
(55*)Any SFS passenger presents a safety problem and subject to point and severity of impact relates to possible damage. (organisation function 7).
(56*)As in 2(a) the safety problems are subject to the severity, point and type of impact. Even with a side impact the opposing side to that of impact could present a safety problem. (organisation function 7).
(58*)No forward protection compared to forward or rear facing seats (seat belts not preferable in public transport). (organisation function 5).
(60*)These seats are too flat; there is insufficient lateral support for a 3-point belt to work in a forward impact. (organisation function 5).
(64*)Passenger more likely to be displaced than alternatives. (organisation function 4).
(69*)Stability of passenger. (organisation function 1).
(70*)Yes in intercity use. For city(urban) buses it is ok. (organisation function 5).
(72*)Side facing seats safer than standing. Single side facing seats safer than double or triple seats. Popular with passengers. (organisation function 6).
(73*)In our opinion you have no control of your body before impact if the case were so. (organisation function 5).
(75*)Occupant sliding and impacting objects located next to the seat eg additional seats, bulkheads etc. (organisation function 2).
(76*)OK in urban buses but Class III and B will require seat belts and the use of belts for side facing passengers is a big unknown. Very doubtful if the known skeleton can take anything like the forces imparted in a forward facing seat belted passenger. It has been known for sometimes that when restraint system are used in side facing situations they can cause injury at relatively light impacts. Special restraint systems would be required to retain side facing passengers and I would then still be apprehensive as to their effectiveness. (organisation function 7).

Q2(f) – In your experience, has any part of a side facing seat ever broken in an accident or emergency stop – If Yes?

(41*)Armrest snapped off. (organisation function 1).
(60*)The support of the seats/couple benched forward. (organisation function 5).

Q4(a) – In your opinion are the use of side facing seats in M2 and M3 vehicles (specially class III and B types) for providing maximum possible number of seats – If NO?

(11*)They can also easily fold away to provide space for a wheelchair – occupied or folded. (organisation function 3).
(14*)Loss of space between side facing seat and gangway. (organisation function 1).
(29*)Often it is to increase circulation/standing capacity rather than seating capacity. (organisation function 4).

(40*)It depends on what the vehicle is being used for – e.g. police or passenger vehicles, etc. (organisation function 1).
(47*)Where wheelchair is carried you can get 3 tip up SFS as opposed to no forward facing seat in the wheelchair area. (organisation function 1).
(53*)If passengers should filling comfortable, must be size of SFS larger, then FFS, RFS (full contact between strange people) Is not possible use for seats full floor surface. More suitable is combination of FFS and RFS. (organisation function 1).
(57*)A normal coach has no wheelarch M3 class III. (organisation function 1).
(74*)Available configuration when mixed with forward facing seats – don't readily mix to give best space solution. (organisation function 1).
(75*)Side facing seats may also be due to vehicles internal geometry, access or to allow standing passengers. (organisation function 2).

Q4(f) – Do you regard the ECE 14:03 and EEC/76/115 for the seatbelt anchorages equally applicable to seats mounted in side facing configuration – If No?

(11*)It is not politically correct to fit side facing seats in our sector. It is widely suggested that where fitted, seat belts could cause more injury. (organisation function 3).
(28*)No reference to side facing seat in regulations. What load would apply? Method of loading belts on side facing seat? (organisation function 2).
(30*)I am unaware of any testing for injuries which would be caused by side facing seats with belts. (organisation function 1).
(39*)Only applied to forward/rearward seats. (organisation function 1).
(40*)How would the seat belt anchorages be tested? (organisation function 1).
(47*)Our buses are Class I i.e. with standees and multi stop vehicles, passengers are unlikely to take the time to fasten seat belts. Therefore I favour no seat anchorages for SFS and no seat belts for SFS in Class I buses. (organisation function 1).
(69*)Commercially available 'tested' seats are not tested as side facing seats. (organisation function 1).
(75*)Testing loads may not be representative. (organisation function 2).

Q4(g) – Do you regard the ECE 16:04 and EEC/77/541 for the seatbelts equally applicable to seats mounted in side facing configuration – If No?

(28*)No reference to side facing seat in regulations. What load would apply? Method of loading belts on side facing seat? (organisation function 2).
(30*)I am unaware of any testing for injuries which would be caused by side facing seats with belts. (organisation function 1).
(39*)Only applied to forward/rearward seats. (organisation function 1).
(40*)How would the seat belt anchorages be tested? (organisation function 1).
(47*)Our buses are Class I i.e. with standees and multi stop vehicles, passengers are unlikely to take the time to fasten seat belts. Therefore I favour no seat anchorages for SFS and no seat belts for SFS in Class I buses. (organisation function 1).
(57*)The design of the belts should be changed so that the movement of the passenger is minimised. (organisation function 1).
(75*)Testing loads may not be representative. (organisation function 2).

(6.3) *GENERAL COMMENTS*

Comment 1 (44*)

I would like to explain in a little more detail our view on this issue and the background behind recent UK policy regarding seats and seat belts on M2 and M3 vehicles.

I have asked our experts to supply any relevant information concerning accidents or notified defects concerning longitudinal seats, and will forward any information if available although this is likely to be limited. The most significant accident experience concerning such seats derives from an accident involving a school minibus on the M40 in Warwickshire in 1993. The minibus was fitted with one row of forward-facing seats and a pair of longitudinal seats with no seat belts fitted. The vehicle collided with a stationary vehicle on the hard shoulder and caught fire, resulting in 13 of the minibus occupants (mostly children) being killed. Although it is difficult to say to what extent the orientation of the seats contributed to the severity of the injuries, it is believed that, had the minibus been fitted with forward-facing seats equipped with seat belts, at least some of the lives could have been saved. It is doubtful, however, whether seat belts and longitudinal seats would have saved lives in the case of such a heavy frontal impact since belts and anchorages are not designed or tested to protect the occupant from a heavy side load. This is why the new UK legislation (resulting in part from this incident) specified that children in organised minibus or coach trips should be provided with forward-facing seats equipped with seat belts

Further changes to UK legislation will implement the latest amendments to the EU seat and anchorages Directives, and will require seat belts to be fitted to all forward and rearward-facing seats of all new buses and coaches registered from 1st of October 2001, apart from those designed for urban use and standing passengers. Longitudinal seats are not included in this legislation for the reasons given in the previous paragraph. Our Gouvernment feels strongly that longitudinal seats are not appropriate for vehicles which would normally have seat belts fitted through. This of course does not exclude the possibility of fitting longitudinal seats to vehicles designed for standing passengers since the occupants of those seats are unlikely to be at greater risk than the standing passengers.

On final point concerns questions 4f and 4g of the survey. Although this is aimed at manufacturers, we should make clear that the scope of all the regulations mentioned only covers forward and rearward facing seats and it would not be possible to approve seat belts or anchorages for longitudinal seats under these regulations. (organisation function 4).

Comment 2

There are two types of vehicle operation and vehicles used these being Coach for Touring work and City bus for Service work the two seem to be confused by many people who believe that what is good and practical for one is the same for the other.

Sideways seating is only fitted for City bus use and the fitment of seat belts is not practical on these vehicles due to the regular on off passenger service use of these vehicles. The seat belts on these vehicles would be useless in less than a month. Coach operators at present are

suffering at the cost of replacing coach seat belts for vehicles used on tour work so the problems for City bus operators would be multiplied considerably for City bus vehicles.

The DDA (Disability Discrimination act) has had the effect that Tip Up side facing seats are now the only option for ALL city bus manufacturers due to the regulations on Wheel chair area design and Accessibility, All manufacturers have to build to the same specifications in these regulations and we all use Side facing Tip Up seats, which themselves have to meet set guidelines on size and position also set out in the DDA, ECE Reg 36 and UK Certification regulations. Please take the time to see the vehicle designs of these vehicles as you can see the wasted area for seating caused for just one wheelchair user, this can be upto one third of the low floor area which could allow for upto 12 forward facing seats.

The designs of the interior seating layouts are now days driven by EU and UK regulations so manufacturers have very similar vehicle interiors.

As highlighted by some operators sine these regulations have been introduced the actual increase of passenger injuries is now within the lowfloor area made available for wheelchair users. (organisation function 4).

Comment 3 (59*)

We would observe that in general we regard longitudinal seating as a sub-optimal layout on buses, though we recognise that it is sometimes unavoidable if sufficient circulation space is to be provided between the seats (e.g. for wheelchair users) and/or to make effective use of otherwise sterile space over wheel arches.

The alternative arrangement found on some buses is now to have back-to-back forward and rear facing seats over the rear arches. This is even less desirable, in our view, as rear facing seats tend to be used as footstools by those seated opposite them, and they offer their occupants on forward view of the location of the vehicle. Private cars do not have rear facing seats at the back, and we see no reason why they should be imposed on bus passengers either.

We cannot offer any statistical data on the relative safety of passengers in forward, side and rear facing seats. But we are well aware of the concern that many frail passengers feel when moving to and from seats and their desire for an abundance of easily reachable stanchions and handles. It is easy to provide these on the backs and at the aisle ends of forward facing seats, but more difficult to do so where they are side facing. We would therefore urge that longitudinal seats be avoided when practicable.

As far as seat belts are concerned, the consensus in this country (UK) appears to be that they are difficult to fit and would be impracticable to use in service buses which principally carry passengers for short distances. Serious injuries are more likely to occur when passengers are standing on such buses than when they are seated (except in circumstances where belts would make no difference, such as double decker buses hitting low bridges). It is immaterial for this purpose whether seats are latitudinal or longitudinal. (organisation function 6).

Comment 4 (64*)

We ban vehicles with a side facing seats from use by contracts using vehicles of less than 16 seats. (organisation function 4).

Comment 5 (69*)

As both a coachbuilder and a van converter we would strongly advise any client against the fitting of side facing seats even with seat belts. In our opinion such seats would not provide the same level of passenger restraint as forward facing tested seat equipped with a three-point seat belt. (organisation function 1).

(6.4) *CONTACT ADDRESS CATEGORIES*

The list was divided into three categories for facilitating identification of their activities In addition a press release was organised and was aimed at publications related to manufacture and operation of buses/coaches and minibuses, see Appendix B

In total five separate list of contact addresses covering the following three categories were produced, see Appendix C.

Category 1
- Manufacturers (Bus/Coach builders and Convertors, Seat)

Category 2
- Organisations (Government and Regulatory/Licensing Bodies, Transport Associations, Trade Organisations, Institutions, Advisory Services, Passenger Transport Executives)

Category 3
- Operators (Fleet or Bus/Minibus)

Appendix B contains the details of the responses to press release.

(6.5) *BELT SYSTEM CONFIGURATIONS*

Consultations with the relevant bodies also concerned the belt system configuration in a side facing seat. The seat belt type issues as seen by the users, in terms of safety, feasibility, use and effectiveness of any restraint system on a side facing passenger were included in the questionnaire.

Based on our experience and consultations with relevant bodies concerned with the safety of side facing seats, the seat belt type issues as seen by the users, in terms of safety, feasibility, cost and other factors, will be addressed.

The type of seat belt systems in side facing seats, whether they are integral part of the seat or otherwise, can greatly influence the kinematics of the occupant and consequently the level of injuries sustained.

The incorporation of either 2 or 3 point belts in side facing seats necessitates examination of design issues with respect to seat/floor connectivity. The elevated load imparted to the seat legs due to restraining of the occupant is transferred to the seat/floor mounting. Hence floor strength to resist warping and the seat detachment will become a design issue. Also aspects concerning the bio-mechanical requirements of the human frame will be a concern.

Both experimental and analytical work, carried out in the previously funded EC project **(Ref. 3.2.1)**, addressed the security of longitudinal seating in various layout and also the benefits and limitations of various belt type configurations. A Review of this study is given in Section 3. In view of the limited evidence, it was concluded that:

- since many passengers in side facing seats may choose not to wear seat belts this could prove more detrimental (both to the occupant thrown and those sitting in front) in front impact accidents than in the ‘protected’ forward facing seats.
- There is a significant sideways excursion of the body with possibility of excessive loading of the neck even when using a 3-point belt with diagonal over the forward shoulder.

(7) DISCUSSION

The work carried out here on the side facing seats in class III and B of M2 and M3 vehicles encompasses various sources of information. The opinion as to whether longitudinal seating arrangements should be permitted and the nature and extent of any condition attached to the use of them have been based on the information available from the following: -

- General overview of the literature survey;
- Inventory of the existing regulations;
- Accident data analysis;
- Consultation with public and private interested parties;
- Suitability of 2 and 3 point belt system configurations.

Literature Review

Despite an extensive perusal of the literature to obtain more information on the issues relating to the side facing seats in M2 and M3 vehicles, it has appeared that although such seats have been in use, the available published data with respect to their safety implications for able persons are rather limited or non-existent.

However, some published work, some of which have been reviewed here, looked at the design and safety issues of side facing seat configuration for disabled persons. They have indicated that the degree of protection provided by the side facing seats for the handicapped, compared to both forward and rearward facing seats, were at significantly reduced level. The wheels of a side facing chair, used by a disabled person, are likely to be supported by triangulated floor housing brackets. The wheels tend to wrap around the support mechanism and resulting in the collapse of the seat, and exposing the occupant to an uncontrolled movement, when the vehicle is involved in a frontal accident. Although the wheels of a side facing wheelchair collapse in the same manner for forward and rearward facing configurations, the speed of impact is usually less in the case of a side impact accident. The published work has indicated that the rear facing seats for disabled persons are preferred in terms of safety and accessibility. This study has indicated that side facing seat configurations for handicapped passengers do not provide similar level of protection, compared to forward or rearward facing seats, in either forward impact or side impact accidents.

By far the most extensive study into the safety of side facing seats in M2 and M3 vehicles that was supported by the European Commission was carried out by a European consortium with CIC as a leading participant **(Ref. 3.2.1)**. This study was comprehensive in terms of conducted tests and simulations by taking into consideration various seating and loading configurations. It indicated that in view of the limited evidence, it was recommended that side facing seats should not be allowed in M2 and M3 vehicles with no standing passengers. There are, however, special vehicles, such as ambulances, where side facing seats may be necessary. It highlighted the perils of side facing seating configurations with and without seat belt effects. In relation to side facing seats and based on directives EEC/76/115 (seat belt anchorages) and EEC/77/541 (seat belts) the following conclusions were drawn: -

- Relative position of occupant body/environment/seat belts differ from those in cars;
- Unbelted occupants thrown sideways and those sitting ahead are in danger of serious injuries;

- Greater variety of obstacles to be impacted by side facing occupants compared with forward facing seats;
- Side facing seats are not to be recommended.

Review of Regulations

Within the current study an inventory of legislation worldwide, but mainly within Europe, has been devised in terms of applicability, construction, positioning, attachment, type approval testing, seat belt and use of seats and seat belts in road transport vehicles. The list of the European standards and other global standards in assisting the possibility of defining a minimum common standard for protection of occupants in the vehicles equipped with side facing seats, have indicated lack of commonality between them. Unlike the European standards the others appeared to be less concerned with the issues of side facing seats in M2 and M3 vehicles which in effect had negated any means of direct comparison.

Of the EC regulations reviewed the majority applied to forward facing seats only and did not specifically exclude the use of longitudinal seating.

The child seat legislation (DETR Document VSE1/96) does not permit occupancy of side facing seats and the use of seat belts with children in such seats. This may have had an influence upon diminishing the number of vehicles, especially minibuses, equipped with side facing seats and on operators preference for vehicles without side facing seats in order to maximise effective use of seats. In addition, it has been viewed doubtful, however, whether seat belts and longitudinal seats would save lives in the case of a heavy frontal impact since anchorages and belts, according to directives EEC/76/115 (seat belt anchorages) and EEC/77/541 (seat belts), are not designed or tested to protect the occupant from a heavy side load.

Accident Data Analysis

Accident data in the UK over the last decade have indicated that majority of accident injuries (killed or KSI) involving buses and coaches are in built up areas. From the accident data it was impossible to differentiate what proportion of the recorded injuries in city buses were due to sudden braking or as a result of vehicle collisions. The available sources indicated that there was hardly any reference in the accident records to the circumstances of longitudinal seating and the effectiveness of restraints in that seating orientation. The review of the data from two major research programmes mentioned in this report also confirmed the scarcity of the accident data.

From any of the available sources of bus and coach accident data documented in this report, it has not been possible, to collect detailed accident data. It was also impossible from the data to distinguish between different bus types (city buses, M2, M3, Class III and B), or the circumstances of the accident, such as collision types, collision speeds, etc. Further it has not been possible to find any information relating to the presence or occupancy of longitudinal seating or the safety implications for bus and coach passengers in longitudinal seats. It is therefore not possible, on the basis of real-world accident data, to say whether longitudinal seating should be permitted or not. It is also not possible on the basis of real-world data to give conditions to which longitudinal seating should be designed or used.

Soliciting Advice from Interested Parties

The results of the survey from soliciting relevant organisations with respect to various issues on side facing seats, so far, have indicated, in general, not to be in favour of the use of such seats in M2 and M3 vehicles. However, this should be seen in the context of the response rate of the questionnaire where a proportion of those who received the questionnaire were not sufficiently concerned about longitudinal seating to provide a response. The views expressed by those concerned with either manufacturing or licensing/regulation comprised 46% of the total responses to the questionnaires. While there appeared to be little evidence of any seat failure, the survey showed that 86% still regarded the side facing seats to be more injurious to passengers, and also that 87% of the opinions expressed viewed side facing wheelchairs not to be a safe option for handicapped passengers. However, 43% did consider the attachment of side facing seats to be a problem.

The survey showed that 67% of the vehicle manufacturers have indicated that less than 10% of the M2 and M3 vehicles they produce have side facing seats. Whereas, 82% of them have indicated that less than 10% of the seats in the vehicles they have produced have side facing seats. The design and cost implications associated with fitting seatbelts to side facing seats appeared to be of concern to the vehicle manufacturers. In terms of passenger safety over 77% regarded a 3-point belt more practical as compared to 23% for a 2-point belt. The proportion of practicality in terms of design implications indicated 78% and 22% for 2-point and 3-point belt configurations, respectively.

The interaction between occupant and seatbelt, and consequently the loadpath through the seat attachment points, differ for seats positioned laterally (forwards and rearward facing) or longitudinally (side facing). Directives EEC/76/115 and EEC/77/541 for seatbelt anchorages and seatbelt tests, respectively, devised to account for either forward or rearward facing seats, have also commonly been used for side facing seats. The views of the vehicle and seat manufacturers concerning applicability of the above directives to side facing seats were sought. The responses of 45% and 41% for the above directives for seatbelt anchorages and seatbelt tests, respectively, indicated that they did not consider these directives to be equally applicable to seats mounted in side facing configuration. However, depending on the type of accident, these directives are applicable to vehicles equipped with side facing seats that may involve side impact accidents.

The survey showed that only 11% of views expressed were based on scientific and statistical data. Fleet or bus/minibus operators, including others not directly related to either manufacturing sectors or regulatory bodies, accounted for 54% of the responses. This has possibly contributed to the low percentage of the views based on scientific and statistical data.

At the start of this study it was hypothesised that the side facing seat configuration in minibuses (M2 vehicles) could be a gradually diminishing issue. As a result of the feedback from the questionnaires, the information from manufacturers and converters of minibuses has indicated that the number of side facing seats fitted to both M2 and M3 vehicles are minimal and appears to be a diminishing trend.

Although a number of replies have initially indicated possibilities of providing their data in support of this investigation, despite further effort no such data has become available. It appeared that they were willing to provide data had it become available.

(7.1) *SIDE FACING SEAT DESIGN ISSUES*

Since it is known that it is safer for passengers to be seated rather than standing, longitudinal seats are a preferable alternative to standees. Therefore in those classes of M2 and M3 vehicles where standees are permitted, longitudinal seating may provide a safer alternative. If such seating was to be permitted, the following aspects should be considered further as a means for improving their safety.

7.1.1 Seat restraints

The majority of restraint systems are designed to be used in conjunction with forward facing seats, with a three-point seat belt configuration offering the greatest protection. However, due to the changed seating orientation and different accident dynamics of M2 and M3 vehicles, it may be inappropriate to fit conventional three-point systems to longitudinal seats and therefore more appropriate restraint systems need to be designed.

However even if suitable restraints were provided, their use on certain types of vehicles may be impractical e.g. local service vehicles on which short journeys are made. Alternative means for improving the safety of those using longitudinal seats therefore needs to be considered and some of these are described below.

7.1.2 Design considerations

A further means for improving the safe use of longitudinal seating is the design of the environment surrounding the passengers seated on them.

Compartmentalisation: The use of compartmentalisation or similar means for containing the sideways facing passenger within a safe zone would appear to be a useful means for improving passenger safety. Whilst it is not clear how many seats can be compartmentalised together, it is likely that the fewer the better.

Interior fittings: Safety for the unrestrained passenger can be increased by reducing the severity of the injuries they may receive from impacts with the vehicle interior. Incorporating interior features which spread loads and soften impacts can be achieved through improved basic design and the use of softer and/or padded materials.

Seats: Helping the passengers stay in their seats, i.e. reducing the sliding effect of longitudinal seating, can be achieved through improved seat design which will improve safety and also the comfort of the passengers. Such measures to improve seat design may include the angles of the seat base and back, seat sculpting and the type of the material on the seat to increase friction.

(8) CONCLUSIONS

In reviewing information for this project, longitudinal seating appears to offer the following advantages:

- The seats are easily accessible by passengers which is of particular benefit to those who are less abled,
- They offer flexibility in the use of space e.g. when wheelchairs are not being carried the space allocated to them is often used by passengers in flip-up longitudinal seating (although this design solution can introduce other problems),
- They provide seating where forward or rearward seating arrangements may not be feasible e.g. over wheel arches.

However, whilst longitudinal seating may offer certain benefits, there may be safety disbenefits to their use. The opinion expressed here as to whether longitudinal seating arrangements on M2 and M3 vehicles, in particular class B and class III, should be permitted and any condition attached to the use of them have been based on the findings of this investigation.

Although recommendations are summarised under "literature review" and "accident data analysis", they reflect the work covered in this study in its entirety. To summarise the results of this investigation, the following recommendations, on whether longitudinal seating arrangements should be used or otherwise are based on: -

Literature Review

A major study previously carried out in the UK and was supported by the EU **(Ref. 3.2.1)**, indicated that in view of the limited evidence, it was recommended that side facing seats should not be allowed in M2 and M3 vehicles with no standing passengers. There are, however, special vehicles, such as ambulances, where side facing seats may be necessary. In relation to side facing seats and based on directives EEC/76/115 (seat belt anchorages) and EEC/77/541 (seat belts) the following conclusions were drawn: -

- The UK-based study that was supported by the EU recommended that side facing seats should not, as far as possible, be allowed in M2 and M3 vehicles with no standing passengers. It highlighted that suitable panelling immediately in front of the seat to restrain the occupant, offered 'a truly safe' solution. Although a 'compartmentalised' seat layout has been used in some Australian off-road vehicles, this approach is not considered feasible in M2 and M3 vehicles. This approach would be suitable for medical personnel in ambulances who have to use side facing seats or for police vans, with bench seats, used for transporting prisoners or disorderly people.

- This study, also taking into consideration the accident data and the views expressed by the concerned organisations, does not refute the inference made in the above-mentioned study.

- The interaction between occupant and seatbelt, and consequently the loadpath through the seat attachment points, differ for seats positioned laterally or longitudinally. It must be recognised that in side facing configuration directives EEC/76/115 and EEC/77/541 may not be considered directly applicable.

Accident Data Analysis

The analysis of accident data concluded that there is no significant evidence to refute the recommendation of Kecman **(Ref. 3.2.1)** that side facing seats should not be allowed in M2 and M3 vehicles with no standing passengers. However it is recognised that longitudinal seating is likely to be a safer alternative for standees.

In general, the responses to the consultation with public and private interested parties indicated that the use of longitudinal seating was not favoured. Even when these responses are considered in the wider context of the response rate, this still represents a sizeable minority. However it is unclear to the extent to which these concerns are based on fact e.g. in terms of accident records, etc.

With respect to the belt system configurations, a previous study **(Ref. 3.2.1)** concluded, in the view of limited evidence, that 3-point belts may not provide the sufficient protection to prevent the possibility of excessive loading of the neck.

Taking an overview on all of these aspects and in the absence of definitive accident data, the authors recommend that longitudinal seating:

- Should NOT be permitted in those classes of vehicle where standees are not allowed.

- SHOULD be permitted in those classes of vehicle where standees are allowed subject to certain design considerations and the nature of operation of the vehicle e.g. whether it is local service, city bus, etc.

(9) FURTHER WORK

There will be certain vehicles where side facing seat configurations are inevitable in terms of design and practicality. Side facing seats are also common on city buses. If they are to be permitted for various other reasons then further work will be required to enhance the safety of such seats. There are two distinct but related areas where further work would be beneficial.

(9.1) Reformatted Accident Data

Since current accident data databases do not contain the appropriate details and cannot be sufficiently interrogated, the system for accident recording needs to be enhanced in order that more details concerning bus and coach accidents are recorded. Such data can then be analysed to provide valid information concerning the safety performance of different aspects of buses, coaches and minibuses including longitudinal seating.

In order to provide accident information on longitudinal seats on local PSVs further studies would have to be undertaken along the lines of the study performed by ICE, using local operators' records.(section 5.6). As reported, this study did not find accidents in which longitudinal seats were a feature. Therefore, further work would have to firstly concentrate on operators that have a good number of longitudinal seats on their fleets. This could be done using a telephone survey where the operator would be asked to keep details of any injuries that occur with longitudinal seats. To evaluate the risk of longitudinal seats compared to forward facing seats, the operator accident records would have to be studied to ascertain what proportion of injuries occur on these seats. Also, surveys would have to be conducted on vehicles during use, to see how many passengers use these seats in order to get a measure of exposure.

(9.2) Tests and Numerical Analyses

Based on CIC's experience in various seat projects, in particular the EU-backed project mentioned in this report and also from a separate project that lead to the design of a universal seat coach meeting all the safety requirements, it would be possible to further augment the safety of side facing seats. The issues that have been highlighted in the discussion section and to be addressed are: -

- Seat restraints (2-point lap belt, 3-point shoulder belt and 5-point double shoulder belt);
- Design considerations (seat design, compartmentalisation and interior fittings).

Since the environment in which the seats are positioned are different for different vehicles, such as minibuses, city buses, ambulances and police vans, each vehicle interior will require its own safety assessment.

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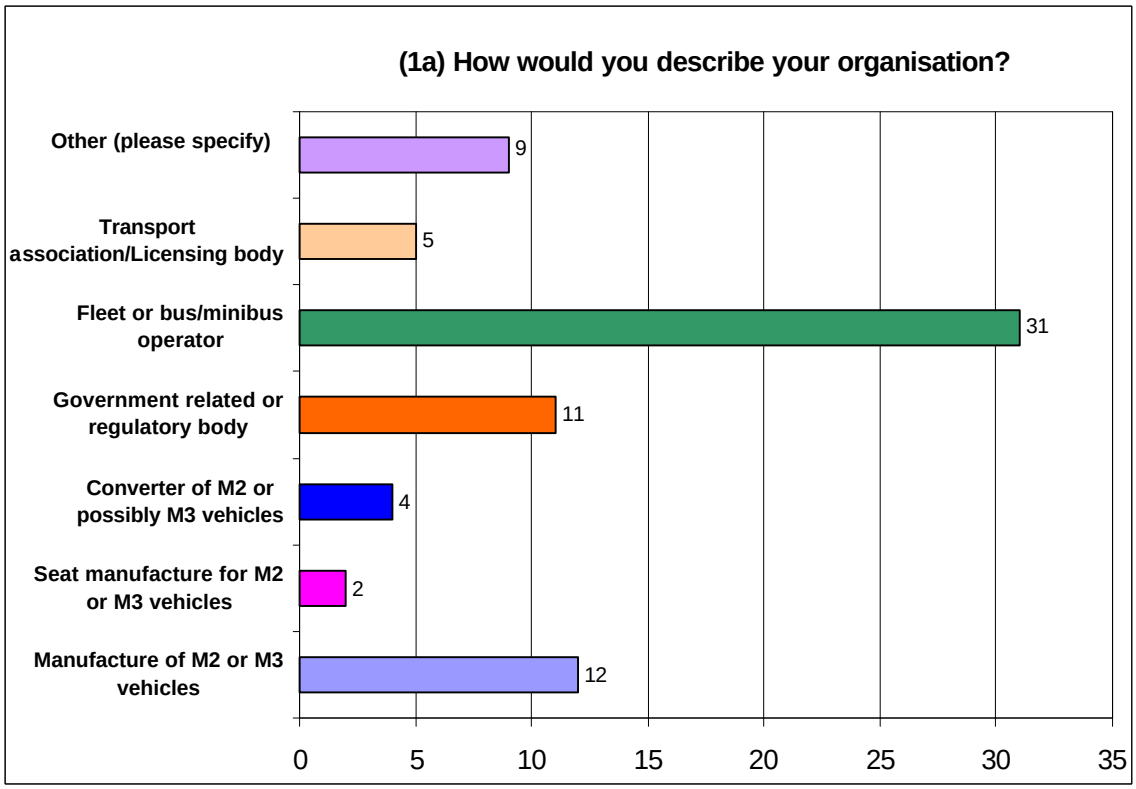
(APPENDIX A)

Results of the replies to the questionnaires

In total over 250 questionnaires were distributed. This section contains information received and processed to date from 76 replies.

Total number of distributed questionnaires:- 250.
Total number of positive replies:- 77 (this does not include responses due to the press release that are summarised in Appendix B)
Response rate:- 30.8%.



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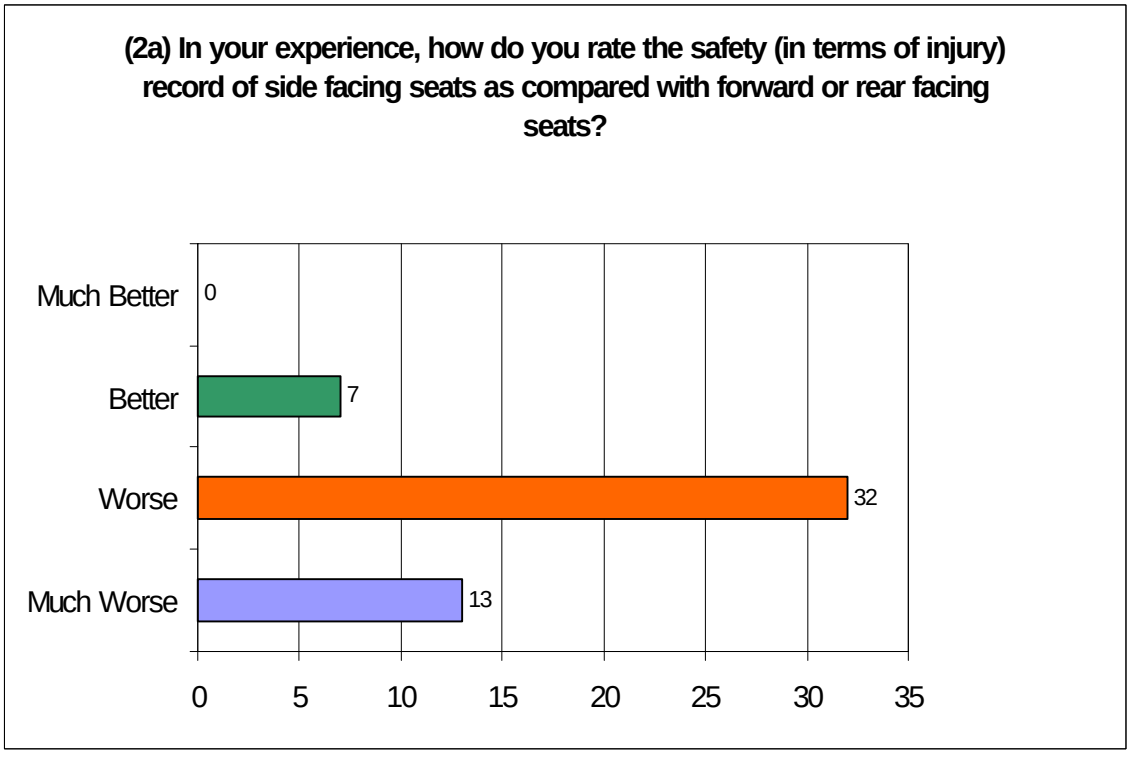

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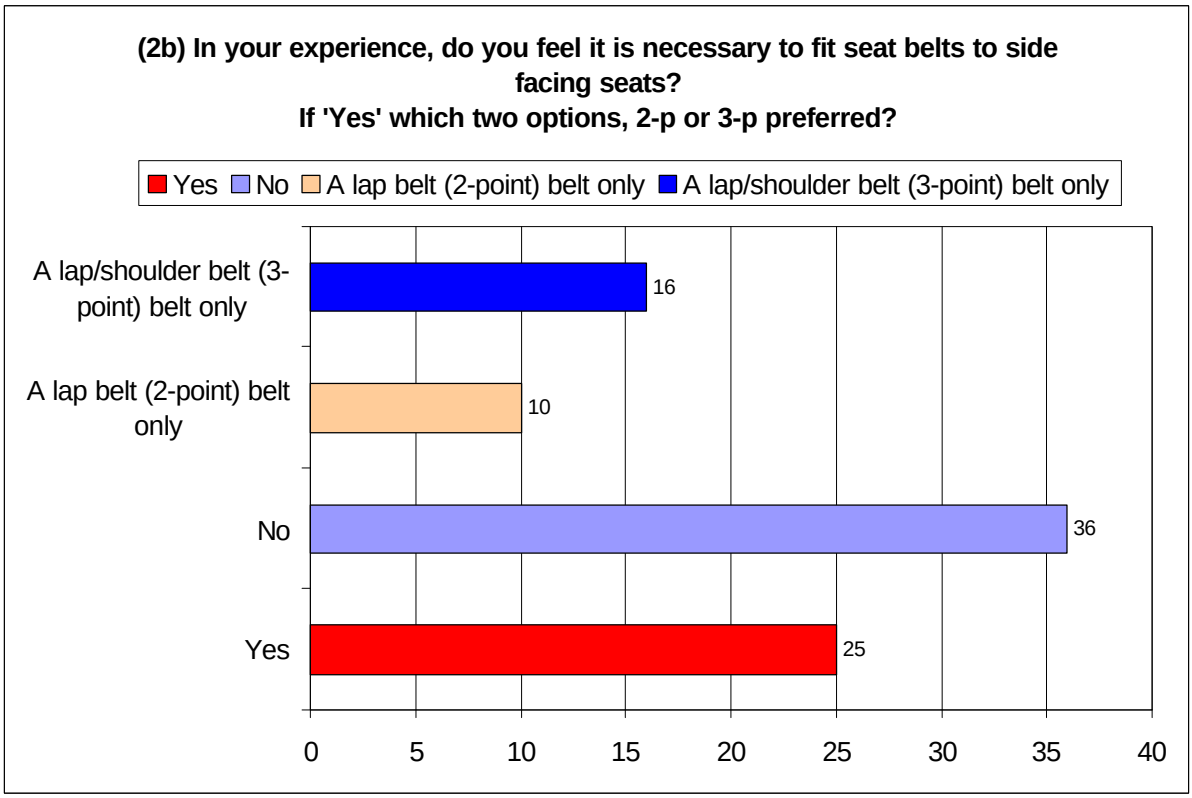

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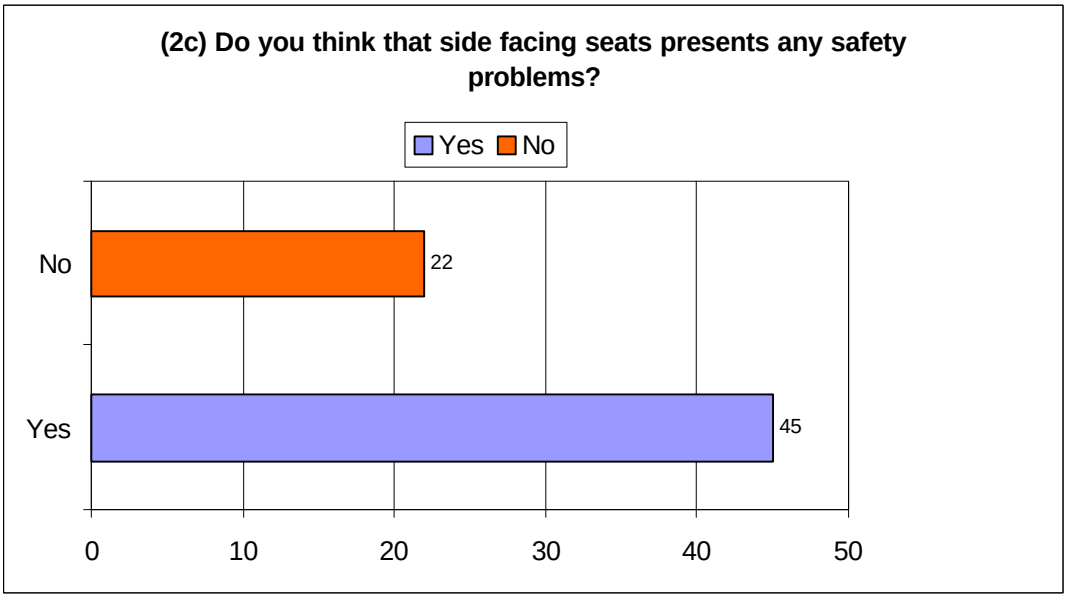

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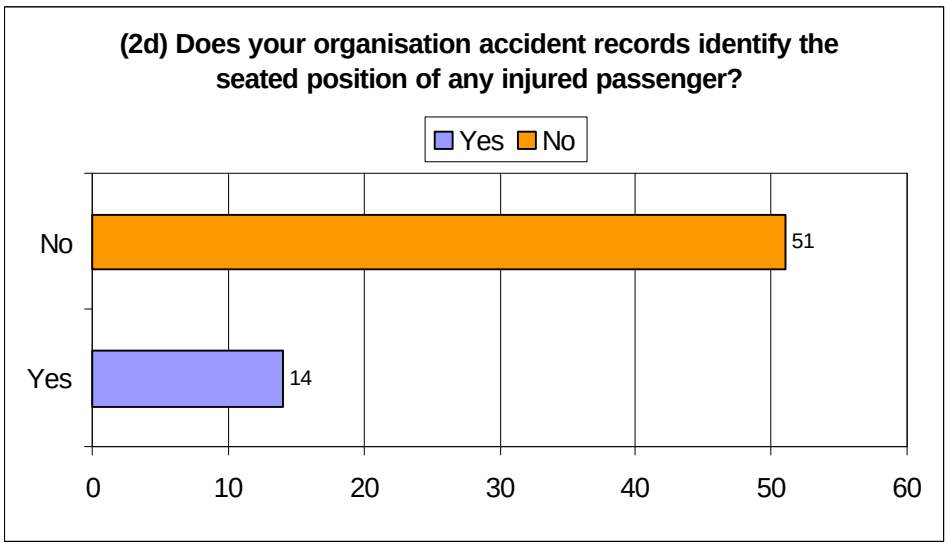

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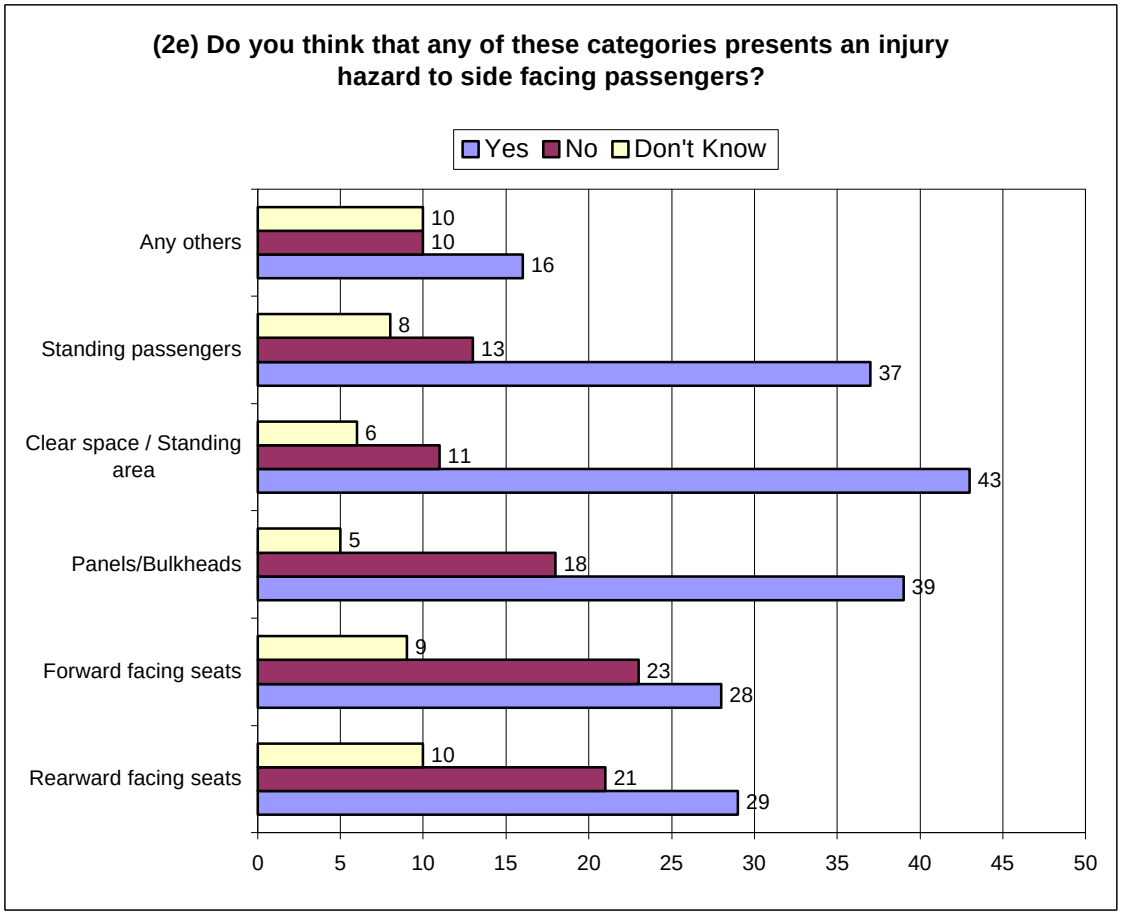

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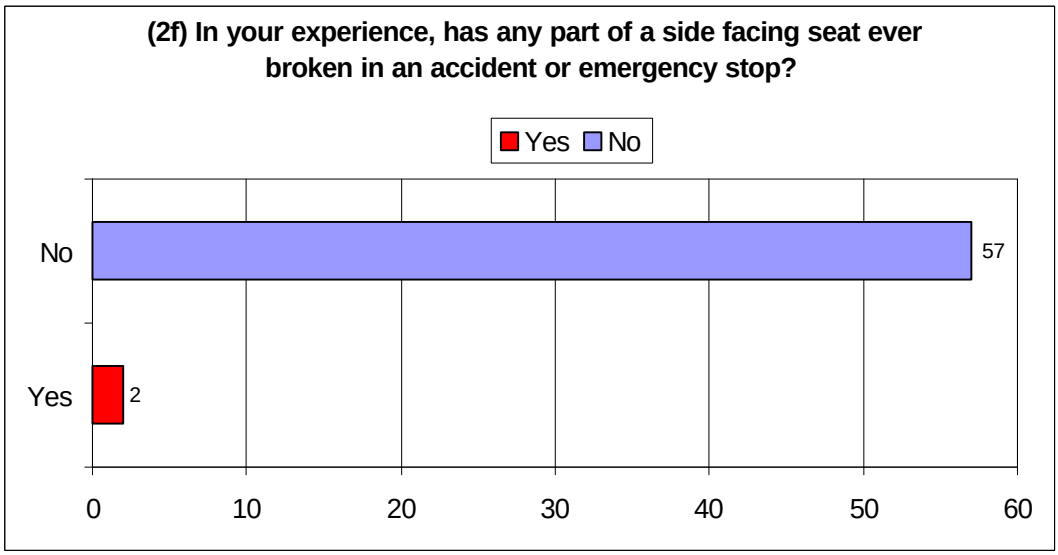

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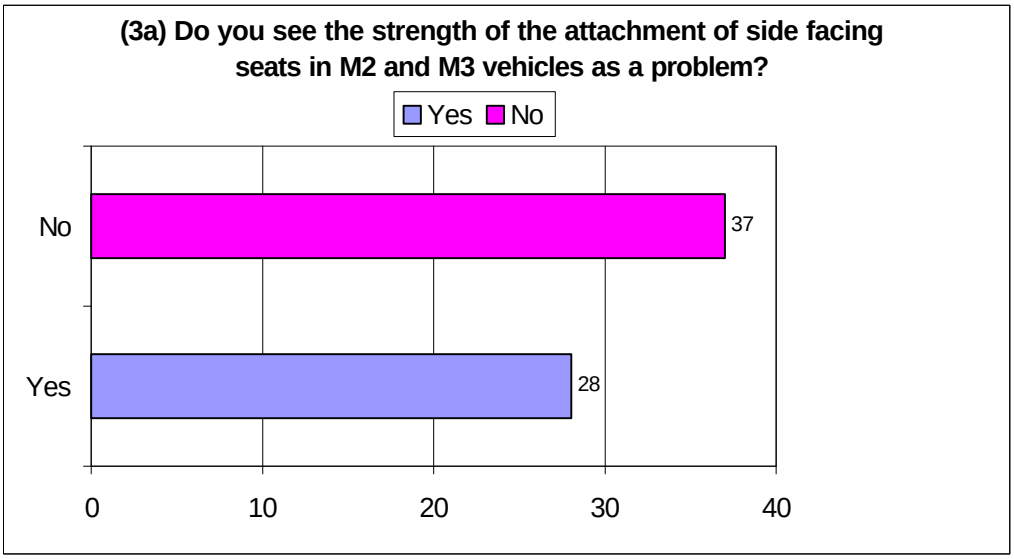

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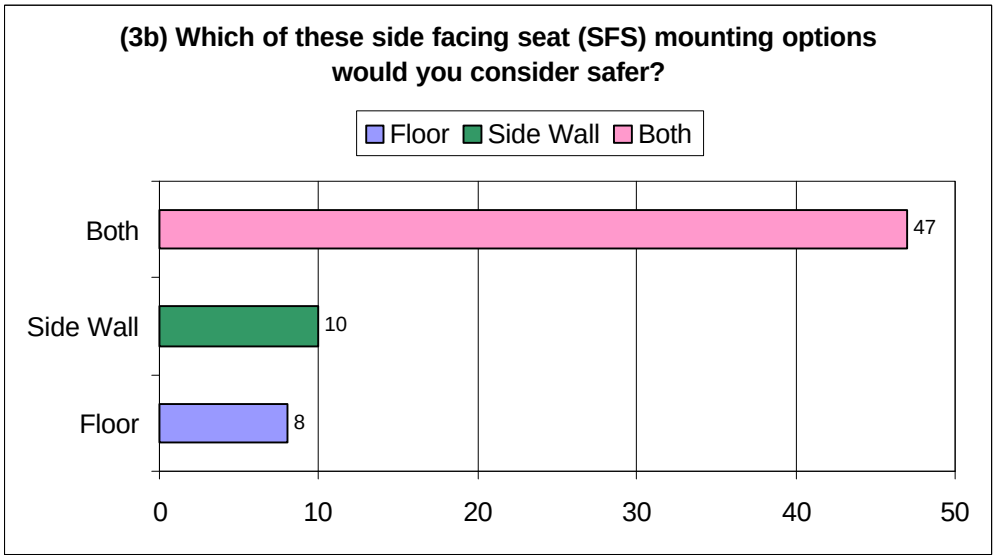

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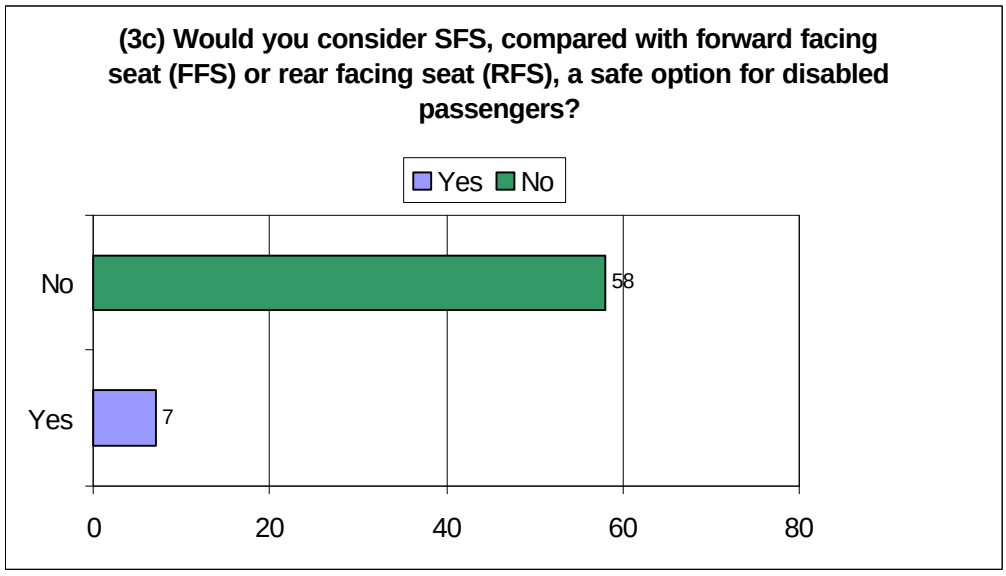

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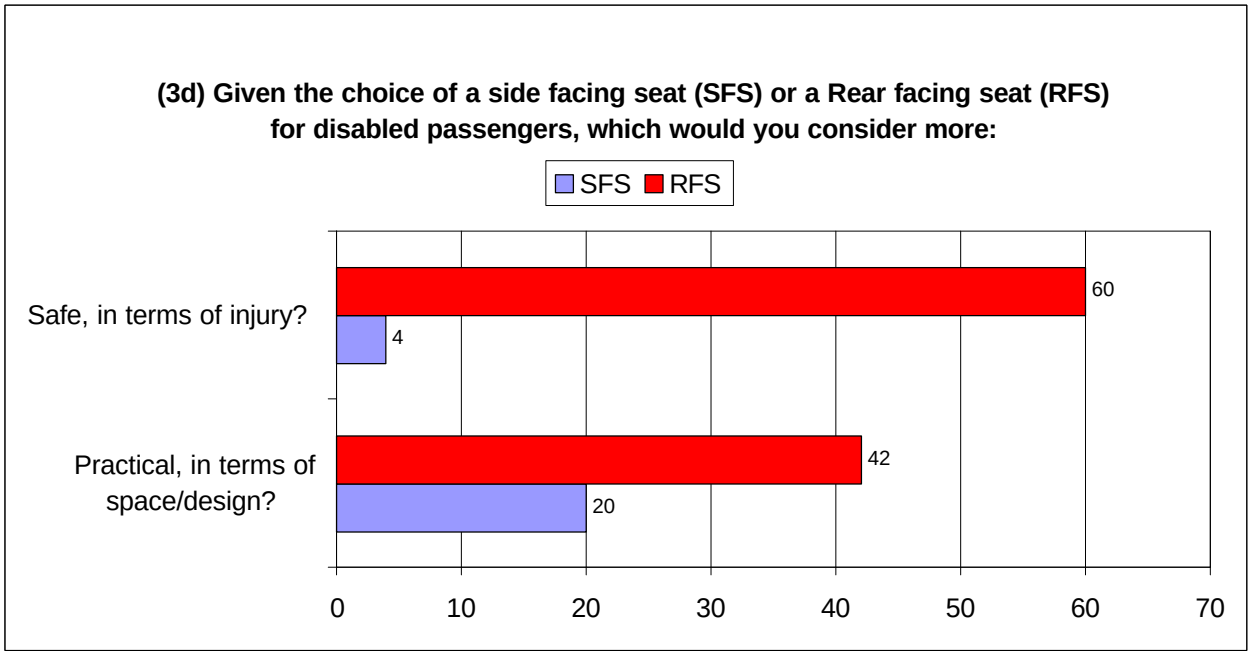

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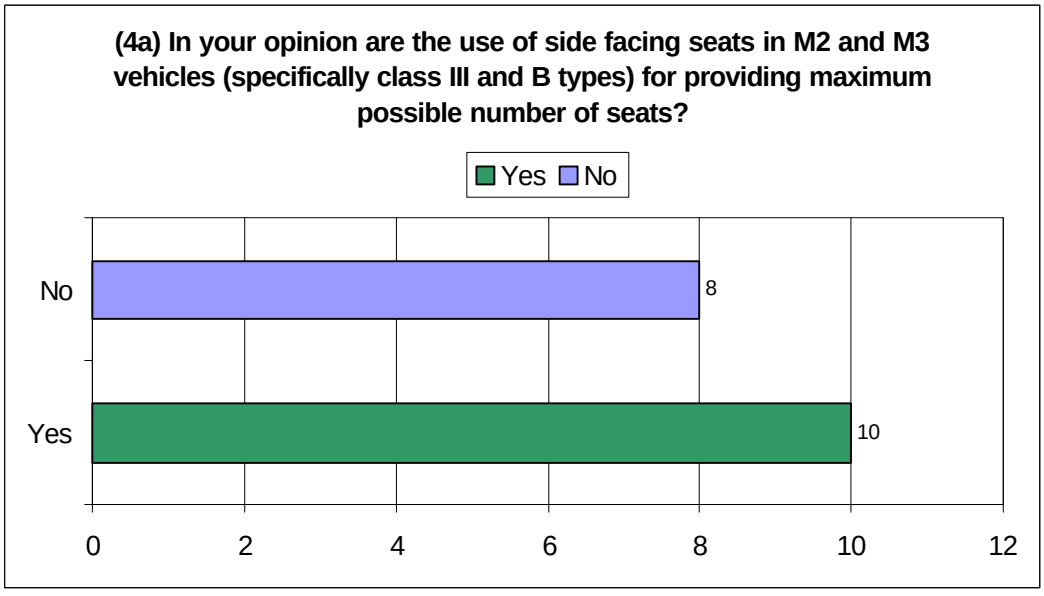

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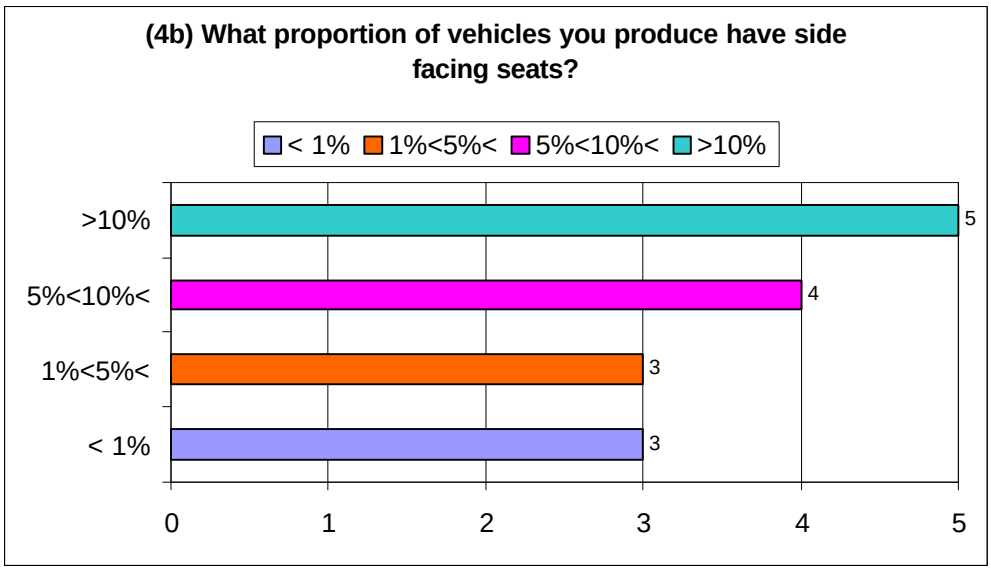

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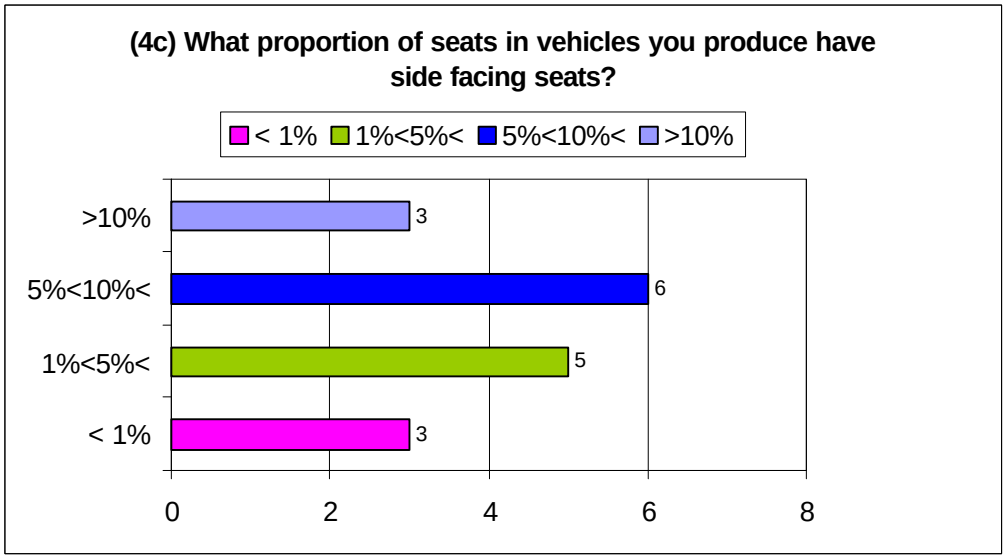

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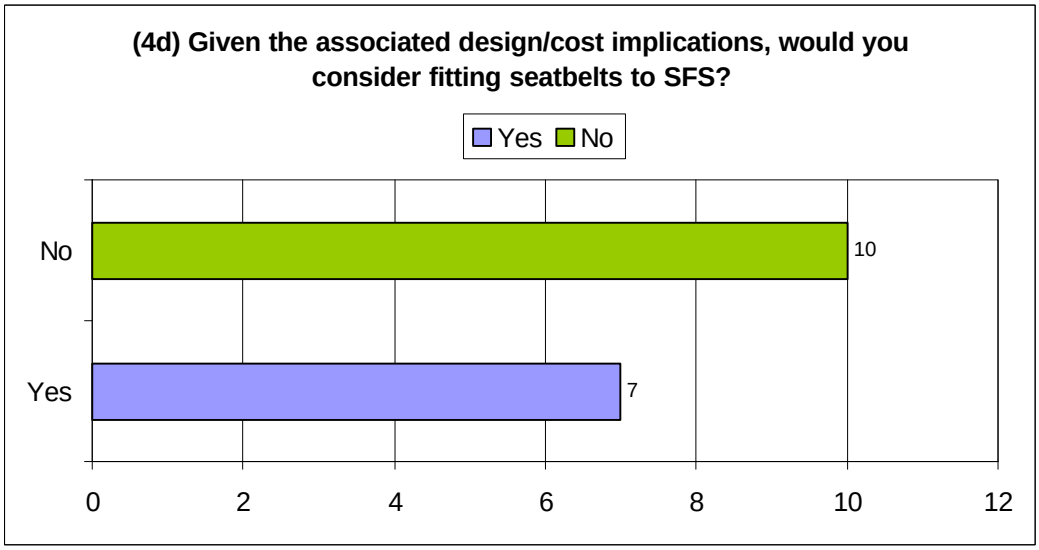

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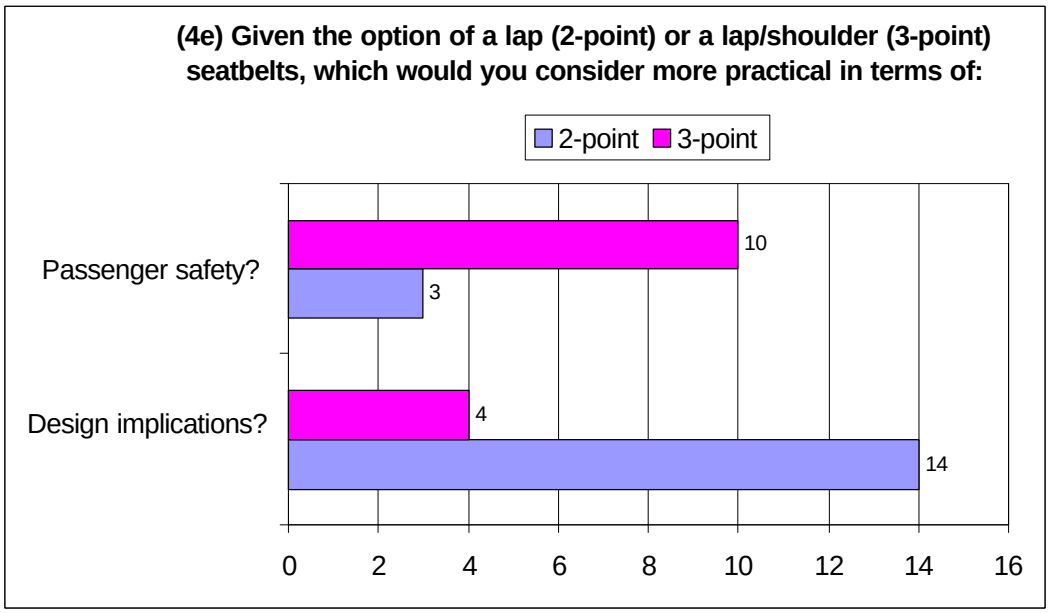

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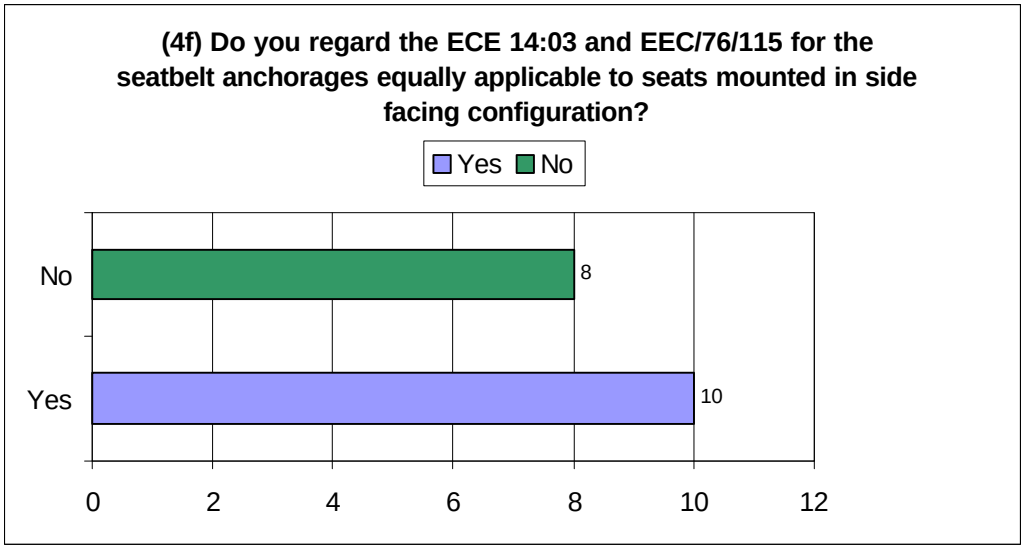

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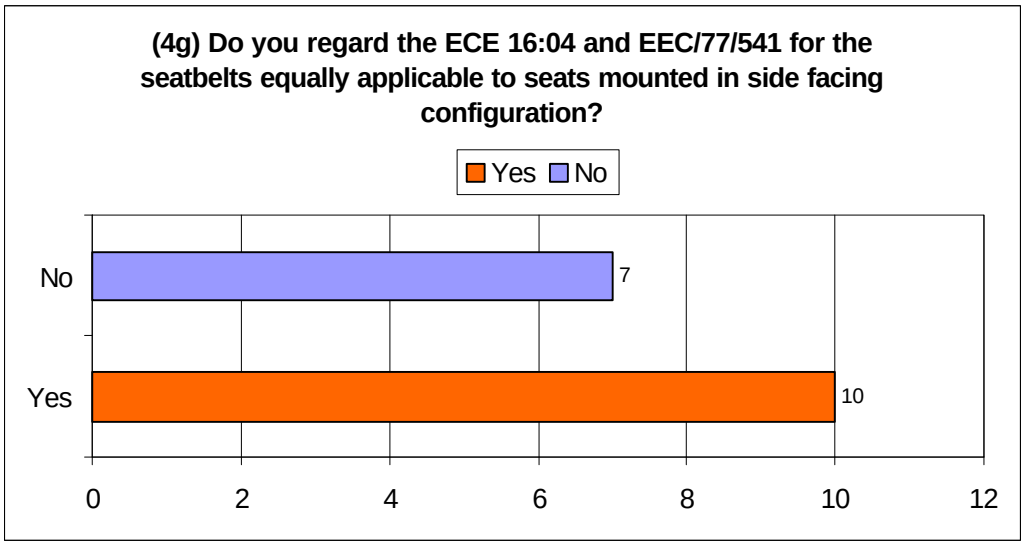

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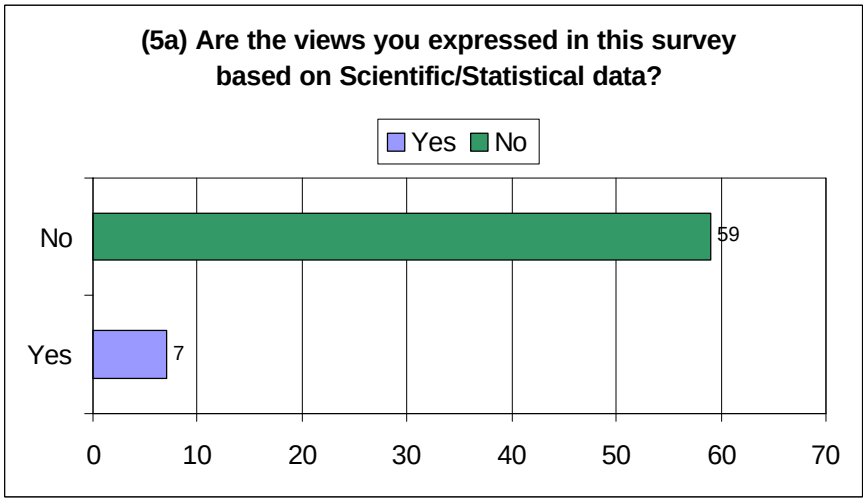

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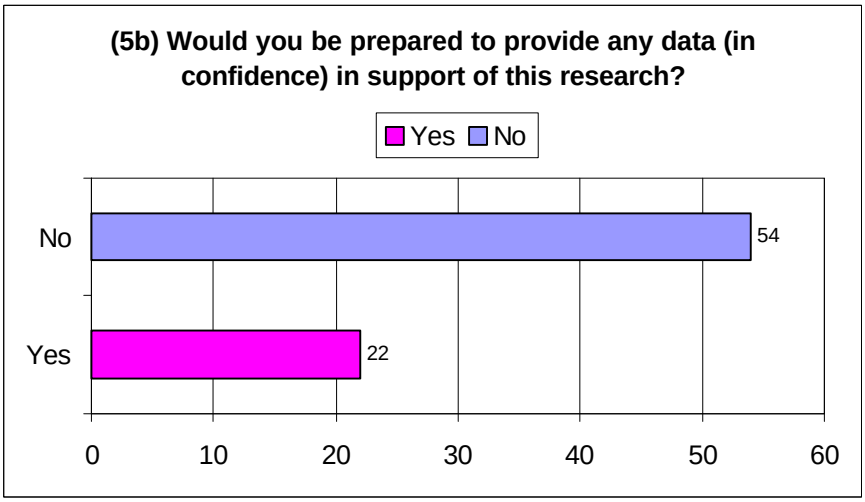

FIGURE A20

(APPENDIX B)

(B1) PRESS RELEASE

… Press release … Press release … Press release … Press release …

Longitudinal seating: Safety study

Cranfield Impact Centre (CIC) of Cranfield University and Vehicle Safety Research Centre (VSRC) of Loughborough University have been contracted by the European Commission to look into issues regarding safety considerations of side facing (inward-facing or longitudinal) seating arrangements in buses/coaches (M3) and minibuses (M2) particularly in Class III and B vehicles.

As part of the brief, the European Commission has requested that the views, recommendations and advice of interested bodies and organisations concerned in enhancing the safety aspects of non-forward facing seats in M2 and M3 vehicles, be solicited.

Views regarding safety, design issues and certification of side facing and rear facing seats in buses and minibuses with regard to construction characteristics, positioning/spacing, attachment, type approval testing and the suitability of use of 2-point and 3-point seatbelts will be welcomed. The information collected will be of use to the European Commission in formulating future proposals in the area of motor vehicle type-approval for M2 and M3 vehicles.

Due to the limited time scale for the study, prompt responses will be much appreciated. Provision of any statistical evidence as requested by the EC, if at all possible, in support of your views on the raised issues will be extremely helpful. All information provided will be treated with utmost confidentiality.

The **deadline** for making effective use of information is **23rd March 2001**.
The extended **deadline** for making possible use of information is **27 th April 2001**.
OR
The **deadline** for making effective use of information is **3 weeks after the publication date**.

Contact . . .

Ms Sharon Cook Vehicle Safety Research Centre ICE Ergonomics Holywell Building Holywell Way Loughborough Leicestershire LE11 3UZ Tel: 01509 283327 e-mail: scook@ice.co.uk	Dr Rasool Hashemi Cranfield Impact Centre Senior Project Engineer Cranfield Impact Centre Wharley End Cranfield Beds MK43 0JR Tel: +44(0)1234-756514 Fax: +44(0)1234-750944 e-mail: s.m.r.hashemi@cranfield.ac.uk	Dr Andrew Walton Cranfield Impact Centre Senior Project Engineer Cranfield Impact Centre Wharley End Cranfield Beds MK43 0JR Tel: +44(0)1234-756515 Fax: +44(0)1234-750944 e-mail: a.c.walton@cranfield.ac.uk

(B2) LIST OF PRESS RELEASE CONTACTS

Publications that received press release

TRANSIT (Bus and rail managers)
TRANSPORT ENGINEER (Includes Transport engineering and technology, aimed at those who specify and maintain bus fleets)
TRANSPORT JOURNAL
TRANSPORT MANAGEMENT (Official newsletter of the Institute of Transport Administration, aimed at professional managers/supervisors within transport industry)
VEHICLE AND FLEET MANAGEMENT (Aimed at public service fleet and transport managers)
WORLD TRANSPORT POLICY & PRACTICE (Transport, public policy, infrastructure, etc)
BUS & COACH BUYER (Coach and bus company operators)
BUS & COACH PROFESSIONAL (Includes Gov. policy, technology, etc, aimed at bus and coach operators)
BUSES (Info. and news re: bus fleets, operators and manufacturers, read by bus industry professionals)
BUS FAYRE (Past and present bus and coach industry, read by bus and coach professionals)
CBW COACH AND BUS WEEK (News reports and in-depth articles on PSV industry, read by managers in the transport industry)
COACH MONTHLY (Read by coach operators)
COMMUNITY TRANSPORT (Aimed at minibus operators)
MINIBUS (Aimed at small vehicle operators)
LOCAL TRANSPORT TODAY (Aimed at Professionals within transport)
CARE ON THE ROAD (Vehicle design, road safety, new legislation, etc)
CRONER'S HEALTH & SAFETY AT WORK
TRANSPORT LAW & POLICY (Read by road solicitors and advisors, transport companies and authorities)

POLICE FLEET MANAGER

A police fleet manager contacted the CIC and VSRC wishing to reply to the questionnaire and to discuss the safety of such seating with respect to the transport of prisoners.

Description of Use

Longitudinal seating is used within cages in the rear of public order vehicles, Normally used with two people on either side, Useful to be able to lie people down between the seats (drunks who may be sick in transit), Probably also applicable to prison vehicles, No seat-belts or restraint systems with these seats.

Scale of Use
One force has 44 such vehicles, another probably has a few hundred, In total there are 43 police forces that may use these vehicles, Vehicles with these seats are still being supplied.

COUNCIL PROVIDER OF TRANSPORTATION SERVICES

I am not able to offer evidential data to your research into longitudinal, or inward facing passenger seats, but I can advise that our Internal Transport Policy forbids, without question, their use for the transportation of our service users. The reasoning for this decision is based on historic data concerning soft tissue and skeletal injury, mainly as a result of impact. This Policy decision was made prior my joining this employment and, although I am unaware of the precise source, I understand the data did not relate to 'in-house' incidents, but rather a collation of external information.

Even though our vehicle fleet is not fitted with inward facing seats, this does not preclude us from the vigilance of endorsing this Policy/safety standard, as a percentage of our clients transportation needs is out-sourced. To maintain our safety standards and duty of care to our clients, such conformity is expected of non-fleet transport providers, where possible.

A more appropriate issue to our needs, and identified in the news article concerning your research, is that of rearward facing seats. I am currently researching the problem of transporting customised wheelchairs where the necessary support offered by the purpose built seat section of the wheelchair, prevents the correct and sometimes adequate, fitting of a passenger restraint. This results in a very well secured wheelchair frame, but a poorly, or inappropriately restrained occupant/seat, or both.

This problem extends into a number of disparate issues concerning passenger safety/suitability of transporting certain types of wheelchairs, seat construction, etc., but the main issue apparent to your research would be that of rearward facing seats.

For a rearward facing seat, particularly if used by those with poor upper body strength, I considered the resultant forces exerted on a passenger, the demands on any passenger restraint, and the resultant forces acting on the seat itself from body movement, should an impact or sudden course alteration occur. Compared to those same, or equivalent forces resultant from forward facing passenger/seat with an inadequate/inefficient passenger restraint fitted, the support offered would seem to be considerably higher for rearward facing seat occupants.

Although we have purchased a number of purpose-built, convertible minibus seats from a well known safety products manufacturer, suitable to accommodate either a conventionally seated occupant, or secure and restrain a wheelchair and its occupant, they have not been crash tested

in the rearward facing position. The manufacturers of this equipment advise me that they have no plans, within the foreseeable future, to carry out such tests/construction. The only option they could suggest was the provision of individual bulkheads for each passenger, which is clearly overwhelmingly restrictive on several counts.

These purpose-built seats lock into rails fitted to the vehicle floor, offering the adaptability of position, removal, etc. In your research into rearward facing seats, recommendations for construction and crash testing (without bulkheads) of such individual equipment as this, could offer the potential of more immediate problem solving in transport safety, where conventional restraints fail to provide the necessary support. I would appreciate your views on this matter, and would be pleased to read the results of your research and any subsequent recommendations.

CHARITY ORGANISATION FLEET MANAGER

Our Charity operates the largest fleet of minibuses designed for the transport needs of people with mobility difficulties in the UK - 160+ vehicles. Our main activity is the door-to-door service.

Our experience has shown that all seats in such vehicles should be fitted with 3-point lap and diagonal seat belts and wheelchairs and their Users should be secured in vehicles of all types (including larger type vehicles despite current PSV requirements).

We are only too well aware that side facing seats can only - at best - be fitted with fixed lap belts as the inertia reel design can only work with seats facing either forwards or backwards. It is a matter of great concern to the Charity that many vehicles (particularly those operated by NHS Trusts on patient Transport Services) continue to be produced with side facing seats and even seats which are angled diagonally forwards - presumably in the mistaken belief that this arrangement will facilitate use of inertia reel seat belts. For elderly and disabled people the use of side facing seats (with or without fixed seat belts) would place an unacceptable strain on parts of the body which would be exposed to lateral braking forces, hence the preference for forward and/or rearward designs which facilitate the use of backrests and the passengers' legs as means of absorbing braking forces.

Despite passenger perception, our understanding from previous research carried out by organisations such as MIRA, is that rear facing seats are if anything the safest configuration but we accept that to fit out vehicles totally with rear-facing seats would be unacceptable for non-safety reasons.

Research on the use of low-floor conventional buses in this area has demonstrated reluctance on the part of wheelchair users to travel in the designated spaces because such vehicles are not required to provide securing systems.

OTHER RESPONSES

Respondee 1

Soon after the M40 accident in which a number of school children were killed, along with their teacher, I made the suggestion, via the letters page in a road safety organisation magazine,

that longitudinal seats be phased out for the following reasons:

- Difficult to restrain people when subject to a fore and aft force, except if a full harness be worn.
- This would be impractical in most vehicles due to lack of suitable anchorages.
- Easy to exceed the vehicles seating capacity, since seats are not so readily defined.
- More chance of head to head contact in event of accident, or even hard braking/cornering.

As a interim measure, since a sizeable number of these vehicles are in use with schools and youth groups, and seatbelt fitting would be unlikely on cost grounds as well as being impractical, that the speed of such vehicles is limited to 30mph, i.e. only used for local trips, and certainly not on motorways.

With these conditions being applied, it is likely that these vehicles would be replaced as soon as possible with vehicles with transverse seating with lap and diagonal seat belts to an approved standard.

Respondee 2

I read with interest in the latest RoSPA Advanced Drivers Newspaper (RoADA) that you were seeking views about side or inward facing seating arrangements in buses, coaches and minibuses.

My initial view is 'been there done that' already, it didn't work the first time, why should it work the next time? I remember sitting in a minibus with inward facing seats and the awkward feeling of nothing to restrict my body when the driver accelerated or braked harshly. One should consider the comfort aspect as well as safety aspects. Other than that I don't have any qualified opinions on the safety aspects.

On another matter, I work for a Market Research company.
We have large national field force and any time you have the need to conduct research, which involves interviewing drivers / road users etc, I am sure we can be of assistance. Feel free to call for a chat at any time. My role with RoSPA and the IAM may be beneficial to any surveys we do.

(APPENDIX C)

LIST 1 – UK OPERATORS

Company Name and Country

Wirral Peninsula Buses, UK
Rollinson Safeway Ltd, UK
First Group plc, UK
Travel West Midlands, UK
Pattersons Coaches, UK
Hallmark Coaches, UK
The Birmingham Coach Company Ltd, UK
Hardings Coaches, UK
Blackburn Borough Transport Ltd, UK
Blazefield Holdings Ltd, UK
Wilts and Dorset Bus Co.Ltd, UK
Metrobus, UK
Coombs Travel, UK
First Cityline, UK
Stagecoach Cumberland, UK
Cambus Ltd, UK
Hedingham & District Omnibuses Ltd, UK
Harry Shaw Travel, UK
Bostock's Coaches ltd, UK
Trent Buses, UK
Wellglade Ltd, UK
G Abbot & Sons, UK
Dartline Coaches, UK
Blackpool Transport Services Ltd, UK
Tillingbourne Bus and Coach Group, UK
Metroline Travel Ltd, UK
Harrogate & District Travel Ltd, UK
Ipswich Buses Ltd, UK
Galloway European Coachlines, UK
Tellings Golden Miller Ltd, UK
Epsom Coaches, UK
Lincolnshire Road Car Co Ltd, UK
Wallace Arnold Tours Ltd, UK
Black Prince Buses Ltd, UK
Chalkwell Coach Hire, UK
The Go-Ahead Group plc, UK
Nottingham City Transport, UK
Dunn-Line Holdings Ltd, UK
First Eastern Counties, UK
Sanders Coaches, UK
Rossendale Transport Ltd, UK
The Oxford Bus Company, UK
Heyfordian Travel Ltd, UK

Stagecoach Holdings plc, UK
Plymouth Citybus, UK
Southern Vectis plc, UK
Yorkshire Terrier Ltd, UK
John Powell Travel, UK
Traction Group Ltd, UK
The Barnsley & District Traction Co, UK
Clarkes of London, UK
Sovereign Bus & Coach Co Ltd, UK
Thamesdown Transport Ltd, UK
Fosseway Ltd, UK
Solent Blue Line, UK
Arriva Group, UK
First PMT, UK
Shropshire County Council, UK
Cooks Coaches, UK
First Western National, UK
Speedlink Charter, UK
Armchair Passenger Transport Co Ltd, UK
National Express Group plc, UK
Hampshire Constabulary, UK

LIST 2 – EUROPEAN OPERATORS

Company Name and Country

Cooperativa Interrurbana Andorrana, Andorra
Autos Pujol Huguet, Andorra
Autocars Nadal, Andorra
Sudburg Austrobus, Austria
Steiermarkische Landesbahnen, Austria
Albus, Austria
Blaguss Reisen GmbH, Austria
Autocars Henri de Boeck SA, Belgium
Societe des Transports Intercommunaux de Bruxelles, Belgium
SA des Autobus Regionaux, Belgium
De Decker-Van Riet PVBA, Belgium
West Belgium Coach Cy, Belgium
TCM Cars SA, Belgium
Gradski Transport, Bulgaria
Zagrebacki Elektricni Tramyag, Croatia
Dopravni podnik mesta, Czech Republic
CSAD Liberac, Czech Republic
Dopravni podnik mesta, Czech Republic
CSAD Klicov s.p, Czech Republic
Hovedstadsomradets Trafikseiskab, Denmark
Nordjyllands Trafikselskab, Denmark
Ostbanen A/S, Denmark

Unibus Rutetrafik A/S, Denmark
Viljandi ATP Ltd, Estonia
Helsinki City Transport, Finland
Tampereen Kaupungin Liikennelaitos, Finland
Les Rapides de Bourgogne, France
Sadac, France
SA Les Autocars Gris, France
Tourisme Verney, France
Transports Armor Express, France
Berliner Berkehrs-Betriebe, Germany
Verkehrs-GmbH, Germany
Hamburger Hochbahn, Germany
Ustra Hannoversche Verkehrsbetriebe, Germany
Stuttgarter Strassenbahnen, Germany
Rock City Services LTd, Gibralter
Nuuk Bussii AS, Greenland
Matra Volan Ltd, Hungary
Budeapesti Kozlekedesi, Hungary
Tisza Volan RT, Hungary
Straetisvagnar Reykjavikur, Iceland
Decouvertes - Gruppo Arfea, Italy
Azienda Trasporte Area Fiorentina, Italy
Azienda Trasporte Area Municipali di Milano, Italy
Azienda Trasporti Consortile Transporti Publicci, Italy
Azienda Consortile Trasporti, Italy
Ferrovie Tramvie Vicentine, Italy
Rigas Pilsetas Pasvaldibas Uznemums, Latvia
Kaunas Bus Company, Lithuania
Voyages Emile Weber, Luxembourg
Service des Transports en Commun, Luxembourg
Compagnie des Autobus de Monaco, Monaco
Gemeente Vervoerbedrijf Amsterdam, Netherlands
NV Verenigde Autobus Diensten, Netherlands
NV Brabantsche Buurtspoowegen, Netherlands
NV Bgroninger Autobusdienst Onderneming, Netherlands
A/S Bergen Sporvei, Norway
Pan Trafikk AS, Norway
Helgeland Bilrtuer A-S, Norway
A-S Oslo Sporveier, Norway
Miejskie Zaklady Autobusowe, Poland
Miejskie Przeds. Komunikacyjne Sp.zo.o, Poland
Isidoro Duarte Lda, Portugal
Sociedada de Transportes Colectivos do Porto, Portugal
Regie Autonoma de Transport Bucuresti, Romania
Gradski Saobracaj Beograd, Serbia
DPMK, Slovakia
Ferrocarrils de la Generalitat de Catalunya, Spain
Transportes Generales Comes SA, Spain
Empresa Municipal de Transportes, Spain

Transportes Urbanos de Sevilla, Spain
Granbergs Buss, Sweden
Gavle Trafik, Sweden
Goteborgs Sparvagar AB, Sweden
Malmo Trafik, Sweden
Swebus Gruppen, Sweden
Bern City Transport, Switzerland
Transports Publics Genevois, Switzerland
Verkehrsbetriebe der Stadt Luzern, Switzerland
Transports Publics du Littoral Neuchatelois, Switzerland
Verkehrsbetriebe der Stadt Winterhur, Switzerland

LIST 3 – WORLD BODYBUILDERS

Company Name and Country

Van Hool NV, Belgium
Euro Coach Builders, Ireland
LDV plc, UK
East Lancashire Coachbuilders Ltd, UK
Arriva Bus and Coach, UK
W.B.Cunliffe & Son, UK
Walter Alexander (Belfast) Ltd, N Ireland, UK
Robert Wright & Son (Coachworks) Ltd, N Ireland, UK
Cannon, N Ireland, UK
Marshall Bus, UK
Ford Motor Co Ltd, UK
Evo-bus (UK) Ltd, UK
ERF, UK
Crystals Conversions, UK
Crest Coach Conversions, UK
Walter Alexander (Falkirk) Ltd, UK
Dennis, UK
Volvo coach Sales (Loughborough) Ltd, UK
G C Smith Coachworks, UK
Leicester Carriage Builders, UK
Salvador Caetano (UK) Ltd, UK
Optare Ltd, UK
Renault VI UK Ltd, UK
Olympus Coachcraft, UK
Jaycas Minibus Sales, UK
Berkhof UK Ltd, UK
Toyota (GB) Ltd, UK
Neoplan, UK
Cymric Conversions, UK
Concept Coachcraft, UK
Frazer Nash Engineering Technology, Ireland
Rohill Brothers Ltd, UK

Iveco Ford Trucks Ltd, UK
Jubilee Automotive Group, UK
Plaxton Coach and Bus, UK

LIST 4 – UK GENERAL

Company Name and Country

IMH Birmingham Ltd, UK
MBCW Ltd Coach and Bus Spares, UK
West Midlands Passenger Transport Executive, UK
RoSPA, UK
Tube Products Ltd, UK
Coach Operators Federation, UK
Austin Analytics, UK
Association of Transport Co-ordinating Officers, UK
Chapman Seating Ltd, UK
MIRA, UK
Callow & Maddox, UK
Scandus Design Limited, UK
Office of Fair Trading, UK
Strathclyde Passenger Transport Executive (PTE) , UK
Vulcan Engineering Co (Halifax) Ltd, UK
Merseyside Passenger Transport Executive (PTE) , UK
Denormo Technics Ltd, UK
Volvo Coach Sales (Loughborough) LTd, UK
Barry Hall Installations Ltd, UK
West Yorkshire Passenger Transport Executive (PTE) , UK
Vehicle Builders and Repairers Association, UK
GMPTE, UK
MTB Equipment Ltd, UK
Woodbridge Foam UK LTd, UK
Nexus (Tyne and Wear Passenger Transport Executive (PTE) , UK
Tricom Automotive Ltd, UK
The Coach Tourism Council, UK
Duoflex Ltd, UK
Kab Seating Ltd, UK
ADG Transport Consulants, UK
Road Operators Safety Council, UK
Abacus Tubular Products Ltd, UK
The National Federation of Bus Users, UK
Transport Research Laboratory, UK
South Yorkshire Passenger Transport Executive (PTE) , UK
Neoplan, UK (REPEAT)
British Road Federation, UK
BEAMA Ltd, UK
The Institute of the Motor Industry, UK
The Institute of Transport Administration, UK

Metropolitan Police Coach Advisory Service, UK
The Institution of Mechanical Engineers, UK
The Institute of Road Transport Engineers, UK
Local Government Association
Society of Motor Manufacturers and Traders, UK
Freight Transport Association, UK
The Institute of Logistics and Transport, UK
Rew (Acton) Ltd, UK
Association of Local Bus Company Managers, UK
Confederation of Passenger Transport UK, UK
TRANSFED, UK

ADDITIONAL LIST 5 – UK Related

List of Companies: Circulation of CIC Longitudinal Seating
Safety Study Questionnaire, Provided by The Society of Motor Manufacturers & Traders Ltd (SMMTL)

Company Name and Country

Bristol Cars Ltd, UK
Morgan Motor Company Ltd, UK
Colt Car Company Ltd, UK
Millbrook Proving Ground Ltd, UK
Meritor LVS UK Ltd, UK
Toyota Motor Manufacturing UK Ltd, UK
Daewoo Motor Company Ltd, UK
LDV Ltd, UK
Britax Child Safety Systems Ltd, UK
Motor Industry Research Association, UK
Ford Motor Company Ltd, UK
Nissan Technical Centre Europe Ltd, UK
Peugeot Motor Company Ltd, UK
MG Rover Group Ltd, UK
Lotus Engineering Ltd, UK
DaimlerChrysler UK Ltd, UK
Jaguar Cars Ltd, UK
Toyota Motor Europe Ltd, UK
Rolls-Royce & Bentley Motor Cars Ltd, UK
Visteon Automotive Systems Ltd, UK
Land Rover, UK
Vauxhall Engineering Centre Ltd, UK
Volkswagen Group UK Ltd, UK
Johnson Controls Automotive UK Ltd, UK
Vauxhall Motors Ltd, UK
Koito Europe Ltd, UK
IBC Vehicles Ltd, UK