DRAFT NATIONAL CODE OF PRACTICE

Retrofitting Passenger Restraints to Buses

August 2005

National Transport Commission

Prepared by

Vehicle Design & Research

National Transport Commission

Draft National Code of Practice for Retrofitting Passenger Restraints in Buses.

Report Prepared by: **Vehicle Design & Research**

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Key Milestones:	A draft of the National Code of Practice is now complete. It is proposed that the 'draft code' would be placed on the NTC website for a period of public/stakeholder consultation before going to ATC for ministerial approval.
Abstract:	A draft Code of Practice has been prepared which set out requirements for modification of existing buses with the intention of improving occupant protection in crashes. The Code of Practice has now been endorsed by the Bus Seatbelts Steering Committee. The Code is intended to replace the original guidelines. The draft Code is based on investigations of bus occupant safety research since the 1994 code was introduced, and the commercial availability of Australian Design Rule 68/00 (ADR68) seats with integral lap/sash seatbelts from several local and overseas manufacturers.
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Comments to be addressed to:

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Important note about this draft

NOTE THAT THE **CERTIFICATION FORM** IS CURRENTLY A SEPARATE DOCUMENT AND THAT THE **SHORT DURATION STATIC TEST** (APPENDIX A) IS A FUTURE ADDITION.

THIS DRAFT DOES SHOULD NOT BE USED FOR MAKING COMMERCIAL DECISIONS.

FOREWORD

The National Transport Commission (NTC) is a statutory body established by an intergovernmental agreement to progress regulatory and operational reform for road, rail and inter-modal transport to deliver and sustain uniform or nationally consistent outcomes.

Following the research that was commissioned for the NSW Roads and Traffic Authority (RTA) into the retrofitting of seatbelts for buses and coaches, as well as advice from the Bus Industry Confederation (BIC), it was concluded that the original guidelines ("Guidelines for the Voluntary Modification of Existing Buses and Coaches to Improve Occupant Protection") needed to be revised. These guideline were originally developed in 1994 by the National Road Transport Commission (NRTC), the Federal Office of Road Safety (FORS) and the Australian Bus and Coach Association (ABCA).

The NTC is leading the review and Bus Seatbelts Steering Committee is involved in providing key input and overall direction on the review. A draft Code of Practice has been prepared which set out requirements for modification of existing buses with the intention of improving occupant protection in crashes. The Code of Practice has now been endorsed by the Bus Seatbelts Steering Committee. The Code is intended to replace the original guidelines. The 'draft code' would be placed on the NTC website for a period of public/stakeholder consultation before going to ATC for ministerial approval.

This review is an important strategic objective under the National Heavy Vehicle Safety Strategy (NHVSS) and the National Heavy Vehicle Safety Action Plan 2003 - 2005 (NHVSAP). The NHVSS and Action Plan (NHVSAP) were originally adopted by the Australian Transport Council (ATC) in 2003, to complement the National Road Safety Strategy and Action Plan and to provide a focus for road trauma resulting from crashes involving heavy vehicles.

The ATC comprises Commonwealth, State, and Territory Ministers with transport responsibilities and includes an observer from local government. Both the NHVSS and the Action Plan are specifically targeted at reducing the number of road users killed or seriously injured in crashes involving a heavy vehicle. They were developed using the advice provided by the road transport industry, Commonwealth, State and Territory transport policy advisors, and road safety researchers. This revised Action Plan 2005/07 has been developed jointly by the Heavy Vehicle Safety Strategy Taskforce, which is comprised of a broad range of representatives from road safety organisations and the heavy vehicle industry.

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EXECUTIVE SUMMARY

Following the research that was commissioned for the NSW RTA into the retrofitting of seatbelts for buses and coaches and the advice from the Bus Industry Confederation (BIC), it was concluded that the original guidelines ("Guidelines for the Voluntary Modification of Existing Buses and Coaches to Improve Occupant Protection") need to be reviewed. The importance of the review was confirmed following an audit by the Roads and Traffic Authority in 2001 that revealed a wide range in quality of seat belt installations on buses in NSW.

The review is an important strategic objective under the National Heavy Vehicle Safety Strategy (NHVSS) and the National Heavy Vehicle Safety Action Plan 2003 - 2005 (NHVSAP). The NHVSS and Action Plan (NHVSAP) were originally adopted by the Australian Transport Council (ATC) in 2003, to complement the National Road Safety Strategy and Action Plan and to provide a focus for road trauma resulting from crashes involving heavy vehicles. Both the NHVSS and the Action Plan are specifically targeted at reducing the number of road users killed or seriously injured in crashes involving a heavy vehicle.

A draft Code of Practice has been prepared which sets out requirements for modification of existing buses with the intention of improving occupant protection in crashes. The Code is intended to replace the original guidelines (developed in 1994 by the National Road Transport Commission (NRTC), the Federal Office of Road Safety (FORS) and the Australian Bus and Coach Association (ABCA)). The intention is that States and Territories insist that retrofitted buses meet the National Code of Practice.

The draft Code is based on:

- investigations of bus occupant safety research since the 1994 code was introduced, and
- commercial availability of Australian Design Rule 68/00 (ADR68) seats with integral lap/sash seatbelts from several local and overseas manufacturers.

The Code recommends that, where seatbelts are to be retrofitted, then only lap/sash seat belts incorporated in ADR68 certified seats and anchored to withstand a 20g crash pulse be permitted. Whilst, in some cases, this places more stringent requirements on the vehicle than at original manufacture, it reflects practical application of available technology to ensure a uniform standard of protection for bus occupants choosing public vehicles with seatbelts fitted.

More than ten years after the introduction of ADR68 there is considerable demand for large/small luxury/basic buses which have seatbelts fitted. This has resulted in continuing retrofit activity of vehicles which were exempted from ADR68 at the time of manufacture, either because of standee provision (route buses) or installation of low back seats. This results in an anomalous situation where a vehicle which has its usage changes after initial manufacture was not required to have occupant protection brought up to the appropriate level (i.e. ADR68).

In addition, the draft Code proposes that:

- all seat belt retrofits be certified by an approved engineer;
- retrofitted buses be fitted with a modification plate or similar for clear identification; and
- further work should be undertaken on a simplified seat anchorage test to facilitate certification of retrofitted vehicles to ADR68 performance levels.

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1. GENERAL

1.1 Publication information

This document is published by the National Transport Commission and relates to:

- the modification of in-service buses to reduce the risk of injury to bus passengers in the event of a crash and
- acceptance by registering authorities of buses which have been modified in accordance with this Code.

Buses and coaches manufactured to comply with Australian Design Rule 68 (ADR68) and Australian Design Rule 59 (ADR59) provide a very high standard of crash protection for occupants. There is now strong market demand for buses fitted with lap/sash seat belts for tours, charters and excursions. In response, there are continuing upgrades of seating and seatbelts of:

- Older buses which predate ADR68 and ADR59, or
- Newer buses which were not originally manufactured to comply with the latest coach-related ADRs.

This Code of Practice sets out minimum standards for such upgrades. It *replaces* and extends an earlier document "Voluntary modification of existing buses and coaches - guidelines to improve occupant protection", issued by the National Road Transport Commission and other organisations in 1994.

1.1.1 Scope

Unless covered by administrative arrangements, this Code applies to all buses and coaches (ME and MD vehicle categories) where original seats or seat anchorages are modified or replaced, or where seat belts are added after original manufacture.

The Code is not intended to apply where

a) original seats are replaced with ones of the same specifications as original build (such as for maintenance purposes) or

b) the vehicle is being modified for private use (such as a motor home).

1.1.2 Relationship with the Laws of Australian Jurisdictions

Subject to Federal laws and the laws of the States and Territories of Australia, this document defines standards of practice in the design and manufacture of modifications to buses to reduce to risk of injury to bus passengers. Other procedures are acceptable subject to adequate technical justification that the intent of the Code is met.

1.1.3 Effective Date

[to be determined]

1.1.4 Administrative Requirements

It is intended that buses modified in accordance with this National Code of Practice will continue to comply with the national vehicle standards regulations and Australian Design Rules (ADR) administered by the Commonwealth Department of Transport and Regional Services and the National Transport Commission. In some cases modified buses are required to meet a higher standard than applied at the time of first registration, in recognition of increasing expectations of safety offered by public vehicles.

While this Code of Practice establishes common technical standards, administrative responsibility for type certification and registration remains with the relevant Federal, State and Territory authorities.

1.1.5 Background

The Motor Vehicle Standards Act 1989 came into effect on 1 August 1989. It made it an offence to modify a vehicle before it is first supplied to the market for use in transport (i.e. a new vehicle) in such a way as to make it ‘non-standard’, that is, no longer complying with the Australian Design Rules. Because some vehicles are modified following the placement of an identification plate (often referred to as a compliance plate) on the vehicle the States and Territories have developed procedures to control such modifications through a single, national code of practice that serves the requirements of both Federal and State/Territory authorities.

1.1.6 Australian Design Rules for bus occupant protection

Heavy buses (ME category) manufactured on or after 1 July 1994 and light buses (MD3 and MD4 categories) manufactured on or after 1 July 1995 are required to comply with ADR68, subject to certain exemptions. In effect, this requires all passenger seats to be fitted with integrated lap/sash seat belts and for the seats to be designed and anchored to the vehicle with sufficient strength to withstand a severe frontal crash. Exempt vehicles include buses designed for route service and buses with low-back seats (top of seat not higher than 1m from floor).

Unless exempt, heavy buses (ME category) manufactured on or after 1 July 1992 and light buses (MD2, MD3 and MD4 categories) manufactured on or after 1 July 1993 are required to comply with ADR59 (rollover strength). Exempt vehicles include certain low-floor buses.

Table 1. Guide to Seat Belt Requirements and Implementation Dates for Buses

Date Of Manufacture	**Vehicle Category**	**Number of Seating Positions** (including driver)	**Seat Belt Requirements for Forward Facing Seats**
From 1/7/1983 (ADR5B)	MD1	-	Front row of seats (including driver's seat)
From 1/1/1987 (ADR5B)	MD1	-	Front and second rows of seats
From 1/1/1988 (ADR5/00)	MD1	-	All seating positions
From 1/7/1983 (ADR5B)	MD2	-	Front row of seats (including driver's seat)
From 1/7/1992 (ADR5/02)	MD2	-	All seating positions except "Protected seats". Not route buses
From 1/1/2000 (ADR5/04)	MD2	-	All seating positions
From 1/7/1988 (ADR5/00)	MD3 & MD4	-	Driver's seat
From 1/7/1992 (ADR5/02)	MD3 & MD4	-	All seating positions except "Protected seats". Not route buses
From 1/7/1993 (ADR66)	MD3 & MD4	17 or more	All seating positions except "Protected seats". Not route buses or where seating reference height less than 1m
From 1/7/1995 (ADR68)	MD3, MD4	17 or more	All seating positions. Not route buses or where seat reference height less than 1m
From 1/7/1988 ADR5/00)	ME	-	Driver's seat
From 1/7/1992 (ADR5/02)	ME	Less than 17	All seating positions except "Protected seats". Not route buses
From 1/7/1992 (ADR66)	ME	17 or more	All seating positions except "Protected seats". Not route buses or where seat reference height less than 1m
From 1/7/1994 (ADR68)	ME	17 or more	All seating positions. Not route buses or where seat reference height less than 1m

MD1 – Light omnibus up to 3.5t GVM & up to 12 seats

MD2 - Light omnibus up to 3.5t GVM & over 12 seats

MD3 – Light omnibus GVM over 3.5t and up to 4.5t

MD4 – Light omnibus GVM over 4.5t and up to 5t

ME – Heavy omnibus, GVM over 5t

'Protected seats' are defined in the ADRs. In effect it means that an unrestrained occupant is prevented from excessive forward movement in a frontal crash by the seat in front or by a screen of other device and that the seat, screen or device is designed to catch the occupant while minimising the risk of injury through appropriate energy absorbing structure.

Except for ME buses, where a driver's seat belt is required it must be a retractable lap/sash seat belt.

1.1.7 Occupant protection

1.1.7.1 Lap/sash seat belts

One of the key principles applying to this Code is that the upgrading of older buses should not significantly undermine the occupant protection standards offered to passengers through the progressive introduction of new buses that comply with the latest ADR. There should be easy public recognition of buses that fully meet ADR 68 and 59. Where a bus is fitted with lap/sash seat belts but is not certified to meet these ADR there should be procedures to ensure that the seats and seat belts offer similar levels of protection to a bus that complies with ADR68. It is unacceptable for a bus to physically resemble an ADR68 bus without offering similar levels of protection.

Inspections of buses that have been upgraded by modification of existing seats, such as strengthening seat frames and/or attaching seat belts to the seats have revealed some very poor practices and questionable protection in severe crashes. It is therefore preferable for seats to be replaced by seats that have been certified to comply with ADR68. The Code does not prohibit the modifications of existing seats but requires the same level of evidence as that required in ADR68 - typically a dynamic sled test of a representative set of seats and anchorages. In most cases the replacement of existing seats with seats that have been certified to comply with ADR68 will be a simpler, economical alternative.

1.1.7.2 Lap seat belts

Since the first retrofit guidelines were published in 1994, the relatively poor protective performance of lap only belts compared to lap-sash belts, has been more clearly identified in published research. A public seminar on lap belts in NSW in 1994 summarised the issues. Subsequent crash tests by authorities in the USA and Canada have confirmed long-standing concerns about inferior protection provided by lap-only seat belts and the extra potential for injury to passengers restrained by these belts, when used in large buses. Therefore lap-only seat belts are not acceptable under this Code for forward-facing seats.

1.1.7.3 Seat strength and padding

Where seats are replaced with high-back seats that are not fitted with seat belts the risk of injury to occupants can be reduced if the seats comply with the requirements of ADR66 ‘Seat Strength, Seat Anchorage Strength and Padding in Omnibuses’. ADR66 is intended to reduce the risk of injury when an unrestrained occupant is thrown forward into the seat in front. It is based on Economic Commission for Europe (ECE) Regulation 80 and was superseded by ADR68, which provides superior protection.

Where seats are not replaced the Code provides for padding hazardous components to reduce the risk of injury to passengers in a low-severity crash.

1.1.8 Other safety issues

Irrespective of the type of upgrading that is undertaken, all buses that are upgraded must meet these additional requirements:

- emergency exit signage must meet specifications
- push-out force of applicable emergency exists must be tested
- operation of door and hatch type emergency exits must be checked
- a thorough inspection should be undertaken to ensure that structural strength has not been reduced through corrosion, cracking or other deterioration (mandatory for seat and seat belt upgrades)
- driver's seat must have a seat belt in good working order and the seat must be securely anchored to the vehicle (mandatory for seat and seat belt upgrades)
- where passenger seat belts are fitted, a prominent sign about the wearing of seat belts must be fitted inside the bus
- where passenger seat belts are fitted, the laden mass of the bus may need to be reassessed.

1.2 Recognition of Safety Levels

Although severe bus crashes are very rare it is important that passengers understand that some buses offer better protection than others. This Code provides for an Australian Bus Safety Recognition system to identify these levels of protection.

This system only applies to buses that are fitted with lap/sash seat belts for all passenger seats. Buses without seat belts or fitted with lap belts are not included in the recognition system.

All rated buses must have seats and seat belts that meet Australia Design Rule 68. Differences in the rating level arise from:

a. Method of testing of the seat anchorages In the vehicle and

b. Compliance with Australian Design Rule 59 for rollover strength.

Full (GOLD) recognition applies where the seat anchorages have been shown to comply with ADR68 and the bus structure complies with ADR59. Many buses built since July 1994 meet this level.

To simplify anchorage testing for retro-fitting, the Code includes a Short Duration Static (SDS) test procedure, which provides a reduced, but acceptable level of confidence in the mounting structure by comparsion with full ADR68 certification (see Appendix A).

SILVER recognition applies to a vehicle which was manufactured to ADR59 and has been fitted with ADR68 seats, where the anchorages satisfy the SDS test.

BRONZE recognition applies to a vehicle which although not manufactured to ADR59/00, has been fitted with ADR68/00 seats, where the anchorages satisfy the SDS test.

[Note: Gold/Silver/Bronze might not be the final names for the proposed categories - the proposal is that there be three levels of recognition, as described]

2. PART B - TECHNICAL REQUIREMENTS

2.1 Introduction

This Part sets out technical requirements applying to buses that are upgraded in accordance with this Code. The sections in this part:

- provide background on the technical requirements and explains the certification process and the responsibilities of certifying engineers;
- sets out requirements for emergency exit signs and checks of the operation of emergency exits;
- describes how structural inspections are to be carried out;
- sets out requirements for padding existing seats;
- sets out requirements for upgrading or replacing existing seats without seat belts;
- sets out requirements for installing seat belts to passenger seats.

2.1.1 Seat anchorage strength

2.1.1.1 Large buses

Up until the late 1980s in Australia, and elsewhere in the world, there was considerable debate over several decades about the severity of crashes that bus passenger seats and seat belts should be able to withstand. In Australia the issue was dramatically resolved following two catastrophic coach crashes in 1989. Both crashes involved 100km/h (verified by tachograph records) head-on frontal collisions with heavy vehicles travelling at a similar high speed-an exposure situation not uncommon for long distance coach travel in Australia to this day.

Technical investigations of these two crashes revealed that nothing less than three point seat belts with a 20g crash pulse capability would offer adequate protection for the bus passengers. This led to the development of Australian Design Rule 68 which requires that the seat and restraint system must withstand the combined loads of the restrained occupant, the inertia of the seat and an unrestrained occupant striking the rear of the seat. This is usually demonstrated by dynamic test of a representative section of the bus floor/wall to which three (or two) rows of seats are mounted and subjected to a nominal 20g crash pulse. ADR68 has a static test alternative to the dynamic static test but there is considerable complexity in obtaining and maintaining representative loading to demonstrate compliance.

Recent crash tests of large school buses in the USA have demonstrated that a 50km/h full-frontal crash test into a solid barrier generates decelerations in excess of 12g in the bus body. This is equivalent to a head-on crash between two similar vehicles travelling at 60km/h. These results supports the conclusion that 20g restraint systems are needed for highway speeds.

Whilst ADR68 seats are now readily available for retrofitting to older buses the key issue is confirming that the anchorages will withstand a 20g crash pulse. It is highly undesirable to allow vehicles to be modified to physically resemble the latest ADR68/00 coaches, without offering the same level of protection. Allowing such an inferior package would be misleading to bus passengers (a possible consumer rights issue) and unfair to bus operators who acquire vehicles meeting the highest safety standards.

There is an expectation of high safety standards for buses and there would be a public outcry if such an inferior bus was involved in a severe crash where occupants were gravely injured due to failure of seat anchorages.

A fundamental requirement of this code is that any installations of lap/sash seat belts be capable of withstanding loads equivalent to those of the ADR68 dynamic test.

2.1.1.2 Small and mid-size buses

ADR68 applies to buses with a GVM more than 3.5 tonnes. During the 1990s Cranfield Impact Centre (CIC) in Britain conducted a comprehensive investigation into the deceleration pulses occurring in minibus crashes. They analysed 25 real world crashes and conducted eleven full scale crash tests. Computer simulations were also undertaken. From this work the CIC researchers recommended a dynamic test very similar to ADR68, with a nominal peak of 20g and combined loading from restrained occupants in the seat and unrestrained passengers to the rear. They note that:

"Provided a satisfactory restraint system is fitted to these [rear] seats, the passengers [in these seats] have the opportunity to survive exceedingly severe impacts...The primary requirement is that the restraint system does not fail, including no separation of the seat and belt anchorages from the floor pan...Seat belts and anchorages in minibuses [should] aim to provide protection similar to that of back seat passengers in cars."

CIC researchers proposed the use of injury criteria for the unrestrained rear seat occupants to ensure that the introduction of stronger seats would not unduly increase the injury risk to these occupants.

Like large coaches, many minibuses in Australia have an exposure to head-on crashes with heavier vehicles travelling at high speed. The resulting velocity change for the minibus can be expected to take it into the 20g deceleration region. There is therefore a strong case for requiring all bus seat belt retrofits in Australia to be capable of withstanding a 20g crash pulse.

2.1.2 Restrictions on lap belts for forward facing seats

The original 1994 Guidelines cautioned that lap-only seat belts might cause additional injuries in some cases and that the level of occupant protection provided by lap belts was far below that of lap/sash seat belts.

Since then Australian and international research has strengthened the concerns about lap belts. In particular Canadian studies and a late 1990s study of school bus occupant protection by the US National Highway Traffic Safety Administration (NHTSA) found a high risk of serious neck injury for lap-belted occupants.

In view of the widespread availability of buses with lap/sash seat belts there is no longer a case for permitting the retrofitting of lap-only seat belts in forward facing seats.

2.1.3 Engineering evidence of compliance

This Code requires certification of the modified vehicle by an engineer because the changes involve significant structural and occupant protection changes.

To reduce the time and cost of compliance, whilst maintaining technical standards and facilitating acceptance by registration authorities, the following points are noted:

Except for some specific requirements, evidence of compliance of an installation or aspects of an installation can be made by:

a) Specific modification of components as set out in Part C of the Code;
b) Written approval from the original vehicle manufacturer (eg vehicle may have same structure as an ADR59/00 complying vehicle from the same manufacturer);
c) Engineering comparison with a vehicle that has been certified to comply with the appropriate ADR. (Evidence must include at least photographs and statement of basis for equivalence);
d) Calculation in accordance with accepted engineering techniques;
e) Physical test (either static or dynamic) to relevant ADR specification using calibrated instrumentation;
f) Physical test of seat anchorages using Short Duration Static test described in Appendix A of this Code [Note: the details of the Appendix have not been finalised but the Appendix sets out some of the objectives of the proposed test].

It is noted that where a test specification forms part of an ADR, the test must be performed and it is not acceptable to perform calculations based on the test load. This is the same as normal certification practice and reflects the inherent difficulty of assessing strength/deformation and injury criteria during short duration impact loads.

2.1.4 Engineering Certificate

Appendix B has an Engineering Certification Form to be used for all vehicles covered by this Code. [Note the form is currently a separate document]

2.1.5 Responsibilities of certifying engineers

It is strongly recommended that the certifying engineer be involved in all stages of the upgrade process. In order to complete the Modification Certificate for acceptance by registering authorities the engineer must:

a) inspect the vehicle prior to any modifications being carried out to assess their likely feasibility, especially when structural changes will be required;
b) inspect and photograph the vehicle and components (typically) during construction to verify that the work conforms with the Code and with good engineering practice;

   With widespread availability of digital photographs, this forms the major recording element of the inspection process and all areas requiring inspection are to be recorded photographically (eg every seat anchorage).

c) complete a Engineering Certification for each vehicle that is modified;
d) arrange for a Modification Plate to be fitted to the vehicle after completion of the Engineering Certification (Client to retain the original);

e) retain, for no less than five years, a copy of the Engineering Certification, and supporting documentation. These are to be made available to authorised officers on request.

2.1.5.1 Identical modifications to multiple vehicles

Where more than one vehicle is modified in the same way then design test work, calculations, comparisons and analysis need only be conducted once. However, an Engineering Certification, physical inspections and photographic evidence of these inspections are needed for each vehicle that is evaluated.

2.1.5.2 Certification process

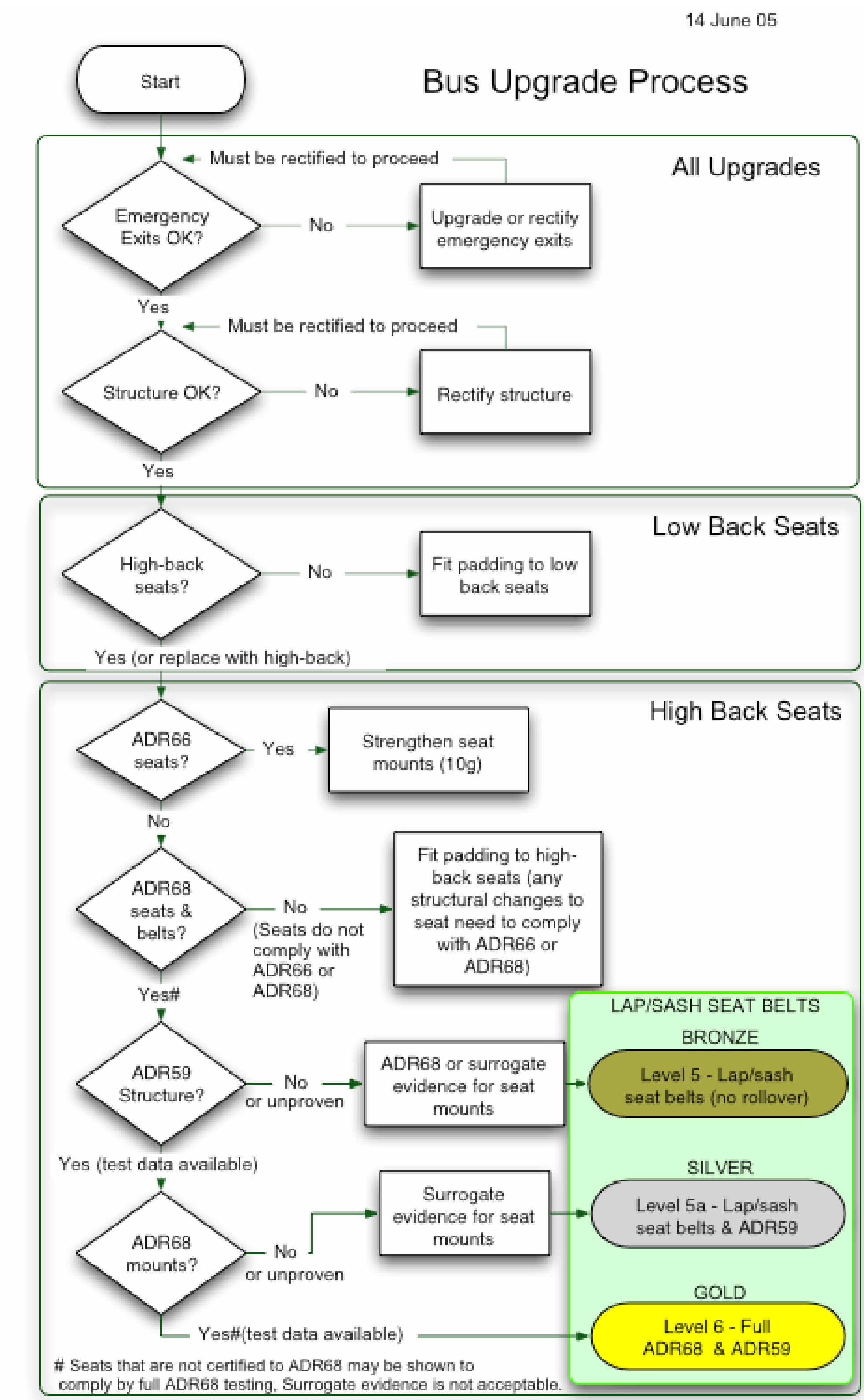


Figure 1. Certification Process

2.2 Emergency Exits

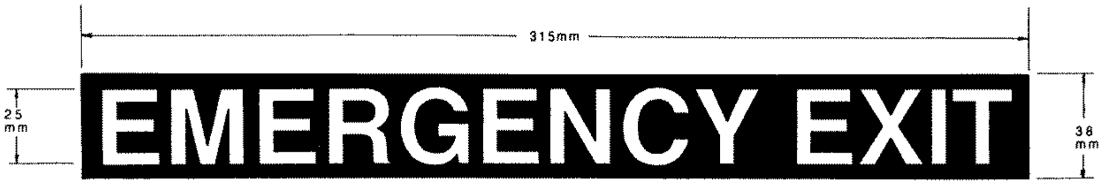
ADR 44/02, which applies to buses built from July 1993, sets out minimum requirements for emergency exits. These requirements were developed following criticism of the performance of emergency exits in several severe coach crashes. The signage requirements set out in ADR44/02 have been used as a guide for upgrading older buses.

ADR58/00 ‘Requirements for Omnibuses Designed for Hire and Reward’ requires that single-deck buses have at least one emergency exit in the rear half of the vehicle. There may be one exit on the rear face of the vehicle or a combination of a roof exit and an exit on the right side of the vehicle. Each exit must have a clear opening area of at least 0.7 square metres and no side less than 500mm. As a minimum, emergency exits meeting these requirements are required on all upgraded buses. However, exits that comply with ADR44/02 provide superior emergency egress and are recommended for any bus that undergoes a major refit. In brief ADR44/02 requires single deck buses to have emergency exits in at least three separate faces (e.g. roof, right and rear), exterior steps for exits that are more than 1m from the ground and the size of the exits is sufficient to allow an injured person to be extricated (see ADR44 for details).

2.2.1 Emergency exit signs

2.2.1.1 Interior signs

Self-illuminating interior exit signs must be located on each emergency exit (exit signs for breakable or push-out windows may be located on the window frame where they will not be covered by curtains). They should read "EMERGENCY EXIT" (see Figure 2) in red letters at least 25mm high on a white background (or white letters on red background). An additional self-illuminated "EXIT" sign may be required in the aisle, if the sign on the exit is not conspicuous to people in the aisle.



Primary "Emergency Exit" sign

Supplementary sign for "Push out" type window

Colour: White letters on red background or vice versa

Material: Self illuminating sheet with minimum 15 minutes illumination retention,

Figure 2. Interior exit sign and instruction

Self-illuminating interior exit instructions (e.g. "IN EMERGENCY BREAK GLASS" or "PUSH OUT") must be located on or adjacent to each emergency exit. The sign may be a diagram or lettering at least 10mm high in a colour that contrasts with the background - see Figure 3. Red and white colours are preferred.

External sign

Material: Retroreflective sheet to AS 1906-1976 Class 2

Colour: White letters on red background or vice versa

Internal sign

Material: Self illuminating sheet with minimum 15 minutes illumination retention

Colour: White letters on red background or vice versa

Figure 3. Example of "break glass" diagrams

2.2.1.2 Checks of interior sign function

The self illumination function must be checked for all mandatory internal signs. This can be done by observing the sign when the bus interior is darkened. The sign should remain illuminated and clearly legible when observed 15 minutes after the power supply to the device is switched off. Some signs require UV light to activate the self-illuminating properties. In these cases a suitable UV light source must be provided to ensure the substance remains active at night. This should be checked by darkening the interior of the bus for 30 minutes before power is disconnected then observing the sign 15 minutes after disconnection. A more convenient solution may be to use a chemical-based self-illuminating sign that needs no external power or light source. However, there may be concerns about radioactive materials used in some of these signs (e.g. tritium). A search of the internet for ‘exit sign tritium’ should provide more information on this subject.

2.2.1.3 Exterior signs

Exterior exit signs (e.g. ‘EMERGENCY EXIT’) must be located on each emergency exit. Red letters at least 50mm high on a *retro-reflective* white background (or white letters on red background) are required - see Figure 4.

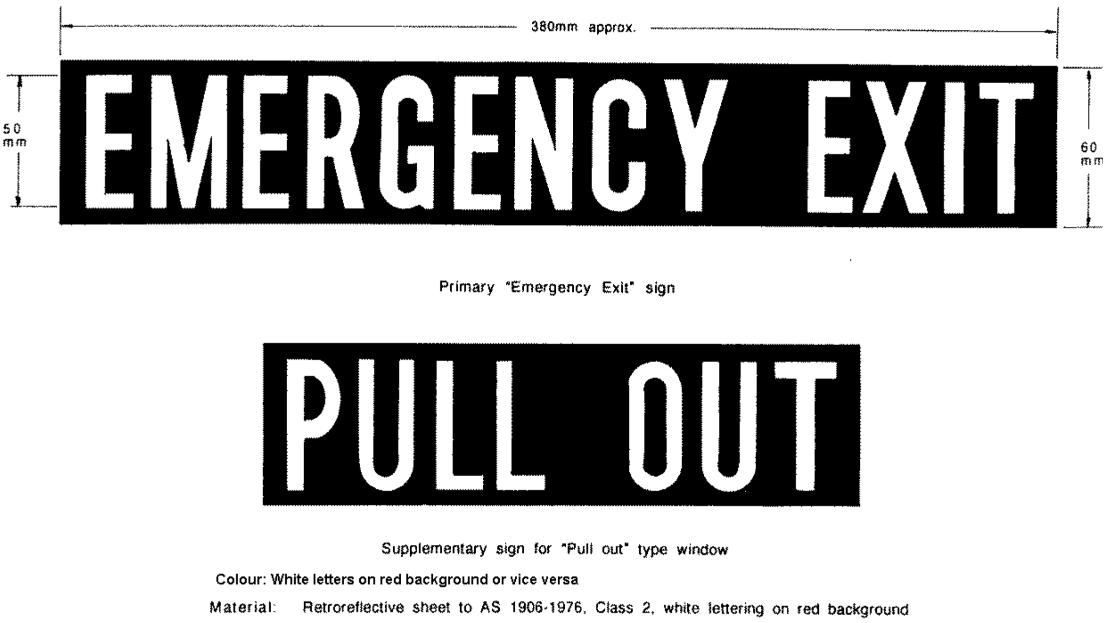


Figure 4. Exterior exit sign and instruction

Exterior exit instructions (e.g. "IN EMERGENCY BREAK GLASS" or "PULL OUT") must be located on or adjacent to each emergency exit. The sign may be a diagram or lettering at least 10mm high in a colour that contrasts with the *retro-reflective* background - see Figure 4.

2.2.1.4 Checks of exterior sign function

Exterior signs must be checked to ensure that the retro-reflective function has not degraded. This can be done by illuminating the sign with a torch in a darkened area.

2.2.2 Functional tests of doors and hatches

All doors and hatches that are designated as emergency exits must be tested for correct operation by:

a. fully opening the door or hatch and ensuring that this can be done with reasonable force (e.g. not more than 500N); and

b. closing the door or hatch and ensuring that it is securely closed (for example by pushing against it with a force of not less than 445N - except roof hatches).

These forces need only be checked with an instrument if a manual test suggests there is a problem.

2.2.3 Functional tests of push-out windows or panels

Many older buses have push-out style windows or panels for emergency exits. These may continue to be used provided they meet the push-out force requirements of ADR58/00. That ADR sets a minimum push-out force of 445N to prevent inadvertent opening of the window/panel and a maximum push-out force of 700N to ensure that occupants or rescuers are able to open the window/panel. In some cases it has been found that original window rubbers have hardened or perished and the windows not longer meet these limits.

A force measuring device that is accurate to within +/-10% over the range of interest should be used to carefully measure the force at which the window/panel releases, either by pushing from the inside or pulling on the handle on the outside of the bus. The instrument may be calibrated by use of a dead weight or by another method that is acceptable engineering practice.

It is not necessary to remove the window/panel totally from its surrounds if it is established that release is imminent. This would be the case where the force is comfortably within the acceptable range and the rubber seals are starting to deform noticeably. As with any force test, care should be taken to avoid injury or property damage, other than damage to deteriorated seals that are not performing their intended purpose.

Where a window/panel push-out force does not fall within the acceptable range and is unable to be rectified to do so then an alternative emergency exit must be provided. The simplest solution would be to provide an internal striking hammer for use with a tempered glass window, as described in the next clause. If, in this case, the original push-out window/panel is retained then it must no longer be marked as an emergency exit (unless it is the breakable window).

2.2.4 'Break glass' exits

Where a designated exit is of the 'break glass' type the following checks should be made:

a. the window is made from readily breakable safety glass bearing an approved mark such Australian Standard AS 2080 -1983 –'Safety Glass for Land Vehicles' (see ADR8/01 for approved standards);

b. a striking hammer is located on the inside of bus in a readily accessible location adjacent to the window. The hammer must be tethered so that it cannot be easily removed from the bus but can be used to break the window; and

c. the required instruction signs are fitted to the interior and exterior of the bus.

Figure 5. Example of 'break glass' installation

2.3 Structural Inspection

2.3.1 Aim of structural inspection

The body frame of any bus that is being upgraded to have seatbelts fitted must be thoroughly inspected to ensure that the structural strength provided at the time of original manufacture has not degraded due to corrosion, cracking or inappropriate repairs.

Particular attention should be paid to components that have to withstand loadings from the passenger seats in a frontal crash or external loads in the case of a rollover crash. Occasionally corrosion and cracking has been found in relatively new buses and so there are no age exemptions for these inspections.

The recommended inspection protocol is intended to identify significant structural deficiencies whilst minimising inspection costs where this can be justified.

2.3.1.1 Inspection Protocol

1. The vehicle must first be thoroughly cleaned and degreased, including underside and wheel box areas using a high pressure washer or similar.

2. Rust areas, rust stains and signs of water leakage or water retention should be photographed in detail and listed as they must first be inspected to assess the likely degree of corrosion.

3. All visible[1] structural members and connecting joints are to be inspected. This includes floor/wall and roof/wall joints as well as the supporting structure for all seat anchorages. Tubes should be carefully examined for signs of internal rusting or water retention. Where provided by the manufacturer, all fasteners should be present and secure.

[1] Visible joints are those which can be accessed without the removal of permanent panels or trim, visible joints may require the use of an inspection mirror.

4. Provided there is no evidence of corrosion[2], cracking[3] or separation of any of the visible joints (each joint to be identified and photographed[4]), then a further two roof/wall and two floor/wall joints should be chosen on each side of the bus, at locations judged to be most likely (either from experience, where there is evidence of a collision or because of design features, e.g. below a window or over a wheel arch) to have sustained corrosion or cracking.

These eight joints can be inspected by removal of panels and/or remote access using mirrors/endoscope or similar.

5. Provided there is no evidence of corrosion, cracking or separation of structural members and joints during inspections (b), (c) and (d) above, then the vehicle can be accepted as having substantially retained the structural integrity provided at time of manufacture.
6. Where evidence of corrosion, cracking or separation of structural members and joints is identified during inspections (b), (c) and (d) above, then panels/trim are to be removed to facilitate full inspection of all members and joints in the sub-floor area, roof/wall joints and floor/wall joints.

(A decision may need to be made at this stage regarding the economic viability of upgrading the vehicle as planned)

Two sets of detailed photographs are to be retained of each area of corrosion, cracking or separation in the (i) as inspected state and (ii) after rectification.

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[2] Evidence of corrosion is defined as oxidation which has extended beyond surface discolouration – ie grinding would be required to expose uniform base metal.

[3] Cracking is defined as separation at the surface along a linear extent which is at least ‘just visible’ with the naked eye under close inspection with bright light. Where close inspection is not practical, then use of a contrasting penetrant dye is recommended.

[4] Photographs should include a positive identification code for the vehicle and the location within the vehicle (eg index number printed on a card within the photograph) and be clear and sharp. Photographs may cover several members and joints and close up photographs are only required for a joint where corrosion, cracking or separation is visible.

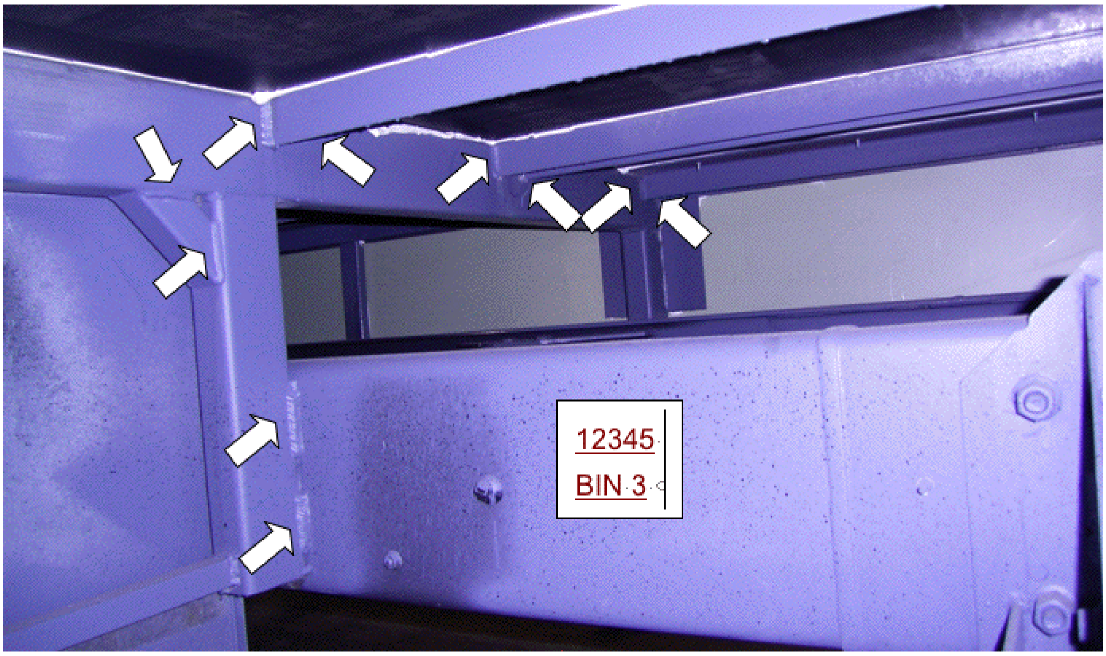

Figure 6. **Illustration of a suitable photograph recording the inspection of the arrowed joints/members comprising the structure supporting the seat anchorages. Placard provides an identification number for this vehicle and an indication of where the photograph was taken.**

Figure 7. **Seat anchorage structure in unitary construction vehicles will typically include both welded and bolted connections. Photograph shows unrepaired accident damage to primary connections which probably makes retrofitting uneconomic.**

2.3.2 Inspections where no seat belts are to be installed

Where seats without seat belts are being installed/replaced, then the structural inspection need only include those members and joints which provide structure to the seat anchorages.

For other upgrades, not involving seat anchorages or seat belts, a structural inspection might still be required by the registering authority.

2.3.3 Methods of reinforcement for retrofit

During the inspection the method of reinforcing the structure to cope with seat and seat belt loads should be determined. Particular attention should be given to difficult access areas such as above fuel tanks, engine and road wheels and across the rear row of seats. In some cases an upgrade with seat belts might not be viable.

2.3.4 Repairs to structural members and joints

Surface rust that has not reduced the strength of the component should be removed and the surface treated with appropriate coatings to prevent further corrosion.

Where rust has penetrated more than 20% of the material thickness the component must be replaced, repaired or reinforced in accordance with good body repair practice. Replacement of the entire component is preferred and insertion of short replacement sections of tube should be avoided because of the difficulty of assessing the strength of butt joints and the introduction of local stress concentrations.

Cracking of welds generally indicates overstressing of a joint. Unless the original weld was defective, re-welding the joint is unlikely to provide a long-term solution and reinforcement of the joint should be considered.

All repair work must be inspected and re-photographed prior to the replacement of body panels that might cover up the components.

2.3.5 Recording structural inspection outcome

Section D of the Engineering Certification has provision for recording the outcome of the structural inspection, including a check that problems have been satisfactorily rectified.

The table in that form must be completed for each bay (or space between pillars) on each side of the bus and for the front and rear faces.

2.4 Padding existing seats

In low-speed accidents, or during severe braking actions, bus occupants might be thrown forward and contact the seat, handrail or partition ahead of them. Padding these components can reduce the risk of minor injuries, particularly facial injuries.

The padding described in this section is low speed comfort padding and is unlikely to significantly reduce the risk of life-threatening injuries in a severe crash.

2.4.1 Location of padding

Padding should be fitted to those hard surfaces in a bus that are likely to be struck by the head of an unrestrained seated passenger if the bus is involved in a frontal collision. 'Hard surfaces' are generally metal components, metal covered by a thin or very soft layer of upholstery or hard plastic fittings that would not meet the load/deflection characteristics described under Padding Materials (Clause B.4.1.5).

Typically, high back coach style seats or new style metro seats will already have padding in the relevant areas or have components that yield sufficiently under impact.

2.4.1.1 Handrails

Exposed handrails are to be padded at least on the top, rear and front faces to within 80mm of the outside (side wall) edge of the seat and to within 80mm of the aisle side of the seat. This allows for the handrail at the aisle to be retained as a handgrip. Refer to figure 8.

Note: Some handrails have large diameter bends at each side making it difficult to pad to within 80mm of the sides. It is permissible to pad up to the start of the bend in these cases, provided the padding is not be more than 120mm from the sides.

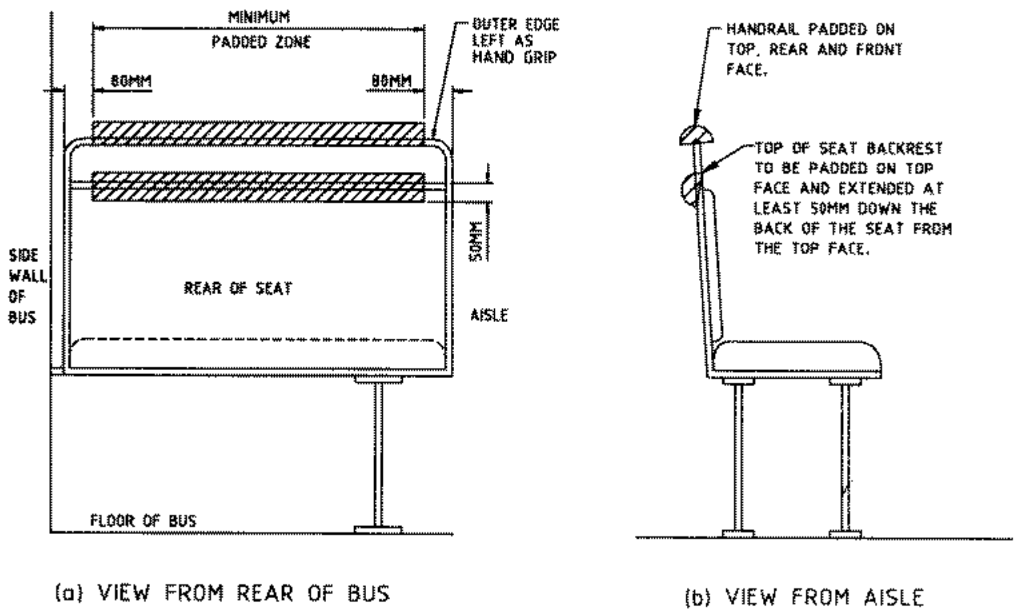

Figure 8. Padding of seat handrails and tops

2.4.1.2 Tops of seats

If the top face and the rear face of the seat is not already padded, additional padding is to be fitted to these surfaces. The padding of the rear face of the seat is to extend at least 50mm down the back of the seat from the top face. The padding across the seat is to be as wide as that required for the handrails. Refer to figure 8. All fittings on the back of the seat outside the padded area must not be likely to cause injury to a passenger during impact. This may require removal/relocation of some hard plastic/metal fittings and replacement with more rounded and yielding alternatives.

2.4.1.3 Partitions

Partitions directly in front of a seat are to be padded along their top edge in a similar manner to seats. That is, the top face and the upper 50mm of the rear face of a partition are to be padded to at least cover a zone between two longitudinal, vertical planes 80mm from either side of the seat behind. Refer to figure 9. Should the aisle side of the partition have a large diameter bend (in a similar manner to the seat handrails) the bend does not need padding. All fittings on the back of the partition outside the padded area must not be likely to cause injury to a passenger during impact.

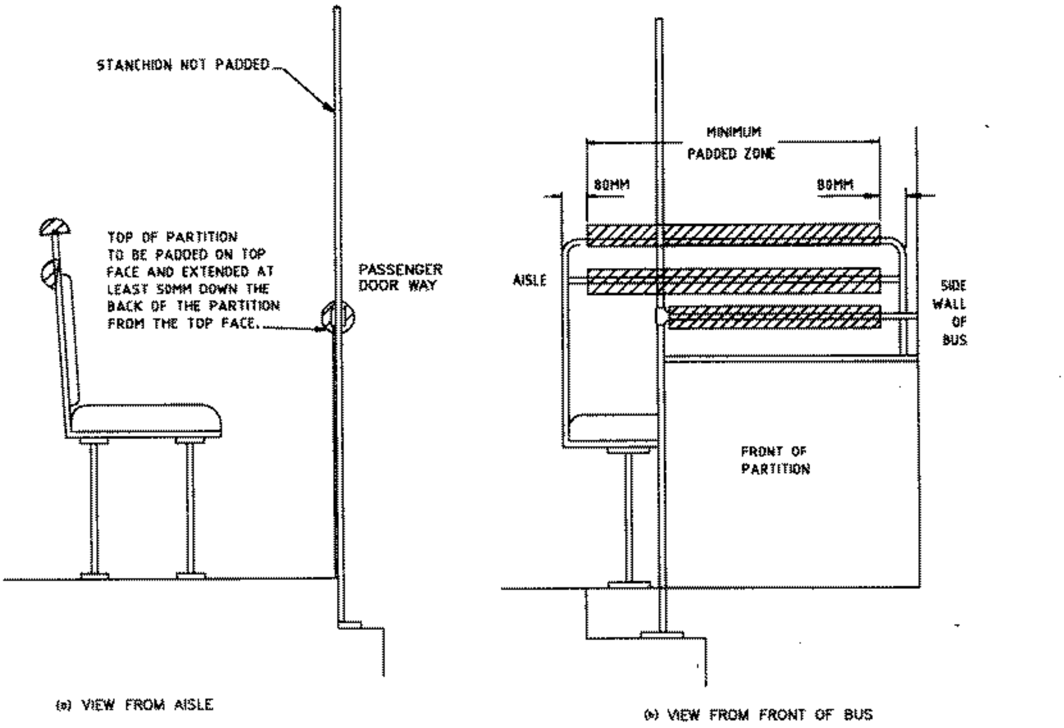

Figure 9. Padding of partitions

2.4.1.4 Stanchions

Padding of stanchions is not recommended since the padding could impair the grip of standing passengers, thus increasing the risk of injury to these passengers.

2.4.1.5 Padding materials

There are some kits available that meet the following recommendations, but they only suit certain types of seat. It is recognised that it is difficult to fit kits to some buses and a different approach may be needed.

Some recommended padding materials are:

- semi-rigid moulded polyurethane (approximate density 300 kg/m^3), 25mm thick;
- self-skinning rigid moulded polyurethane (approximate density 300kg/m^3), 25mm thick;
- closed-cell polyethylene foam (approximate density 300 kg/m^3), 25mm thick; and
- closed-cell EVA foam (approximate density 300 kg/m^3), 25mm thick

Alternative materials that offer similar levels of protection may be used. As a guide, flexible cellular materials are frequently specified to ASTM Standard 3575. Suffix D of this standard defines a compression deflection test which reports the pressure in kilopascals to compress by 25% a 25 mm thick circular specimen of 2500mm^2 area. Materials suitable for padding would generally have ASTM D3575 compression deflection specifications within the range 250 to 500 kPa.

[In effect this is the same as saying a 60mm diameter disk of the material will deflect by at least 6.5mm under a load of 200N]

The padding should be securely fastened to the structure with fastenings designed to ensure that they do not present a source of injury.

2.5 Replacement high-back seats

Where lap-sash seat belts are not intended to be fitted, it is recommended that the requirements of ADR66 (or ECE Regulation 80) be followed.

The aim of ADR66 is to minimise the risk of serious injury to occupants in a moderate severity crash by using the seat in front as a restraint (i.e. compartmentalisation) and by avoiding seats and anchorages that are likely to break and expose hazardous projections and sharp edges.

These seating systems have much lower ability to reduce the risk of serious injury in a severe crash than seats with lap/sash seat belts designed according to ADR68.

Although ADR68 seats (with seatbelts removed) may not have been tested to ADR66, they will usually provide a suitable seat for retrofitting, alternatively seats may be available which meet the ECE R80 requirement.

Structural modifications to existing seats should be avoided unless testing of the modified installation is planned to ADR66 because investigations have identified that inappropriate reinforcements could cause seat failure and significantly increased risk of serious injuries to occupants.

An exception is the replacement, or reinforcement, of certain *Denning* cast aluminium seat legs and armrests, as described in Clause 2.5.1.

Assessment of seat anchorage strength is covered in section 2.5.3.

2.5.1 Cast aluminium legs and armrests

Cast aluminium seat legs can fracture in a crash resulting in portions of broken casting projecting from the vehicle floor and these have caused severe lacerations and limb amputations to occupants in some crashes. In particular, it is recommended that the *Denning Easy Ride* cast aluminium seat legs be replaced.

In addition, the cast aluminium armrest of the *Denning Easy Ride Single Action* seat has sometimes been found to fail when the seat is struck by a rearward occupant in a crash. This can leave broken cast aluminium components projecting where they can injure occupants. It is recommended that these seats be reinforced or replaced.

Part C of this Code includes details of replacement legs and armrest reinforcement for these Denning components. When modified correctly, these seats have been found to provide acceptable performance.

There is no record of hazardous failures of other brands of seat with cast aluminium components but they should be considered for replacement rather than restoration.

2.5.2 Seat belts

Seat belts and anchorages provided by the original manufacturer or replacement seat belts to the same specifications (i.e. lengths, components, anchorages and AS compliance) as original equipment are also acceptable.

This may result in some vehicles continuing to have lap only seatbelts fitted whereas other retro-fitted vehicles of the same age would need to have lap-sash seatbelts. Continued acceptance of a manufacturer provided lap-only seatbelt is a reflection of the manufacturer's responsibility for compliance of the whole occupant protection system.

Some large buses certified to ADR66 have seat belts fitted to 'unprotected' seats (that is, seats with no seat ahead of them and no energy absorbing screen or partition to provide similar protection).

Some small buses were provided with seat belts as standard or optional equipment. ADRs 4 and 5 apply where seat belts are fitted to these lighter buses.

Some vehicles have already been retrofitted with lap only seatbelts prior to the publication of this Code.

In all these situations, the lap only seatbelts provide inferior protection for bus occupants, compared with ADR68 because:

- Recent research confirms ongoing concerns that lap-only seatbelts are associated with substantially increased risk of serious neck injury in forward collisions;
- Lap anchorage locations can vary widely (eg there is no requirement for seat belt to be attached to seat) and the risk of severe abdominal injuries from an incorrectly fitted lap belt is much greater than for ADR 68 style seatbelts;
- ADRs 4 and 5 make no assessment for the additional loads caused by the impact of an unrestrained occupant(s) located behind the seat belt wearer in buses and coaches;
- Original seat belts fitted to MD3, MD4 & ME buses built before ADR68 need only meet the equivalent of 10g dynamic test loads. These restraint systems may not withstand the forces generated during a head-on crash between heavy vehicles at highway speeds.

It is therefore strongly recommended that any lap-only seat belts in forward facing seats of buses be replaced with ADR68 systems, in accordance with this Code.

Upgrading of original equipment lap-only seatbelts to lap-sash seatbelts in accordance with this Code will significantly increase occupant protection in a severe frontal crash.

2.5.3 Seat anchorage strength

Where seats complying with ADR66 (without seat belts) are installed it is important that the anchorages are able to withstand the crash forces at least equivalent to the ADR66 dynamic test (nominally 10g pulse and seat struck by unrestrained occupant to the rear).

As a first step, the bus or seat manufacturer should be contacted to determine whether advice is available for anchoring ADR66 seats to the bus in question. Seat mounts which meet ADR 68/00 requirements will be suitable for mounting of ADR66 seats of similar mass.

Alternatively, the adequacy of the anchorages for ADR66 seat installations can be assessed by:

a. Dynamic or static test of a representative section of the vehicle in accordance with ADR66;

b. Static test of the anchorages using the Short Duration Static test procedure with the peak load reduced by 50% (ie 10g vs 20g comparison);

c. Engineering comparison with a bus that is certified to comply with ADR66 showing that all relevant structure is no weaker than the certified bus; and

d. Conformance with design recommendations for specific bus types provided in Part C of this Code.

Due to the nature of bus construction it is frequently necessary to tailor the design to available underfloor and wall structure. The modifications for each section should be described on the Certification Form and the assessment method recorded.

2.5.4 Flowchart for replacement seats (other than ADR68 seats)

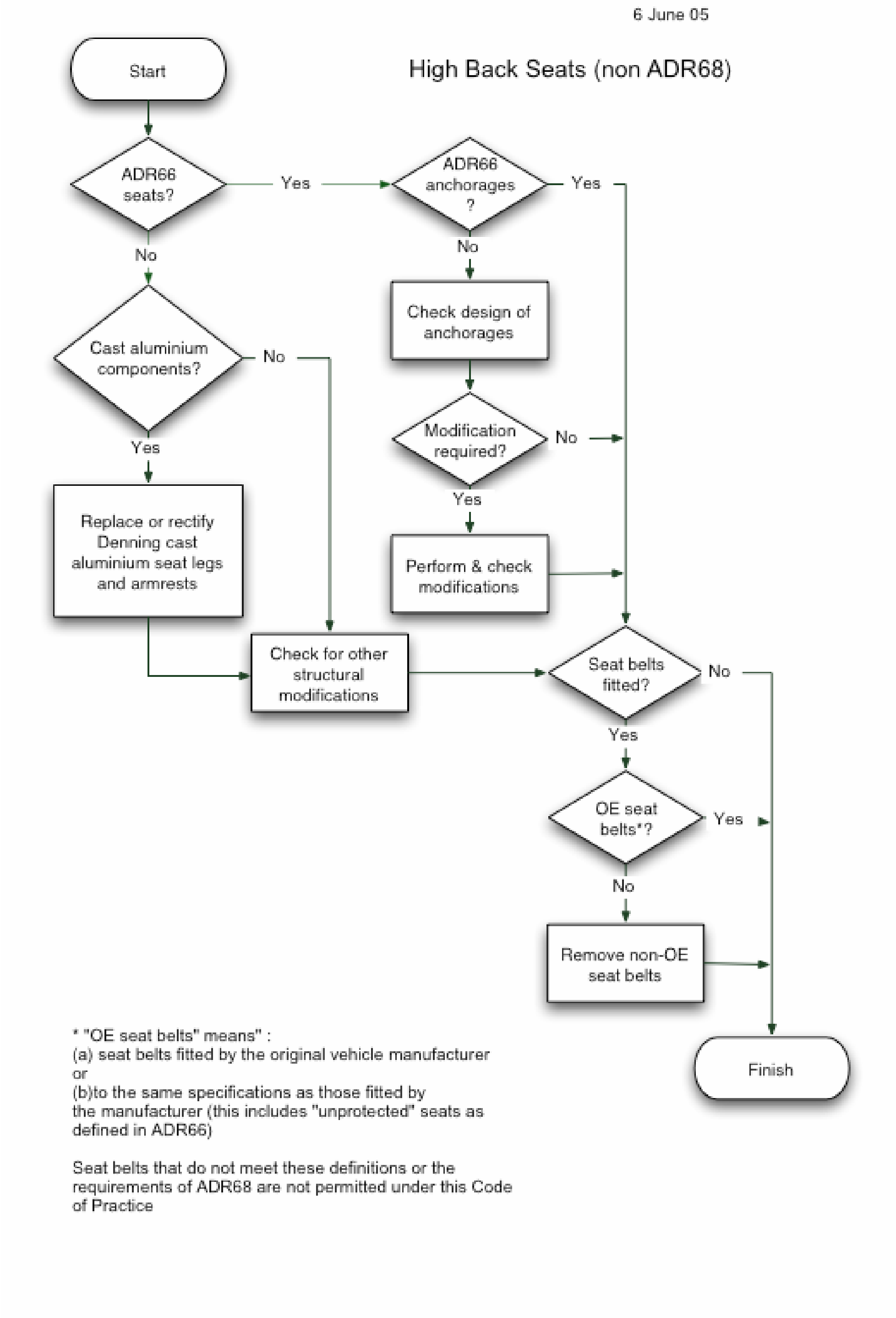

Figure 10. Flowchart for replacing seats(other than ADR68 seats)

2.6 Retrofitting seat belts

Only seats that have been shown to comply with the requirements of ADR68 should be used for retrofitting seat belts to buses.

Anchorages for these seats should provide protection that, to an adequate degree of confidence, is equivalent to ADR68 requirements.

Anchorage strength can be assessed using either:

- 20g dynamic test per ADR 68 on a representative section of the bus structure, using the seat type to be installed;
- static test per ADR 68 Appendix A, using a representative section of the bus structure, using the seat type to be installed; or
- short duration static test as per Appendix A of this Code [pending], using representative seat locations within the bus being evaluated or a representative section of the bus structure.[5]

2.6.1 Seat design

ADR68 seats have retractable lap/sash seat belts built into seat structure and they have been proven to withstand the combined loads from the restrained occupant, an unrestrained occupant to the rear and the seat mass in a severe crash, while keeping dummy injury parameters to acceptable levels.

Evidence of compliance with ADR68 may be in the form of:

- Advice from the seat or vehicle manufacturer that the seat is certified to ADR68; or
- Testing in accordance with ADR68 (full dynamic test or static test plus energy dissipation test) by a competent authority. (Typically an independent laboratory or supervised testing by the Certifying Engineer).

Note that the Short Duration static test described in Appendix A is for testing the anchorages only and is not an alternative for testing seat performance.

Geometrical limits for seat pitch, vertical and transverse offsets from the seat manufacturer must be followed.

2.6.2 Seat anchorage strength

Where seats complying with ADR68 are installed it is important that the anchorages are able to withstand the crash forces at least equivalent to the ADR68 dynamic test (nominally 20g pulse and seat struck by unrestrained occupant to the rear).

The bus or seat manufacturer should be contacted to determine whether advice is available for anchoring ADR68 seats to the bus in question.

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[5] The SDS test is intended to be applied *in-situ* although it may be preferred to either construct a representative test module (eg for an ME vehicle) or test a section from an undamaged portion of a wrecked vehicle for smaller vehicles.

Adequacy of the anchorages for ADR68 seat installations can be established by:

a. dynamic or static test of a representative section of the vehicle in accordance with ADR68;
b. engineering comparison with a bus that is certified to comply with ADR68 showing that all relevant structure is no weaker than the certified bus; and
c. static test using the SDS test in accordance with Appendix A of this Code.

Because ADR68 requires outcomes in terms of injury criteria, there is no provision for compliance using analysis.

The SDS test has been developed to provide assurance of seat anchorage performance when coupled with an ADR68 seat. This provides a reduced level of confidence compared with dynamic testing, but is regarded as acceptable for retrofitting.

Additional reduction in confidence would occur using an analytical approach (eg assumed failure mode) and is thus not acceptable for retrofitting. In particular, *the SDS test load is not to be used as the assumed load for an analysis to support compliance*.

Where an SDS test is performed it should cover the seat/pair with the weakest anchorage, based on engineering evaluation of each seating position. The SDS test should also be performed where there is any doubt about other anchorages.

Due to the nature of bus construction it is frequently necessary to tailor the design to the available underfloor and wall structure. The modifications for each section should be described on the Certification Form.

2.6.2.1 Fasteners for Seat Anchorage

1. Installation of fasteners can be within plain or tapped holes but in both cases will require suitable self-locking nuts/washers[6] to be fitted wherever possible.

   Use of back nuts to tapped installations is to firstly ensure that structural integrity is maintained, even if the tapped thread is damaged during installation, and secondly to facilitate direct inspection by the certifying engineer and other authorities.
2. Where back nuts cannot be installed (e.g. a tapped hole without a back nut) or inspected then fasteners must be installed using a torque wrench for final tightening to an appropriate minimum torque to induce 65% proof load (eg 22Nm for an M10 x 1.50 (8.8) bolt/screw, ref AS2465)
3. Fasteners (bolts/screws/nuts) should be minimum grade 8.8.
4. Self drilling/self threading fasteners are not to be used because of inherent uncertainties regarding thread condition after fixing.

[6] either self locking nuts with a plain washer or plain nuts with a locking washer

2.6.3 Driver's seat belt

The driver’s seat belt must be certified as being in good working order. Whilst a retractable lap-only seat belt attached to the driver’s seat is acceptable when supplied as original equipment, it is strongly recommended that a lap/sash seatbelt be fitted where possible.

Where the driver's seat belt was not provided as original equipment then a check should be made that the seat anchorages are able to withstand the loads specified in ADR5. This can be shown by a static test according to ADR5 or by engineering analysis using the loads specified in ADR5 (for the relevant category of bus).

2.6.4 ‘Fasten seat belt’ sign

A bus with retrofitted seat belts must have an interior sign fitted so that it is visible to all passengers. The sign should have the following, or similar, words in letters at least 50mm high:

"FASTEN SEAT BELTS WHILST SEATED"

It is preferred that the sign is illuminated. For buses with passenger video systems a useful supplement to a permanent sign is a video presentation about the wearing of seat belts that is always played at the start of each journey.

Multi-lingual signs (e.g. English and Japanese) or pictorial signs are preferred where the bus is frequently used for foreign tourists.

2.6.5 Rollover protection

As indicated in Part A, ‘GOLD’ and ‘SILVER’ recognition are only available where it can be shown that the bus structure can withstand the loads occurring in a rollover crash, as set out in ADR59.

In some cases the bus will already be certified to ADR59. In other cases the vehicle manufacturer might be able to provide advice which shows that a bus is identical in construction to one that is certified to ADR59. Some manufacturers might be able to provide advice about structural reinforcement that is needed to enable the bus to comply with ADR59.

The following methods may be used to establish the adequacy of the bus structure during rollover:

- a pendulum test of a representative body section in accordance with ADR 59/00; and
- engineering analysis in accordance with ADR 59/00.

Alternative means of demonstrating compliance may be used, provided the methods are thoroughly described.

Compliance with ADR59 will enable a retrofitted bus to reach SILVER recognition level after correct installation of ADR 68/00 seats.

The Certification Form has provision for describing any modifications necessary to comply with ADR59. These modifications should be personally checked at an appropriate stage of the retrofit and photographed, before crucial components are covered by permanent panels/trim.

2.6.6 Laden mass

Where tare mass is increased by more than 200kg, or the number of passenger seats is increased by more than two positions then Section I of the Certification Form must be completed. That section sets out a method for estimating laden mass of the bus and checking the allowable axle loads (see vehicle tyre placard) and gross mass. Alternative methods of estimating laden mass are acceptable, if the working is described.

In some cases the extra mass associated with replacement seats may result in the allowable axle loads or manufacturer's gross vehicle mass (GVM) being exceeded when the vehicle is fully laden. In such cases the seating capacity may need to be reduced. It is therefore recommended that an estimate of laden mass be undertaken early in the upgrade process.

2.6.7 Flowchart for retrofitting seat belts

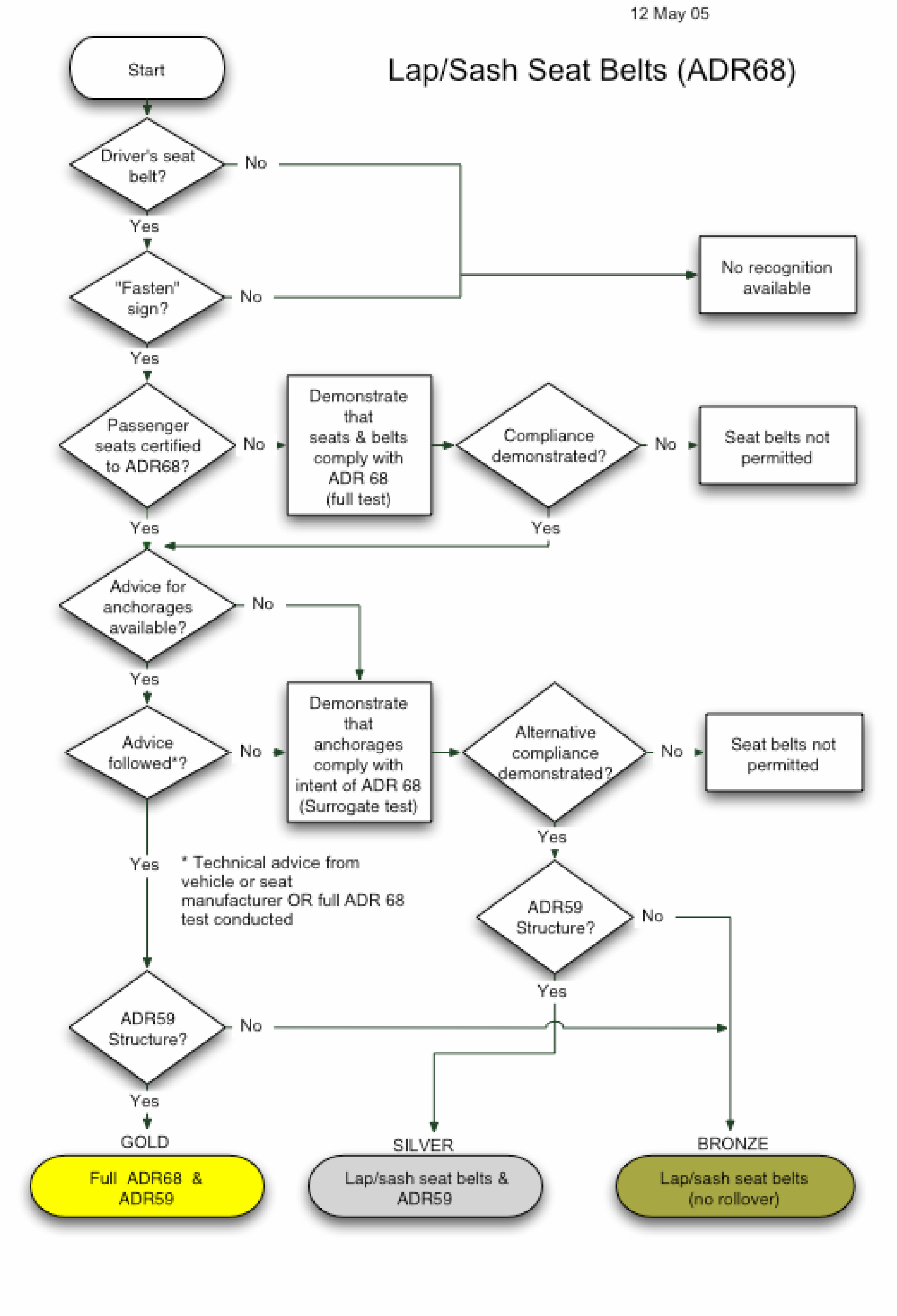

Figure 11. Flowchart for retrofitting seat belts

3. PART C - EXAMPLES OF MODIFICATIONS

3.1 Padding of metro seats

The following photographs show some examples of padded handrails, seat tops and partitions.

F

Figure 13. Example of partition padding

(Note the stanchion is padded with a graspable product but this is not mandatory)

3.2 Buses Certified to ADR68

The following table shows most makes and models of buses holding certification to ADR68 in May 2005. The list includes some specialised vehicles such as off-road tour vehicles.

The list is provided as guidance for people seeking advice about ADR68 compliance for these buses. However, some manufacturers may no longer be in business or may not be in a position to provide advice. The information is derived from online data maintained by the Road Vehicle Certification Unit of the Australian Department of Transport and Regional Services [http://rvcs-prodweb.dot.gov.au/]. Some models certified to ADR68 might be missing from this list. Also some pre-ADR68 models might have the same model name but are not suitable for upgrade without substantial modification.

Table 2. ADR68 Certified Buses (May 2005)

Bus Manufacturer	Models Certified To Adr68	Location
Able Tours Pty Ltd	NPS300-16, FTS750-22, FRR500-30	BAYSWATER WA
Amesz Design & Development Pty Ltd	Canter FG637 Bus15	MIDVALE WA
Caboolture Commercial Motor Bodies P/L	Mitsubishi F-Series	CABOOLTURE QLD
Ciropaul Pty Ltd	6000, 3300	YANDINA QLD
Coach Concepts Pty Ltd	3ax Explorer, 2ax Explorer	FOREST LAKE QLD
Custom Coaches Sales P/L	Road Cruiser NS, Road Cruiser	SMITHFIELD NSW
Denning Manufacturing Pty Ltd	Mini Bus, Midi Bus, Integral 2ax	ARCHERFIELD QLD
Express Coach Builders Pty Ltd	ECB	MACKSVILLE NSW
Geelong Coachworks Pty Ltd	Torquay 12,	GEELONG NORTH VIC
Mitsubishi Fuso Truck & Bus Australia Pty Ltd	Rosa (BE600)	BAULKHAM HILLS NSW
Mixford Pty Ltd	Colt 3ax, Colt OD, Colt	ARCHERFIELD QLD
Motorcoach Pty Ltd	D/Deck, 3ax OD, 3ax	ACACIA RIDGE QLD
Motorcoach Australia Pty Ltd	3310, 3000, 3310 OD	WEST END QLD
North Coast Bus & Coach Pty Ltd	Coach OD, Coach	CALOUNDRA QLD
P&D Coachworks Pty Ltd	Coach, Coach 2ax OD, FRR	MURWILLUMBAH NSW
Queensland Coach Company Pty Ltd	Majestic, Majestic OD, LRP, Austral Denning Coach	EAGLE FARM QLD
RV Fabrications Cairns Pty Ltd	4x4 Bus	MNAUNDA QLD
Specialised Vehicle Manufacture Qld Pty Ltd	F-series Safari	NARANGBA QLD

Bus Manufacturer	Models Certified To Adr68	Location
The Australian Bus Manufacturing Company Pty Ltd	PMC 160	PORT ADELAIDE SA
Volgren Australia Pty Ltd	2ax, 3ax, 3ax OD, Artic	DANDENONG VIC
Wenmay Pty Ltd	3300, 4000, 3300 F-series	YANDINA QLD
Willowstar Pty Ltd	Coach	UNDERWOOD QLD

Key: OD = "over dimension"

3.2.1 Route service buses certified to ADR68

Route service buses are not required to comply with ADR68 but recent discussions indicate several models have ADR68 certification to provide flexibility in the market. It is strongly recommended that technical advice be sought from the manufacturers of these buses as there may be considerable variation in specifications of individual vehicles.

3.2.2 Information provided by bus manufacturers:

3.2.2.1 Custom Coaches

Custom Coaches models built since July 1994 can generally be retrofitted with ADR 68 seats from Styleride and McConnell. Precautions necessary are:

a) The wall mount must not be less than 330mm in height from the floor structure (the standard wall mount is suitable).

b) Floor bolts must pass through a longitudinal steel angle 65x65x6 under the floor. If the angle is smaller than this then it must be reinforced to Custom Coaches specifications.

c) Bolts with self-locking nuts must be used for all seat anchorages.

Some buses built before ADR68 came into force might also be suitable for retrofit with minimal structural changes.

Custom Coaches offers a retrofit service.

3.2.2.2 Volgren

Volgren use a modular aluminium structure in their buses. Buses built since July 1994 can generally be fitted with ADR68 seats from Styleride and McConnell but the seat anchorages need to be checked for appropriate structural components. Replacement components should only be obtained from Volgren - existing components must not be modified.

Some buses built before ADR 68 came into force might also be suitable for retrofit with minimal structural changes.

Volgren offer a retrofit service.

3.2.2.3 Other vehicle and seat manufacturers

Details were not available from other manufacturers at the time of publication however contact with seat or vehicle manufacturers is recommended to help identify combinations of seat/vehicle which have already been certified as this will generally result in considerable reduction in effort and cost when upgrading a vehicle.

3.3 Retrofitting ADR66 seats (without seat belts)

This appendix is mostly based on the Guidelines that were issued in 1994. Only "Level 3" upgrades are covered-that is, the installation of seats that comply with ADR66 and *do not have seat belts*. Some examples from the 1994 Guidelines have been omitted from this Code based on advice received or the extreme age of the buses covered by the examples.

ADR66 requires the seats to withstand crash forces at the 10g level, without (i) breakage that exposes hazardous projections or edges or (ii) exceeding injury criteria for test dummies.

It is inadvisable to strengthen the anchorages of seats that were not built to ADR66 (or ADR68) without conducting the performance tests of ADR66 because there might be less of a hazard if the anchorages fail rather than the seat structure.

ADR 66/00 is based on ECE R80 and includes references to seats including seat belts because this is allowed under ECE rules, however the introduction of ADR 68/00 in Australia effectively superseded the technical requirements of ADR 66/00 and as discussed elsewhere, research in both the US and Europe since the introduction of ECE R80 has confirmed the undesirability of lap-only seatbelts. Provision of a lap-sash seatbelt on a bus which does not meet ADR68/00 requirements produces a conflicting situation for consumers and cannot be endorsed. Therefore seats which have been tested and shown to comply with ECE R80 with seat belts would need to be retested to ECE R80 or ADR 66/00 *without seat belts* before retro-fitting to ensure they were capable of retaining unrestrained occupants.

In many cases, bus owners might find that the overall economics of retrofitting ADR66 seats and upgrading structure is similar to that of installing ADR68 seats with lap/sash seat belts. The latter provides superior occupant protection and is strongly recommended.

3/8" grade 5 bolts are an acceptable alternative to M10 Grade 8.8 bolts. As described in Clasue B6.2.1, a ‘self-locking nut’ is either a self-locking nut (e.g. ‘Nyloc’) with a plain washer or a plain nut with a locking washer (e.g. spring washer).

3.3.1 Wall Mounts

3.3.1.1 Wall Mount Type 1 (not for seats with seat belts)

Description: Steel flat, welded between posts and to steel wall panelling. Drilled and tapped to take seat mounting bolts.

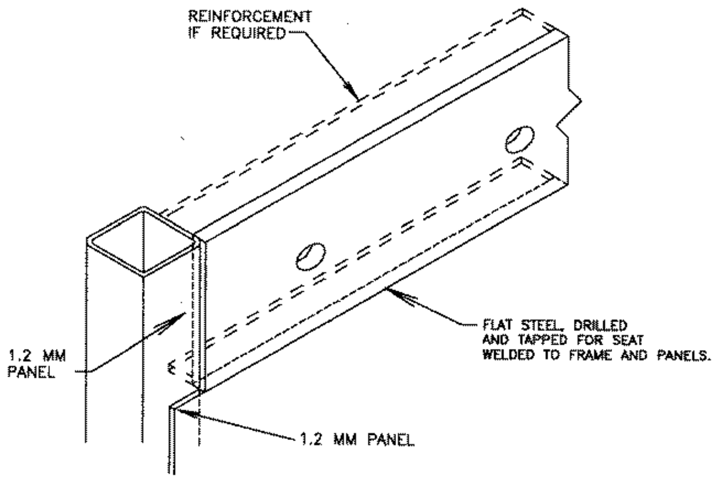

Figure 14. Wall Mount Type 1

Possible bus models: Austral Tourmaster, Austral Metro, Austral Starliner, North Coast Bus & Coach (early models), PMC (early models).

Requirements:

- minimum flat width 50mm. Minimum flat thickness 5mm. 3mm flats require reinforcing webs (30x4) welded along the top and bottom of the flat;
- welded to frame. Welded to lower panel with a minimum of 50mm of weld for each 150mm of mounting bar length. Additional welding to top panel preferred;
- minimum bolt size M10 grade 8.8 with hardened washers. Holes to be drilled and tapped (self-tappers not acceptable). Where flat is less than 5mm thick self-locking nuts are required (and flats must be reinforced as indicated); and
- unless the seat manufacturer specifies otherwise, the minimum seat bracket thickness is 4mm and the minimum bolt pitch is 300mm.

Wall Mount Type 2 (not for seats with seat belts)

Description: Roller steel angle, welded between posts and to steel wall panelling. Drilled and tapped to take seat mounting bolts.

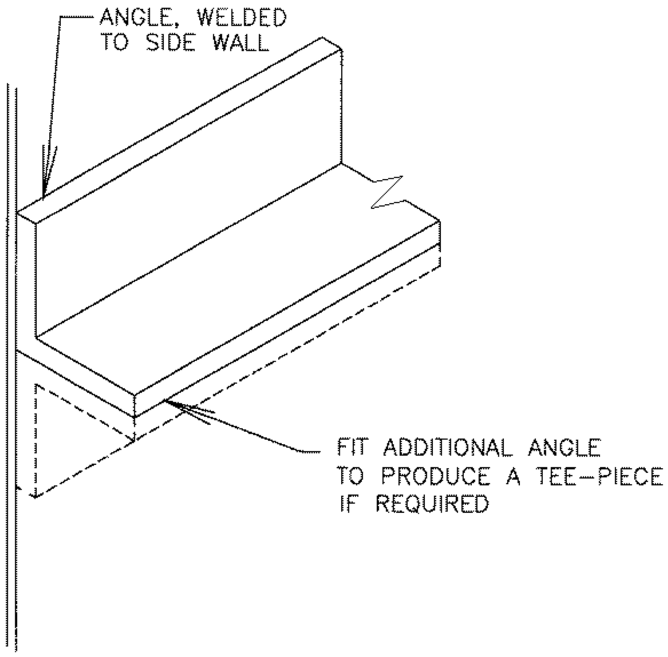

Figure 15. Wall Mount Type 2

Possible bus models: Austral Tourmaster, PMC, North Coast Bus & Coach, Superior Industries.

Requirements:

- Minimum 40x40x3 angle (50x50x3 preferred). Smaller angles require a second angle, forming a T as indicated;
- Welded to frame. Welded top and bottom to lower panel with a minimum of 50mm of weld for each 150mm of mounting bar length;
- Minimum bolt size M10 grade 8.8 with hardened washers. Holes to be drilled and tapped (self-tappers not acceptable). Where angle is less than 5mm thick self-locking nuts are required; and
- Unless the seat manufacturer specifies otherwise, the minimum seat bracket thickness is 4mm and the minimum bolt pitch is 300mm.

3.3.1.2 ´Wall Mount Type 3 (not for seats with seat belts)

Description: Pressed steel body panel with flange and pressed steel support angle.

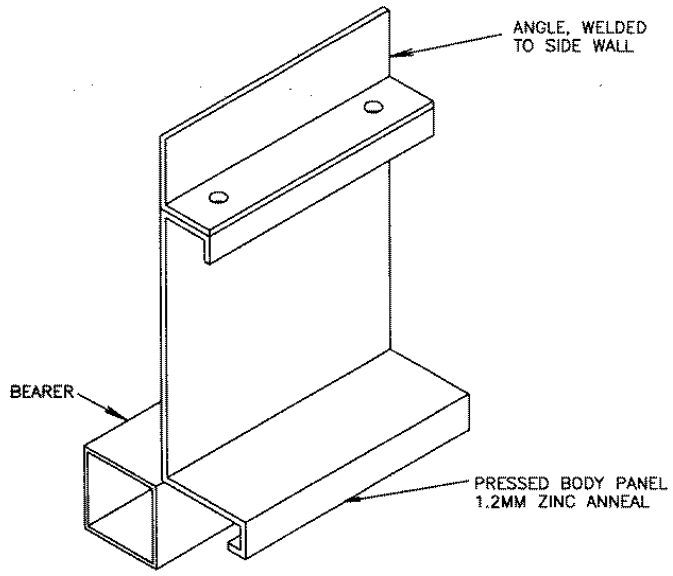

Figure 16. Wall Mount Type 3

Possible bus models: Motor Coach Australia Marathon.

Requirements:

- minimum angle 40x40x4;
- welded to frame at each end. Angle welded to side panel with a minimum of 50mm of weld for each 150mm of mounting bar length. Pressed steel body panel welded to floor bearer;
- minimum bolt size M10 grade 8.8 with hardened washers. Holes to be drilled and tapped (self-tappers not acceptable). Where angle is less than 5mm thick self-locking nuts are required; and
- unless the seat manufacturer specifies otherwise, the minimum seat bracket thickness is 4mm and the minimum bolt pitch is 300mm.

3.3.1.3 Wall Mount Type 4 (not for seats with seat belts)

Description: 45° pressed steel angle bolted to matching body panel flanges. Drilled and tapped to take seat mounting bolts.

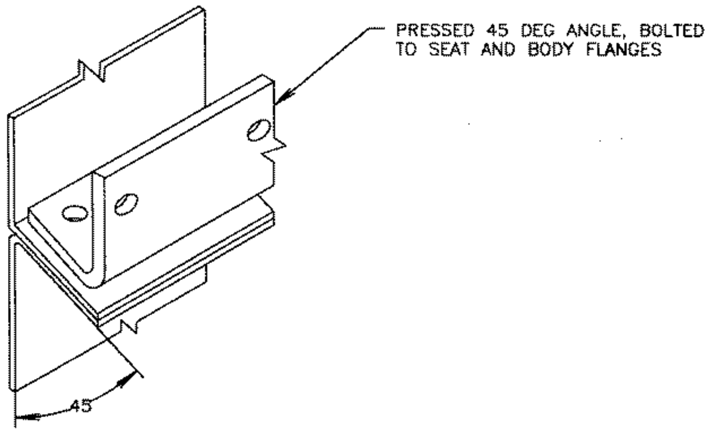

Figure 17. Wall Mount Type 4

Possible bus models: PMC Galstress.

Requirements:

- components and attachments to manufacturer's specifications.
- minimum bolt size M10 grade 8.8 with hardened washers. Holes to be drilled and tapped (self-tappers not acceptable). Where angle is less than 5mm thick self-locking nuts are required.
- unless the seat manufacturer specifies otherwise, the minimum seat bracket thickness is 4mm and the minimum bolt pitch is 300mm.

Wall Mount Type 5 (not for seats with seat belts)

Description: Vertical extruded aluminium C-channel riveted to side wall.

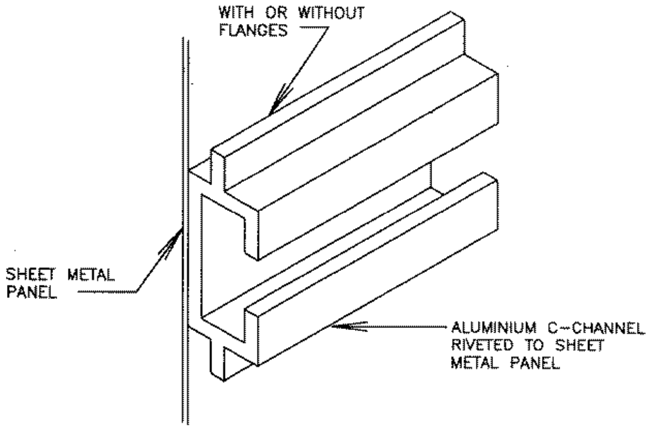

Figure 18. Wall Mount Type 5

Possible bus models: Denning Denflex, Howard Porter

(Note: Some Volgren buses use this system - contact Volgren for advice)

Requirements:

- components to manufacturer's specifications.
- channel attached to side wall with a minimum of 6mm steel rivets at 150mm spacing.
- minimum bolt size M10 grade 8.8 with minimum 3mm thick T-plate and hardened washers for seat bracket.
- unless the seat manufacturer specifies otherwise, the minimum seat bracket thickness is 4mm and the minimum bolt pitch is 300mm.

3.3.1.4 Wall Mount Type 6 (not for seats with seat belts)

Description: Horizontal extruded aluminium C-channel riveted to steel angle that is welded to side wall.

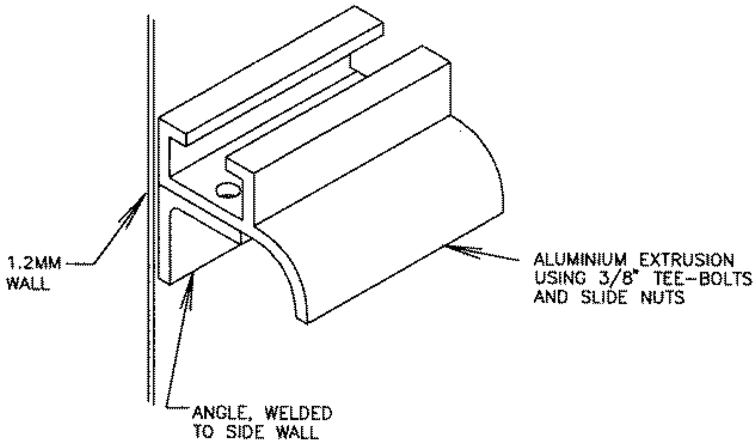

Figure 19. Wall Mount Type 6

Possible bus models: Denning Mono, GBW

Requirements:

- components to manufacturer's specifications (angle is 40x40x3).
- channel attached to angle with a minimum of 6mm steel rivets at 150mm spacing. Additional rivets at T-plate locations.
- minimum bolt size M10 grade 8.8 with minimum 3mm thick T-plate and hardened washers on seat bracket.
- unless the seat manufacturer specifies otherwise, the minimum seat bracket thickness is 4mm and the minimum bolt pitch is 300mm. A total of four bolts are recommended to provide additional strength, with the outer bolts spaced at no more than 300mm.

3.3.1.5 Wall Mount Type 7 (not for seats with seat belts)

Description: Extruded aluminium section with vertical C-channel riveted to side wall.

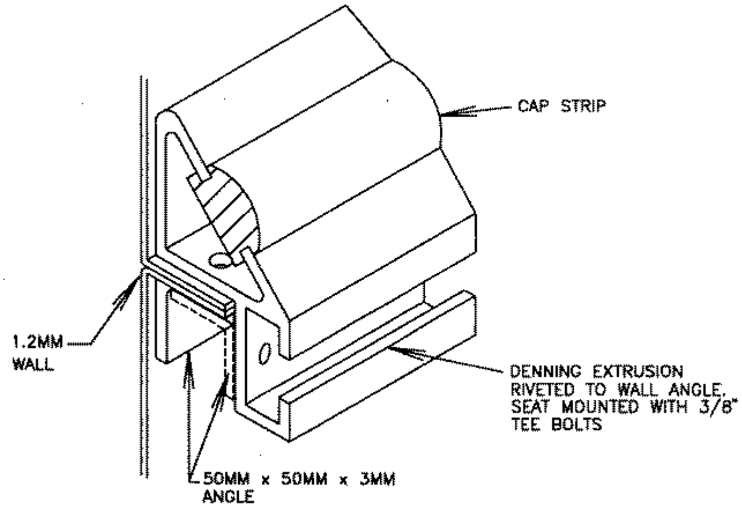

Figure 20. Wall Mount Type 7

Possible bus models: Denning Landseer (pre 1991), Denning Doubledeck

Requirements:

- extrusion attached to side wall with a minimum of 6mm steel rivets at 150mm spacing. Additional rivets at T-plate locations.
- the extrusion is supported by a right angle flange on the lower body panel. It is recommended that this be reinforced with two 50x50x3 angles (or similar) as illustrated and that the C-channel be riveted to the reinforcement.
- minimum bolt size M10 grade 8.8 with minimum 3mm thick T-plate and hardened washers for seat bracket.
- unless the seat manufacturer specifies otherwise, the minimum seat bracket thickness is 4mm and the minimum bolt pitch is 300mm. A total of four bolts are recommended to provide additional strength, with the outer bolts spaced at no more than 300mm.

3.3.1.6 Wall Mount Type 8 (not for seats with seat belts)

Description: Unistrut steel C-channel welded to side wall.

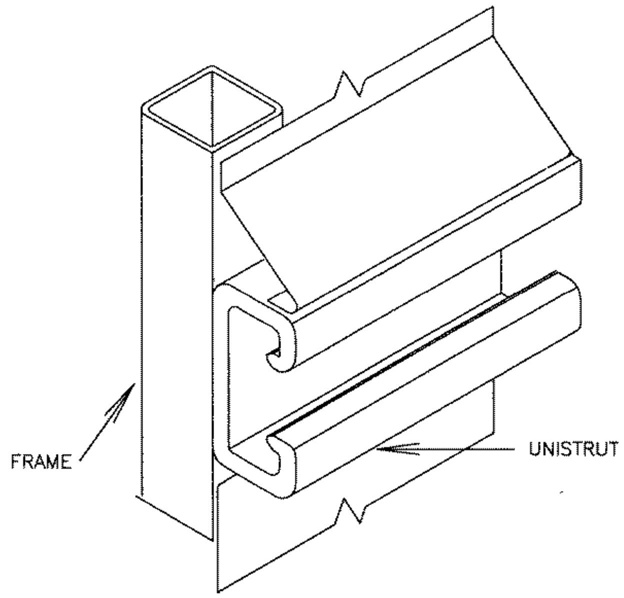

Figure 21. Wall Mount Type 8

Possible bus models: Denning Landseer (1991 on)

Requirements:

- welded to frame. Welded top and bottom to side panels with a minimum of 50mm of weld for each 150mm of Unistrut length.
- minimum bolt size M10 grade 8.8 with specified Unistrut nuts and hardened washers for seat bracket.
- unless the seat manufacturer specifies otherwise, the minimum seat bracket thickness is 4mm and the minimum bolt pitch is 300mm. A total of four bolts and T-plates are recommended to provide additional strength, with the outer bolts spaced at no more than 300mm.

3.3.2 Floor mounts

3.3.2.1 Floor Mount Type 1 (not for seats with seat belts)

Description: Underfloor steel flat, welded to floor bearers.

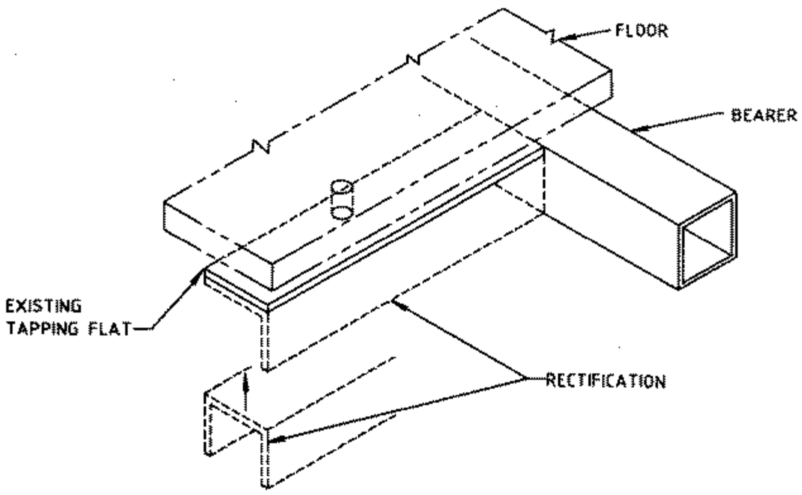

Figure 22. Floor Mount Type 1

Possible bus models: Numerous.

Requirements:

- minimum flat width 50mm. All flats require reinforcement. Flats 3mm thick require reinforcing with 50x50x5 steel angle or equivalent. Thicker flats may be reinforced by welding a 50x5 web along the entire length but a 50x50x5 angle or equivalent top-hat section is preferred.
- minimum bolt size M10 grade 8.8 with hardened washers. Holes to be drilled through flat and reinforcement. Holes may be tapped (self-tappers not acceptable). Self-locking nuts are preferred.
- unless the seat manufacturer specifies otherwise, the minimum bolt pitch is 300mm.

3.3.2.2 Floor Mount Type 2 (not for seats with seat belts)

Description: Underfloor steel angle welded to bearers.

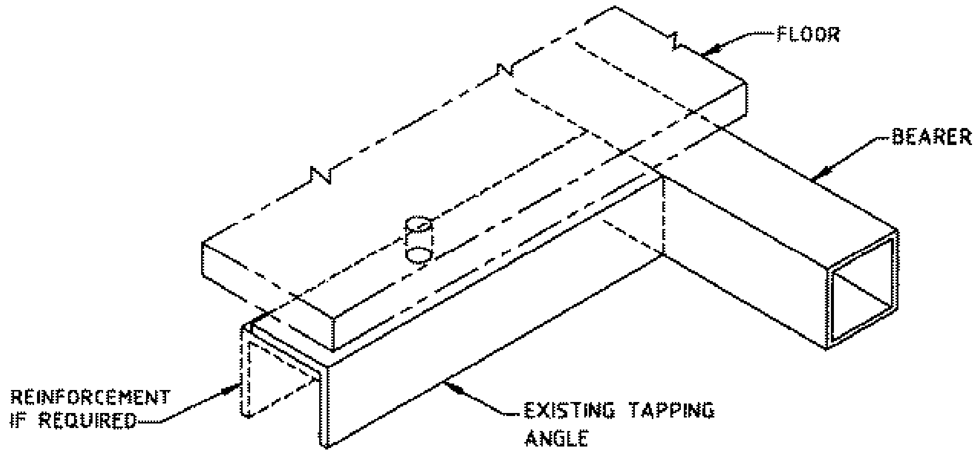

Figure 23. Floor Mount Type 2

Possible bus models: Numerous.

Requirements:

- minimum angle width 50mm. Angles less than 5mm thick (or less than 50mm wide) require reinforcing with 50x50x3 steel angle or equivalent to form a channel (see illustration). It is recommended that thicker angles be reinforced in a similar way.
- minimum bolt size M10 grade 8.8 with hardened washers. Holes to be drilled through both angles. Holes may be tapped (self-tappers not acceptable). Self-locking nuts are preferred.
- unless the seat manufacturer specifies otherwise, the minimum bolt pitch is 300mm.

3.3.2.3 Floor Mount Type 3 (not for seats with seat belts)

Description: Seats anchored into longitudinal chassis.

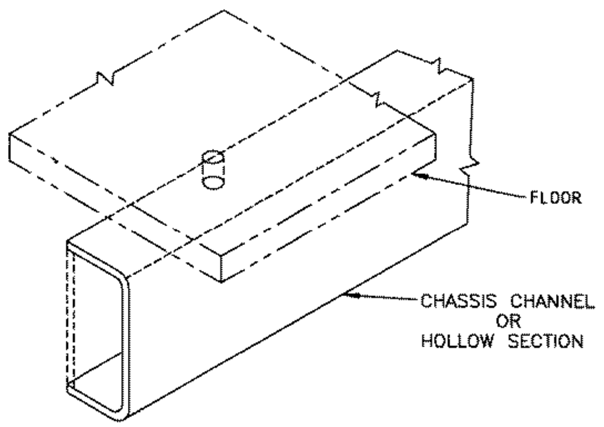

Figure 24. Floor Mount Type 3

Possible bus models: Denning Mono, Denning Landseer.

Requirements:

- minimum chassis thickness 5mm. Caution is needed when drilling the chassis to avoid damage to airlines and wiring. Drilling in highly stressed regions of the chassis is inadvisable.
- minimum bolt size M10 grade 8.8 with hardened washers. Holes to be drilled through chassis . Holes may be tapped (self-tappers not acceptable). Self-locking nuts are preferred.
- unless the seat manufacturer specifies otherwise, the minimum bolt pitch is 300mm.

3.3.2.4 Floor Mount Type 4 (not for seats with seat belts)

Description: Horizontal extruded aluminium C-channel along length of bus.

This type of floor mount is only acceptable if there is evidence that the system complies with ADR66 or ADR68, as appropriate (for example the bus is certified to comply with the ADR using the C-channel). The system must be installed to the manufacturer's specifications.

3.3.2.5 Floor Mount Type 5 (not for seats with seat belts)

Description: Steel Unistrut C-channel welded to side of aisle angle.

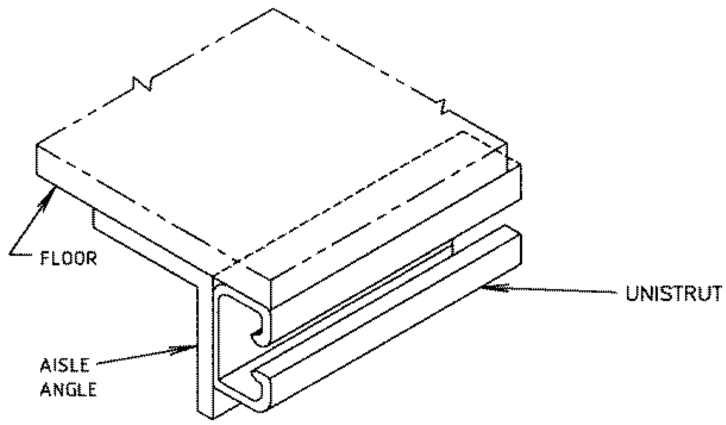

Figure 25. Floor Mount Type 5

Possible bus models: Denning Majestic, Denning Landseer.

Requirements:

- components to manufacturer's specifications.
- minimum bolt size M10 grade 8.8 with specified Unistrut nuts and hardened washers for seat bracket.
- unless the seat manufacturer specifies otherwise, the minimum bolt pitch is 300mm.

3.4 Engineering practices

The following advice provides a non-exclusive outline of acceptable practice for retro-fitting of ADR66 or ADR68 seats, whilst acknowledging that other methods can be equally acceptable.

When devising vehicle modifications, it is good practice to choose a method which provides ready verification by both the certifying engineer and any future inspection authority, as well as satisfying the technical requirements.

3.4.1 Fasteners for Seat Anchorage

i) Installation of fasteners can be within plain or tapped holes but in both cases will require suitable self-locking nuts/washers[7] to be fitted wherever possible.

Fitment of back nuts to tapped installations is to firstly ensure that structural integrity is maintained even if the tapped thread is damaged during installation and secondly to facilitate direct inspection by the certifying engineer and other authorities.

---

[7] either self locking nuts with a plain washer or plain nuts with a locking washer

ii) Where back nuts cannot be installed (or inspected), then fasteners must be installed using a torque wrench for final tightening to an appropriate minimum torque to induce 65% proof load (e.g. 22Nm for an M10 x 1.50 (8.8) bolt/screw, ref AS2465). Certifying engineers would need to check the torque on at least a sample of these fasteners.

iii) Fasteners (bolts/screws/nuts) should be minimum grade 8.8.

iv) Self drilling/self threading fasteners are not to be used because of inherent uncertainties regarding thread condition after fixing.

Self-locking (e.g. 'Nyloc') nuts provide simpler inspection than use of spring washers, without the risk that a washer will be missed during assembly. However spring washers will generally cost less and usually do not require a second operator if the fasteners were first secured to tapped holes.

Figure 26

3.4.2 Hardened washers

Hardened washers should be used wherever high-tensile bolts and nuts bear on mild steel, to prevent the bolt head or nut biting into the material.

3.4.3 Bolting through hollow sections

Where anchor bolts pass through a hollow section then a spacer tube should be installed to prevent crushing of the hollow section (Figure 27).

It is preferred that the tube is fixed in place (e.g. welded) but a removable insert is acceptable where suitable steps are taken to ensure that (i) the bolt will not 'pull through' the unsupported hollow section under crash loads and (ii) a tube is used for each fastening.

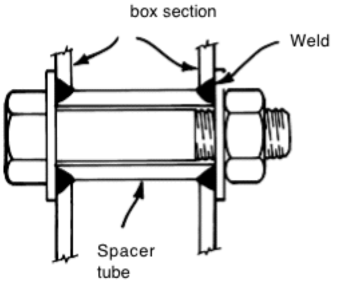

Figure 27. Hollow sections

Figure 28. Failed channel

3.4.4 Aluminium channel for floor mount

Floor mounts that utilise aluminium channel provide some extra flexibility in the longitudinal spacing of seats. However they are generally not suitable for the installation of ADR68 or ADR66 seats (see Figure 28). Only complete systems (channel, t-plate and fasteners), installed to the vehicle manufacturer's specifications for ADR68 installations should be used.

3.5 Modifications to Denning seats with cast aluminium components

In accordance with Clause 2.5.1, it is recommended that the cast aluminium leg on the Denning Easy Rider seat be replaced. It is also recommended that the cast aluminium armrest on the Denning Easy Rider Single Action seat be reinforced.

The 1994 Guidelines contained drawings of possible modifications to these seats:

- 884/DEN-1 Denning Easy Ride Single Action - seat leg and armrest installation
- 884/DEN-3 Denning Easy Ride Dual Action new seat leg installation
- 884/DEN-5 Denning Easy Ride Single Action armrest reinforcement
- 884/DEN-6 Denning Easy Ride Single Action seat leg replacement
- 884/DEN-8 Denning Easy Ride Dual Action seat leg replacement

These drawings may be downloaded from the following Internet website:

http://...[pending]

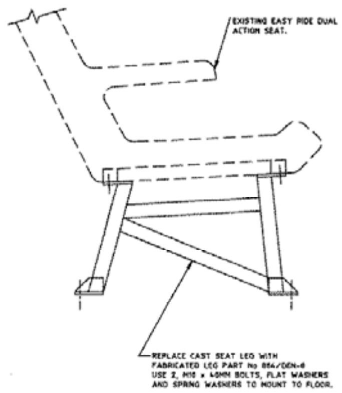

Figure 29. Sample Drawing

DOCUMENT UPDATES

This Code will be distributed electronically and interested parties should ensure that they have the latest copy (downloadable from http:// [pending]).

Major updates will include a cover page that summarises the amendments which have been made since issue of the previous version of the document.

Organisations may decide to print copies of the Code from the latest electronic version. There is no copyright restriction on printing and distributing such copies, provide that it is made clear that electronic copies are freely available. In these cases it is important that any subsequent amendments are recorded in the printed copy or that replacement pages are issued to holders of the printed copy. A copy of the cover sheet for the amendment package should be inserted in the printed copy of the Code as a record of the amendment process.

APPENDIX A - SHORT DURATION STATIC TEST

Note: the details of this Appendix are pending. The following notes give a brief description of the intended content of the Short Duration Static Test.

A requirement to test seat installations according to the dynamic test prescribed in ADR68 is regarded as too onerous for most retrofit situations.

The proposed Short Duration Static Test only applies where a seat that is certified to ADR68 is used. In these cases there is a need to test anchorage strength in a way that the gives reasonable confidence that the complete system would comply with the dynamic test of ADR68.

The test should be simple, safe and suitable for use in a typical workshop. It should not cause excessive damage to vehicles with adequate seat anchorage strength.

It is proposed that a special type of static test be developed to simulate the loads that are generated for very short periods of time during the dynamic test. The static load needs to also have a very short duration, otherwise components could yield in a manner that is not representative of the dynamic test.

At the time of preparation of this draft Code the NTC was considering ways to develop the Short Duration Static Test.

APPENDIX B - ENGINEERING CERTIFICATION FORM

The form - for use by certifying engineers - has been issued as a separate document during the public draft phase.