



Office of Transport Safety Investigations

BUS SAFETY INVESTIGATION REPORT

UNINTENTIONAL OPENING OF BUS REAR DOOR

POINT CLARE

19 MAY 2016



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EXECUTIVE SUMMARY

On 19 May 2016, at Point Clare, while travelling home on a Busways school bus service, an 11-year-old student standing in the rear vestibule area leant against the rear door of the bus. The force applied by the bus turning right on a rough road surface with the student leaning against the door caused the door to open and the student fell onto the road sustaining minor injuries.

The investigation determined that the unintentional opening of the door occurred because the operating mechanism was not adjusted according to the manufacturer's specification. The maladjustment permitted parts of the mechanism to separate when an outward and downward force was applied to the door. It is reasonable to expect that a bus door will not open when a passenger leans against it.

The operator's maintenance program did not detect that the door mechanism was out of adjustment. Following the incident and after an internal investigation, the bus operator implemented a modification to the door system. The door manufacturer was consulted about this design modification; agreeing that the modification would not compromise the structural integrity of the system.

Contributing to the incident was the action of the student who was standing in a no standing area leaning against the door. The bus driver also should have ensured that there were no passengers standing in this area.

NSW Roads and Maritime Services alerted all bus operators in NSW with the same door mechanism to this risk and gave directions to comply with the manufacturer's maintenance instructions.

It was recommended that the bus operator monitor passenger compliance with designated no standing areas and review its maintenance procedures. Another recommendation was to conduct monitoring of the door modification to ensure its continued effectiveness.

Full details of the Findings and Recommendations of this bus safety investigation are contained in Parts 3 and 4 respectively.

PART 1 FACTUAL INFORMATION

Introduction

- 1.1 At about 1553,¹ on Thursday 19 May 2016, a Busways school bus service was transporting students home when an eleven-year-old student fell from the rear door of the moving bus. The student was standing in the rear vestibule area and leant against the closed door. The bus was travelling around a right-hand bend when the single door opened outwards and the student fell onto the roadway sustaining a minor elbow injury and a torn school blazer.

Location

- 1.2 The incident occurred on Wendy Drive, Point Clare on the Central Coast in NSW (see *Figure 1*). The suburb of Point Clare is 49 km north of Sydney's central business district.
- 1.3 Wendy Drive is a residential suburban street with a speed limit of 50 km/h. The location where the student fell out is a gradual right-hand curve in the direction of travel for the bus, outside the entrance to the ambulance station where a driveway enters the road. The road surface is bitumen with numerous filled potholes. In addition, there are areas of the road that have deteriorated to loose gravel creating a rough road surface. The road has a slight slope down towards the ambulance station driveway (see *Figure 2*).

¹ Time as stated by driver. Times in this report are in 24-hour clock form in Australian Eastern Standard Time.



Source: GeoScience Australia annotation by OTSI

Figure 1: Incident location - Point Clare



Source: OTSI

Figure 2: Wendy Drive, Point Clare

Environmental information

- 1.4 The afternoon of 19 May 2016 was dry and sunny. The Bureau of Meteorology recorded a temperature of 23°C at 1500 at the Gosford weather station about 5 km to the north of Point Clare. It was determined that the environmental conditions played no part in the incident.

Bus information

- 1.5 The bus, a 2007 Scania K230UB model, was a two door city bus, registration 6971MO. It was fitted with a Custom Coaches CB 60 body. The bus was operated by Busways out of their Kincumber Depot. The odometer reading at the time of the incident was 535,177 km. The two door openings were on the near side² of the bus (see *Figure 3*). The front door consisted of two door leafs, and the rear door had a single door leaf. It was the rear door that opened during the incident. The door aperture measured approximately 815 mm wide by 2050 mm high.



Source: OTSI

Figure 3: Busways bus 6971 MO

² The left side when looking forward in the bus is the near side. The right side is the off side.

Development of the occurrence

- 1.6 The bus driver started the first afternoon run at 1541 from the St Philip's Christian College, Narara Creek Rd, Narara. The driver had previously worked a morning shift from 0715 to 0910 and then had a break before starting the afternoon shift. This morning and afternoon split shift is a common arrangement in the bus industry that allows bus operators to cater for peak passenger times.
- 1.7 The driver said that approximately 50 students boarded the bus at the school and did not notice how many were standing. The student said that about 5 students were standing at the time of the incident. The bus is authorised to carry 80 persons, 49 seated and 31 standing.
- 1.8 The bus departed St Philip's Christian College and a few minutes later picked up another 4 students from Glenvale Special School, which is also on Narara Creek Rd. The driver said that a stop was made on Brisbane Waters Drive to drop off a number of students. The bus continued its journey along Brisbane Waters Drive. The total time from the start of the journey to when the incident occurred on Wendy Drive was approximately 12 minutes.
- 1.9 The investigation found that the driver did not conduct an adequate check utilising the internal rear view mirrors (see *Figure 4*); and did not notice the student standing in the area next to the rear door. The middle interior saloon mirror showed the view down the aisle and provided a limited view of the area adjacent to the rear door. It is possible that there were students standing in the aisle between the driver and the rear door. However, the mirror to the top left, the centre door spotter saloon mirror, provided a clear view to the mirror above the centre door.
- 1.10 It is essential that drivers ensure that no passengers travel in this area. Some buses are equipped with internal cameras and screens to enable the driver to monitor this area. This bus was not fitted with this facility. Also, confirmation of the position of passengers was not possible as the recording device attached to the closed circuit television was not operational on the day of the incident.



Source: OTSI

Figure 4: Driver's internal rear view mirrors

The incident

- 1.11 The bus turned the corner into Wendy Drive and made a gradual right-hand turn past the rear of the ambulance station when the student fell out (see *Figure 5*). The road camber and the uneven surface of the road likely created instability for the leaning student and introduced additional forces against the rear door.



Source: Google Maps annotations by OTSI

Figure 5: Bus route leading up to incident

- 1.12 The student was standing with their back leaning against the rear door. There is a handrail also attached to the door. It is possible that the student was resting on the handrail, which is positioned across the lower half of the door.
- 1.13 The in-motion forces and the load applied on the door and (possibly) the handrail by the leaning student were sufficient to disengage the door mechanism. Once this occurred there was nothing to stop the door opening outward. The student said that there was no warning when the door opened. The driver received no notification or alarm. The driver estimated the speed at the time of the incident as 25 km/h.
- 1.14 The student said that there were no other students in the vicinity of the rear door and that no contact was made with any other student. The student landed on the road and quickly got to their feet and rejoined the bus, which had stopped ahead. An unexpected and uncontrolled fall of this type is dangerous; it is possible the backpack the student was wearing cushioned their fall.
- 1.15 The driver of the bus was unaware of the incident and continued driving until being notified of what had happened by one of the other students on the bus. The driver stopped the bus approximately 30 m away, while the student got up and walked back to the bus. The driver reported the incident to the Busways control room at Pymble using the bus communications radio.
- 1.16 When the student got back on the bus, the driver asked if the student was alright. The student did not request medical treatment and assured the driver that no injuries were sustained. The driver did not think that the student required assistance. No ambulance was requested, and the student waited with the rest of the passengers for the replacement bus to arrive. The replacement bus arrived and continued to transport the students to their destinations. This bus left the incident site at 1610.
- 1.17 OTSI received notification of the incident at 1620. The Busways controller told the driver to wait for a company representative to arrive. The driver waited with the bus until a depot mechanic arrived at 1630. While waiting on site, the driver took photographs of the bus door and the door mechanism. These photographs were later provided to the OTSI investigator. The mechanic and

the driver secured the rear door with cable ties, and the mechanic drove the bus back to the depot. The bus was secured inside the depot to await further examination.

- 1.18 An OTSI investigator arrived the following morning to examine the bus and the door mechanism. Following this inspection, the Chief Investigator determined that OTSI would conduct an investigation into the incident.

PART 2 ANALYSIS

Introduction

2.1 The investigation focussed principally on the factors that contributed to the unintentional opening of the door. This included the design of the door mechanism, door safety mechanisms, compliance with existing design standards, service and repair history. The positioning of the student against the door, the actions of the driver and the reasons for the lack of recorded video footage were also reviewed.

Bus door examination

2.2 OTSI inspected the bus on 20 May 2016 at the Kincumber Busways' depot. The following was observed during this inspection:

- The rear door was secured with cable ties, once the ties were cut the door was able to swing freely.
- The rear door mechanism's pivot pin had disengaged from the bearing block, and there were fresh scratch marks on the base of the bearing block.
- There was an identification disc riveted to the rear door. It read "SER. No. D20247 SMC TRANSIT".
- There was no breakage of the toughened door glass.
- The door electrical and hydraulic systems were operational.
- All warning and door alarm systems on the bus were functional.
- The outside of the door was squarely aligned with the door aperture and the exterior of the bus.
- There was no vertical movement, and no wear detected on the door bushes.
- The brake interlock on both doors operated as specified by Roads and Maritime Services (RMS) *Technical Specification 146* (see *Appendix 2*).
- The vertical adjustment of the door was lower in the assembly than found on another similar bus of this type.

- The upper door mechanism was covered in dirt and dust, and appeared undisturbed in recent times.

2.3 The investigation found that the door opened unexpectedly when the pivot pin disengaged from the bearing block (see *Figure 6*). The force of a student leaning or falling against the door was sufficient to open the door (see *Figure 7*). It was likely the door was not correctly adjusted. The pivot pin was positioned lower in the bearing block than specified, which meant that less force was required to disengage the mechanism and hence, open the door.

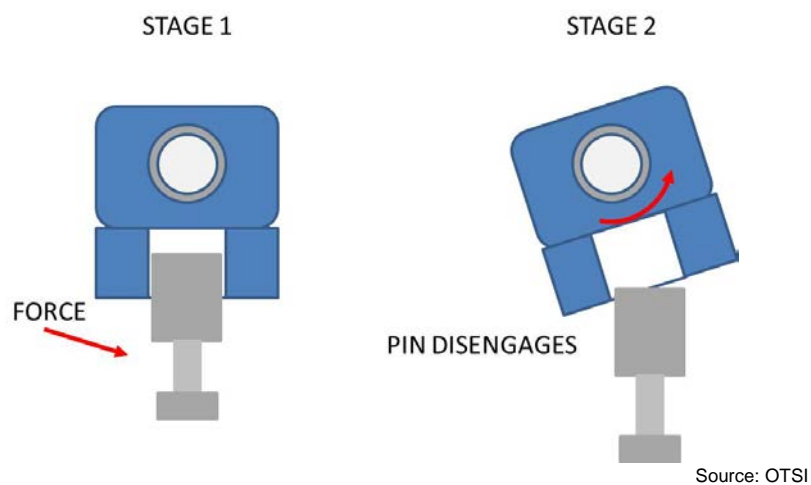


Figure 6: Bearing block disengaging from pivot pin

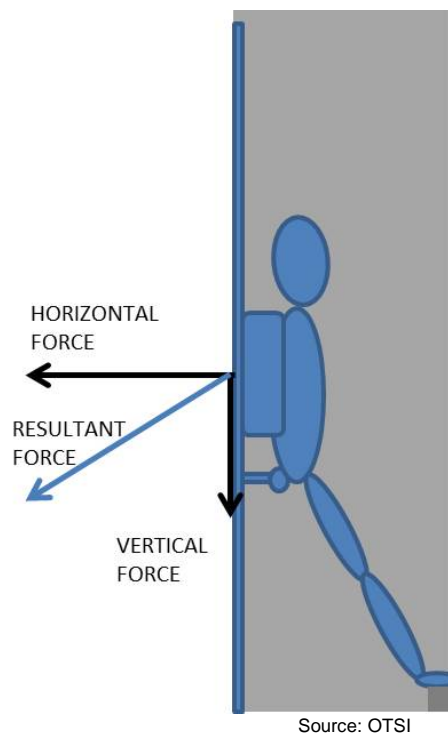
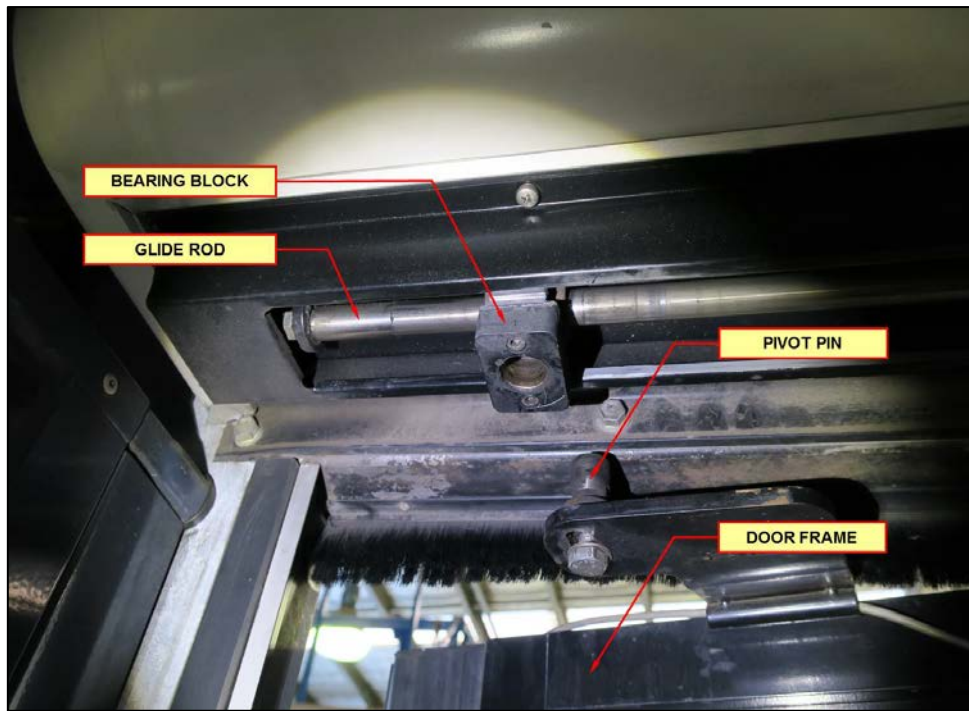


Figure 7: Forces applied by student

- 2.4 During the investigation, testing was conducted to determine the force required to open doors with the same type of door mechanism. The test was repeated at least 10 times on some buses with an outward horizontal force applied against the door. Both a steady and a sudden force were applied. The amount of force used was not measured but was enough to flex the door and give concern that the glass would break. The force applied during these tests was more than could reasonably be expected to be applied during service. The door was unable to be opened using a similar horizontal force on a correctly adjusted door.
- 2.5 Further testing conducted found that the door could be opened if both a moderate horizontal and vertical force was applied to a door with the pivot pin situated lower in the bearing block. It is likely that this is the type of force applied by the student.
- 2.6 Both Busways and SMC Pneumatics (Australia) Pty Ltd (SMC) concurred that the door mechanism was out of adjustment (between 7 to 9 mm). However, it is unknown if the adjustment was from the original bus body builder's installation or occurred gradually since 2007.

Door mechanism

- 2.7 All doors on this bus were designed and manufactured by SMC, an Australian company. The door is a bus single gliding door (model BDK276-XAK5038). The design of the door mechanism, particularly the upper linear glide assembly features, as the connection between the door leaf and the sliding linear glide, a pivot pin engaging in a bearing block (see *Figure 8 and 9*).



Source: OTSI

Figure 8: Rear door bearing assembly with pivot pin disengaged from bearing block

- 2.8 The part number for the bearing block is XAL5011D and the pivot pin is D19055. Many other parts make up the assembly, but these two parts are the critical interface, and in this instance separated, allowing the door to swing open.



Source: OTSI

Figure 9: Close-up of bearing block (left) and pivot pin (right)

- 2.9 According to SMC, there are another 1280 buses in New South Wales fitted with the same door mechanism. The types of buses and numbers that use this type of door system are:
- Custom Bus/Customs Coaches (CB60 & CB80) - 1179,
 - Express Bus - 24,
 - Ventura – 75. and
 - Designline - 2.
- 2.10 There are 63 Scania models in the Busways fleet with either the same or similar door mechanism. These buses are located at the following Busways depots: Coffs Harbour, Glendenning, Laurieton, Mulgrave, Penrith, Port Macquarie and Wyong.
- 2.11 Passenger buses have several safety mechanisms in place to prevent doors opening during travel and also to prevent the doors closing as passengers get on and off. The opening of the doors is controlled by the driver from a control panel adjacent to the driver's seat. (see *Figure 10*). These controls were fully functional when tested following the incident.



Source: OTSI

Figure 10: Door controls

- 2.12 There is an alarm to indicate when doors are in an open condition. The alarm illuminates a warning light on the dashboard in conjunction with an audible alarm. This alarm was functioning when tested the day following the incident. However, this alarm did not activate when this door opened as the sensor is attached to the mechanism rather than the door leaf.

Compliance with existing standards

- 2.13 The door safety system complied with all current standards. The current standard that applies to the safety system of bus doors in NSW is *Technical*

*Specification 146.*³ A bus door safety system has the primary intention of preventing passengers from being caught and trapped by a closing door and then potentially being dragged by a moving bus. The system also seeks to ensure the bus does not move when the doors are in the open position. Neither this specification nor the Australian Design Rules concern themselves with the lateral force that a door should withstand.

- 2.14 Transport for NSW specifies the requirements for buses purchased by accredited bus operators in NSW. The most recent bus specification requires that: *“doors shall be designed not to burst open if a person falls heavily against the doors”*.⁴ When this bus was purchased by Busways in 2007, there was no such requirement written into the specifications. However, it is reasonable to expect that bus doors do not open when subjected to the forces such as those that occurred during this incident.
- 2.15 Another requirement by Transport for NSW is that: *‘all rear vision mirrors must be in accordance with the recommendations contained in the NSW Department of Transport report ‘Bus Door Safety Inquiry final Report January 1995’ by Dr Michael Henderson. (RTA Technical Specification TS147)’*.⁵
- 2.16 Improvements were made to internal driver vision on buses after an incident where a girl was caught in the rear door of a bus in 1994. As a result of this and other incidents an inquiry was set up to investigate door safety systems⁶. This resulted in the creation of two technical specifications concerning bus doors: TS146 Bus door safety systems and TS147 Field of view of passenger entrance doors of a bus. These specifications were gazetted by the NSW Roads and Traffic Authority in 1997.
- 2.17 More recently, the Bus Industry Confederation published a Door Safety Advisory which provides an comprehensive overview of the door safety systems which *‘presents successful door safety systems used by the bus and*

³ Bus door safety systems first issued by NSW Roads and Traffic Authority 16 July 1997.

⁴ Transport for NSW Bus Specification – Two door city buses (Diesel) BC14/23549 – December 2014.

⁵ Ibid.

⁶ Henderson, M., Bus Door Safety Inquiry final report (1995)

*coach industry to ensure safe work practices by drivers and passenger safety.*⁷

- 2.18 The bus involved in this incident also complied with Technical Specification TS147 Field of view of passenger entrance doors of a bus.

Maintenance history

- 2.19 The bus maintenance history indicated that the bus was regularly serviced and maintained. The most recent general service occurred on 6 May 2016. This included a general test on the door systems.
- 2.20 Busways have service schedule at 6000 km intervals. Qualified mechanics use a 146-point checklist to examine each bus. The following items on the checklist relate to door checks (see *Figure 11*).

NO	DESCRIPTION	CHECKED
7	CHECK DOOR INTERLOCK AND SAFETY SYSTEMS FOR OPERATION	YES
8	CHECK DRIVER SEAT/DOOR HANDBRAKE WARNING SYSTEM	YES
30	DOOR LIGHTS	YES
69	CHECK DOOR BRACKETS AND MOUNTS	YES

Figure 11: Checklist items relating to door checks

The check on the door bracket and mounts in item 69 is the relevant item that needed attention in this instance.

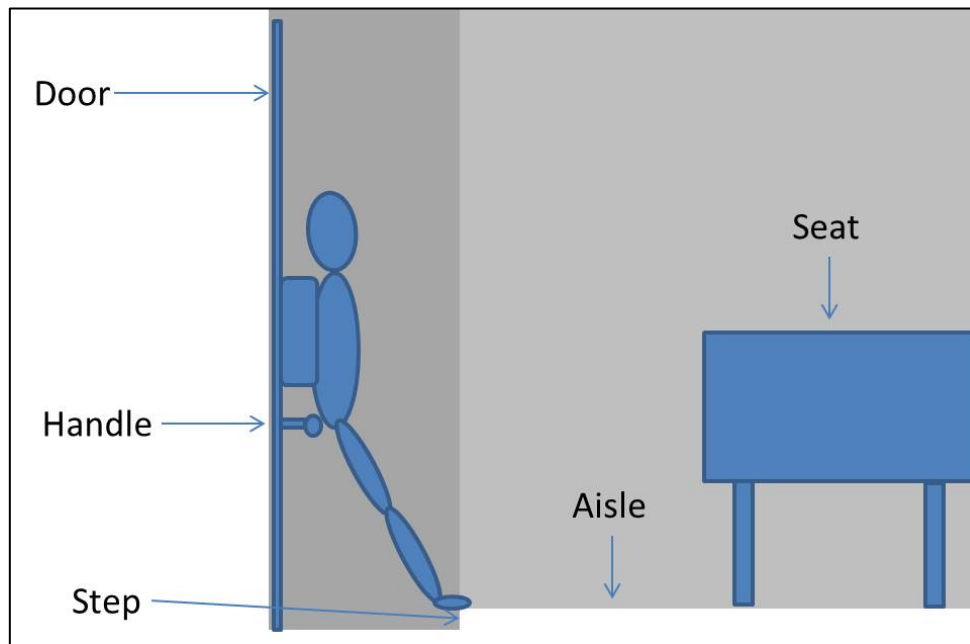
- 2.21 The door manufacturer recommended a maintenance period of 3 months. A maintenance booklet was provided to the coachbuilder and the bus operator. This 20 page booklet listed all aspects of maintenance including checking, adjustment, and lubrication. The SMC maintenance instructions are detailed in contrast to the Busways checklist. Evidence from an examination of the door mechanism suggested that the door mechanism had not been cleaned or lubricated in quite some time.

Positioning of the student and actions of driver

- 2.22 The student was positioned with their back to the door in the no standing area (see *Figure 12*). The bus was full but not so crowded that this was the only area available. The student could have stood in the aisle of the bus. The Transport for NSW student code of conduct for school students travelling on

⁷ Bus and Coach Industry Door Safety Advisory (2012) p.4.

buses states that *“It is every students’ responsibility to behave in a manner that ensures the safety and comfort of passengers and driver’s.”*⁸



Source: OTSI

Figure 12: Position of student leaning against bus door

- 2.23 While still only a primary student, the 11-year-old student should have had a reasonable understanding that leaning against a door was not a sensible action. While not mandatory, due to the nature of bus travel, it is prudent for standing passengers to assist stability by holding onto a handrail or overhead strap. The student that fell from this bus was standing and not using any handhold, besides the door, at the time.
- 2.24 The Busways driver-training module has a section on managing student safety, which states: *“Do not allow students to travel in stairwells ...”*. The training document also places emphasis on this: *“Regardless of how crowded the bus is, you must ensure that at no times are any passengers permitted to travel in the stairwells”*. Busways provided documents to show the driver had received training on 16 July 2015.
- 2.25 It is recognised that bus drivers have a lot of information to process while driving a bus, particularly on a fully loaded school run. Drivers can only process a limited amount of information during any particular period. Therefore, in general, if a person is focussing on one particular task, then their

⁸ Transport for NSW Student code of conduct – accessed online at www.transport.nsw.gov.au on 16 June 2016.

performance on other tasks will be degraded. Research has shown that visual attention narrows as workload increases.⁹ A driver should monitor the position of passengers before the bus is underway before their focus is on driving. No request was made by the driver for the student to comply with the requirement to move out from the no standing area.

Digital video recorder malfunction

- 2.26 There was no bus video footage available regarding the incident. This made it difficult to verify the accounts of the witnesses. According to the last service on 6 May, a problem was identified with the power going to the digital video recorder (DVR). According to the maintenance record, this was fixed. The mechanic who did the maintenance stated that all the wiring was checked and was fine. Once the power plug was reinserted the DVR powered up and recorded normally.
- 2.27 According to the driver, the pre-departure check indicated that the DVR was functional on the morning of the incident. A flashing light was observed on the DVR front camera, which indicated it was working. Following the incident, a test determined that a timer on the DVR was defective and had caused the system to shut down. After a new timer was installed, the system was fully functional.

Previous incidents

- 2.28 Two previous incidents of this type occurred in June 2012 and April 2014. The model bus in both incidents was an articulated Volvo B12BLEA model, both operated by the State Transit Authority. The first incident occurred on 14 June 2012 when five students fell from the double rear doors of the bus. The combined force of five students falling against the doors caused the upper door bracket to separate from the pivot pin on door leaf six. The first two students fell out of the bus facing forwards, the next two students fell out of the bus facing backwards, and the last student fell forward onto the road (see *Figure 13*). The students sustained minor injuries.

⁹ Driver distraction and inattention – Advances in research and countermeasures (2013). Regan, M.A, Lee, J.D., Victor, T.W., Vol.1. p.71.



Source: State Transit Authority

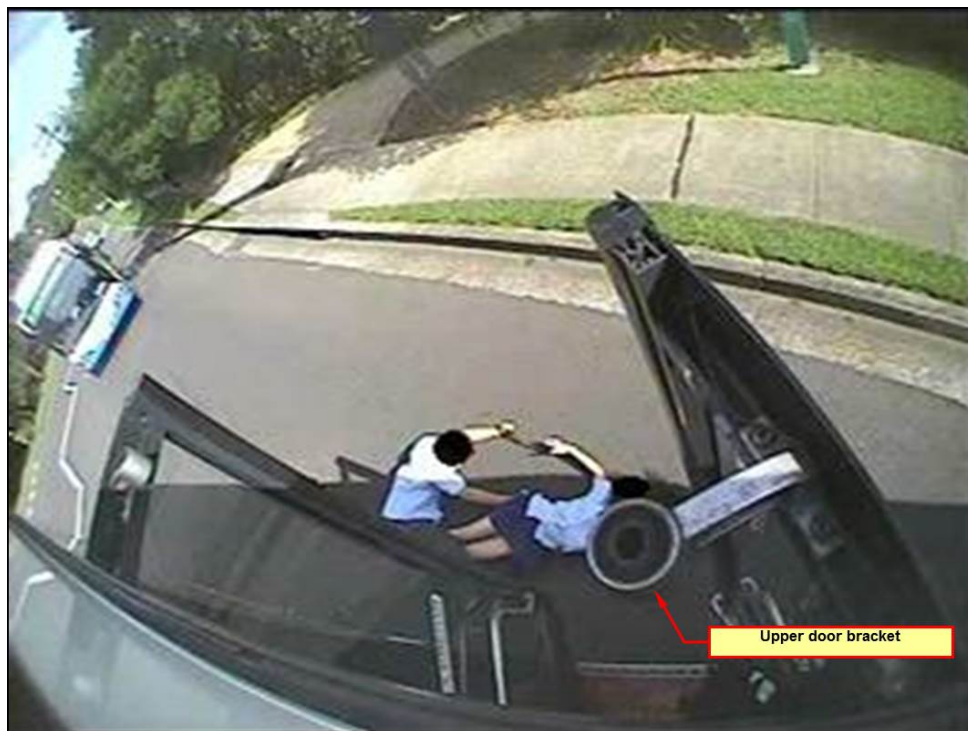
Figure 13: Students fall out of bus (2012)

- 2.29 A second incident occurred on 3 April 2014, when, two students standing in the rear vestibule area fell against the rear doors of the bus. As the bus was making the turn, a student, standing in the vestibule area, stumbled and fell against a another student (see *Figure 14*). The student was standing unsupported facing away from the doors and talking on a mobile phone. The force of the students falling against the doors again caused the upper door bracket to separate from the pivot pin of the door. The students fell onto the road sustaining minor injuries (see *Figure 15*).



Source: State Transit Authority

Figure 14: Student A stumbles against student B (2014)



Source: State Transit Authority

Figure 15: Students fall out of bus (2014)

- 2.30 These previous occurrences involved door mechanisms from a different company (FBT Fahrzeugbau) than for this incident. The OTSI investigation found that with the application of sufficient force, the pin disengaged from the block allowing the door to open (see *Figure 16*).

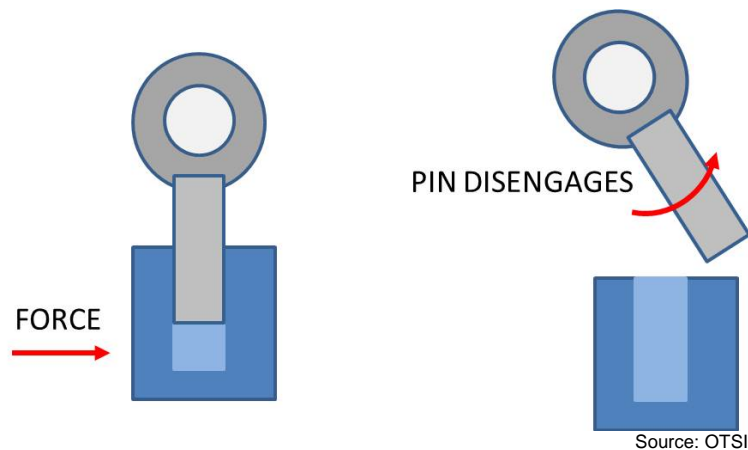


Figure 16: Pivot block pin disengaging from upper door bracket (2012 & 2014 incidents)

- 2.31 A modification was made to the design to make the pin captive (see *Figure 17*). The modification was made by the bus operator, State Transit Authority, in consultation and with the approval of the manufacturer (Volgren and FBT Fahrzeugbau).

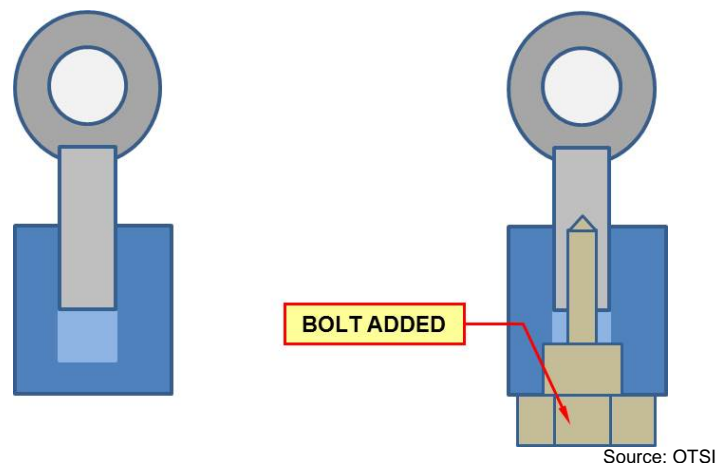


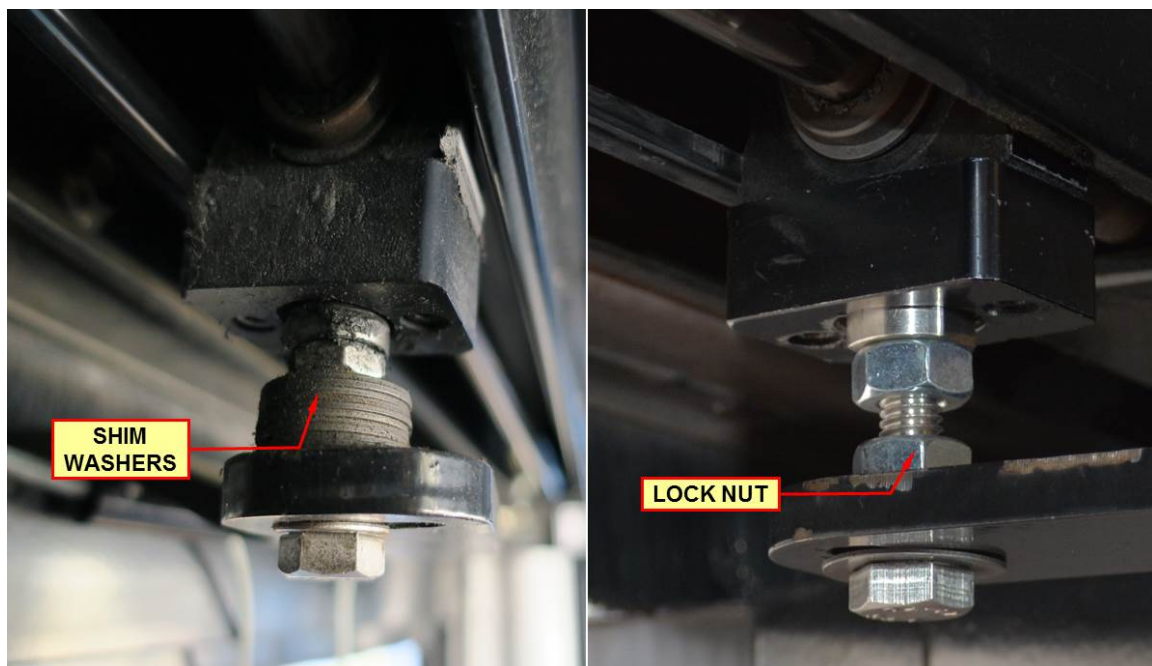
Figure 17: Modification made to make the pivot pin captive (2012 & 2014 incidents)

Safety actions taken

- 2.32 Following the current incident, Busways conducted an inspection of all affected buses in their fleet. All door systems were checked and adjusted to specification.

2.33 The Busways management team also designed an in-house modification to the door mechanism to reduce the likelihood of maladjustment (see *Figure 18*). Once this principal control measure was finalised, Busways took the following steps:

- Produced a technical bulletin which was circulated to all workshops affected by the modification,
- Re-trained all relevant workshop staff on door inspection and adjustment,
- Adopted increased inspection protocols to monitor door component wear rates,
- Specified that genuine SMC components must be used in the modification, and
- Ensured the modification was completed on all affected buses.



Source: OTSI

Figure 18: Modification made to door mechanism to add lock nut in place of shim washers

2.34 The manufacturer was consulted about the design modification who concurred that the Busways modification would not compromise the structural integrity of the system. It also commented that Busways had considered the risks and taken appropriate steps to improve door safety via increased maintenance protocols.

- 2.35 Busways also produced and distributed a safety bulletin for drivers. This bulletin reminded drivers of the importance of monitoring compliance in the luggage and no standing areas (see *Appendix 3*).
- 2.36 SMC examined the design of other door mechanisms that they manufactured. They found that there were no other door guide mechanisms in their back catalogue that was manufactured in a way that could disengage in the same manner as the door mechanism in this incident.
- 2.37 Roads and Maritime Services also took action by contacting accredited bus operators and alerting them of the incident. It also explained that: *“inspections of these types of buses have identified that, if incorrectly adjusted, the upper pivot pins are not fully engaged into the upper glide bush. With some downward and outward force, it was found the door would open if the pin is not fully engaged with excessive axial movement.”* The details of the affected buses were provided to operators along with a directive to follow the manufacturer's installation and maintenance manuals.

PART 3 FINDINGS

From the evidence available, the following findings are made with respect to the unintentional door opening and student falling from Scania K230UB bus, registration 6971MO that occurred at Point Clare, NSW on 19 May 2016.

Contributory Factors

- 3.1 The rear door opened when parts of the upper door guide mechanism separated. The pivot pin disengaged from the bearing block bush allowing the door to swing open.
- 3.2 The rear door upper door guide mechanism was not adjusted according to the manufacturer's specification. The engagement of the pivot pin in the bearing block was situated lower than that specified by the manufacturer.
- 3.3 The maintenance program of the bus operator did not detect the out of adjustment door mechanism before the incident.
- 3.4 The bus operator's maintenance instructions for door adjustment lacked detail when compared to the manufacturer's recommended routine maintenance instructions.
- 3.5 The driver did not conduct an adequate check to see if any student was standing in the no standing area next to the rear door of the bus.
- 3.6 A combination of in-motion forces and the student leaning against the door, provided sufficient force to open the door.
- 3.7 The rough road surface and the slight slope of the road likely increased the dynamic forces against the door.
- 3.8 The student had chosen to stand in a clearly defined no standing area.

Other Safety Factors

- 3.9 The digital video recorder, which would have captured video footage of the incident, was not functioning when the incident occurred.

PART 4 RECOMMENDATIONS

Noting that some remedial safety action has already been implemented, it is recommended that the following additional safety actions be undertaken:

Busways

- 4.1 Monitor the adjustment of the door mechanism to ensure that implementation of the modified design remains effective.
- 4.2 Conduct regular targeted audits on the incidence of students standing in designated no standing areas on school buses.
- 4.3 Revise door maintenance procedures as necessary to ensure that the door manufacturer's installation manual and routine maintenance instructions are followed during the scheduled servicing.

PART 5 APPENDICES

Appendix 1: Sources, Submissions and Acknowledgements

Sources of Information

- Busways Pty Ltd
- Roads and Maritime Services
- SMC Pneumatics Pty Ltd
- Transport for NSW

References

- *Door Safety Advisory* (2012). Bus Industry Confederation.
- *Driver distraction and inattention – Advances in research and countermeasures* (2013). Regan, M.A, Lee, J.D., Victor, T.W., Vol.1.
- *Bus Door Safety Inquiry final report.* (1995). Henderson, M.
- RTA *Technical Specification 146* 'Bus door safety systems' issued by NSW Roads and Traffic Authority 16 July 1997.
- RTA *Technical Specification 147* 'Field of view of passenger entrance doors of a bus' issued by NSW Roads and Traffic Authority 16 July 1997.
- Transport for NSW Bus Specification – *Two door city buses (Diesel) BC14/23549* December 2014
- Transport for NSW *Student code of conduct when travelling* (accessed on transport.nsw.gov.au on 9 September 2016)

Submissions

The Chief Investigator forwarded a copy of the Draft Report to the Directly Involved Parties (DIPs) to provide them with the opportunity to contribute to the compilation of the Final Report by verifying the factual information, scrutinising the analysis, findings and recommendations, and to submit recommendations for amendments to the Draft Report that they believed would enhance the accuracy, logic, integrity and resilience of the Investigation Report. The following DIPs were invited to make submissions on the Draft Report:

- Busways Pty Ltd

- SMC Pneumatics Pty Ltd
- Roads and Maritime Services
- Transport for NSW

Submissions were received from the following DIPs:

- Busways Pty Ltd
- SMC Pneumatics Pty Ltd
- Roads and Maritime Services
- Transport for NSW

The Chief Investigator considered all representations made by DIPs and responded to the author of each of the submissions advising which of their recommended amendments would be incorporated in the Final Report, and those that would not. Where any recommended amendment was excluded, the reasons for doing so were explained.

Appendix 2: Technical Specification 146



Roads and Traffic Authority of New South Wales

TECHNICAL SPECIFICATION 146

Bus Door Safety Systems

1 Scope

- 1.1 This Specification sets the criteria for the design of a bus door safety system which is intended to prevent passengers from being trapped by a door system in a moving bus.
- 1.2 A door safety system meeting the criteria in this Specification will prevent the bus from moving or stop it, if already moving, which in turn will minimise any chance of injury to a passenger. The door safety system will also limit the door closing force in some positions of the door.
- 1.3 This Specification applies only to buses fitted with a driver controlled door.

2 General Requirements

- 2.1 Each passenger access door shall be fitted with a door safety system as described in this Specification.
- 2.2 The door safety system shall operate:
 - (i) without any driver intervention,
 - (ii) whenever the engine ignition key is in the "on" position,
 - (iii) in the case of a stored energy system, whenever there is sufficient energy to operate the door (see Clause 2.8).
- 2.3 The door system may or may not automatically reopen when the door safety system is activated.
- 2.4 The door safety system shall be capable of detecting a 20 mm diameter rod. Note: the rod is intended to simulate the thickness of the wrist of a child.
- 2.5 The door safety system shall detect the rod at all vertical positions of the rod when placed on the door step up to 1500 mm from the door step.

ISSUED: 16 July 1997

- 2.6 When the rod is detected, the door safety system shall prevent movement of the bus or stop it, if already moving, by:
 - (i) mechanically or electronically securing the engine in idle mode and,
 - (ii) applying the brakes on at least one axle or by locking the driveline.
- 2.7 The control of the braking or driveline system shall be designed so that it will not cause the brakes or driveline mechanism to apply while the bus is in motion if there is no controlled operation of the door system. Note: This can be achieved by disarming the brake or driveline control once a preset speed (nominally 10 km/h) has been reached.
- 2.8 The operation of the door safety system shall not affect the compliance of the bus with any Australian Design Rule in particular, any braking rule. If the braking system uses stored energy, the brake system shall be preferentially supplied.
- 2.9 When the door is being closed, the steady force applied to an object which is located at any position up to 1500 mm above the door step shall not exceed 150N when measured from 20 mm to 300 mm from the fully closed position (see Appendix A).
- 2.10 An audible warning and/or visual warning shall be given to alert the driver that the door safety system has activated. If a visual warning device only is installed, it shall be located in the area of the driver's normal driving controls and be marked with or display the word "DOOR FAULT". An audible warning device which reproduces a recorded message shall say in English "DOOR FAULT".
- 2.11 When activated, the door safety system shall only be capable of being deactivated by a reapplication of the door control.
- 2.12 Any emergency door release control or other device fitted to a door system shall not be rendered ineffective by the installation of a door safety system.
- 2.13 The correct operation of the door safety system shall be capable of being readily checked without the use of special tools or dismantling any component. In the case of components which have "normally open" circuits, there shall be a method of automatically checking the integrity of the circuit.
- 2.14 The door safety system shall be capable of operating reliably under the full range of environments likely to be encountered during bus operation. This includes extremes of temperature and cleaning with pressurised water. Note: rubber or plastic components might perform differently over a range of temperatures such as, the flexibility of a door seal.
- 2.15 All components shall be located or designed to minimise the risk of passengers tampering with their operation.

3 Checking the door safety system performance.

- 3.1 Place a 20 mm diameter rod between adjacent door panels in a two piece door system or, in the case of a door closing to one side, between the edge of a door panel and the door frame.
- 3.2 The rod shall be perpendicular to the vertical edge of the door and the end of the rod shall protrude no more than 30 mm beyond the inside surface of the door (see Appendix B).
- 3.3 Close the door using the normal door closing control.
- 3.4 Hold the rod loosely so that when the door makes contact the rod will self-align with the door closing geometry.
- 3.5 Once the rod is detected:
 - (i) the door may or may not automatically reopen,
 - (ii) the engine shall remain at or go to idle speed and be incapable of increasing engine revolutions,
 - (iii) the vehicle shall be immobilised by locking the brakes on at least one axle or by locking the driveline,
 - (iv) an audible and/or visual warning shall be given to alert the driver that the interlock function has operated.
- 3.6 Open the door using the normal door control or in the case of an automatic opening door safety system, operate the door control to release the brakes or driveline lock and throttle control.
- 3.7 Operate the engine throttle and attempt to move the bus to ensure the brakes or driveline lock and throttle control have released.
- 3.8 Close and open the door again to ensure normal vehicle operation.
- 3.9 Check the rod sensing operation at all vertical positions from the rod sitting on the door step up to 1500 mm from the door step.
- 3.10 Using a suitable gauge, check the door closing force between 20 mm and 300 mm to ensure that it does not exceed 150 N at all vertical positions up to 1500 mm from the door step.

Note: In order to assess the correct performance of the door safety system it might be necessary to disarm or override some of the automatic functions.

4 Certification

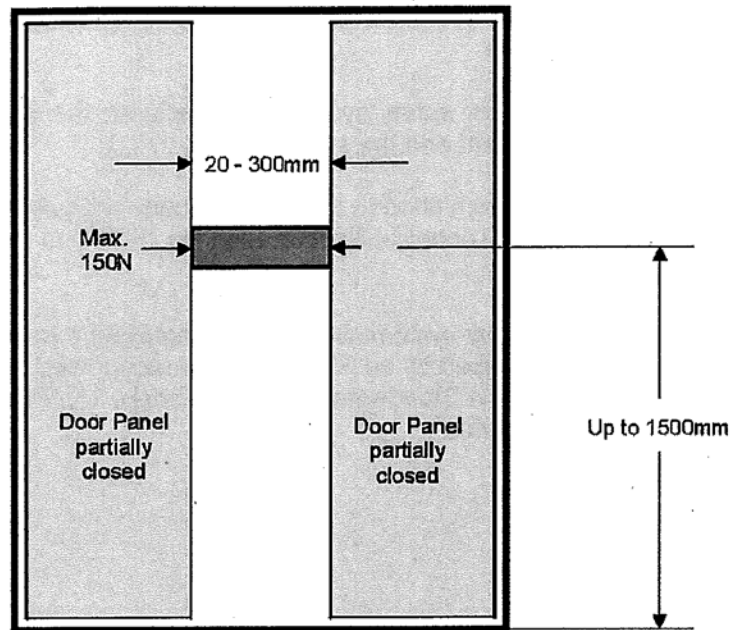
- 4.1 A plate or label made of durable material shall be fitted adjacent to the vehicle manufacturer's Compliance Plate. The plate or label shall display the following information:

The name of the door safety system manufacturer; the person who installed the door safety system and the statement,

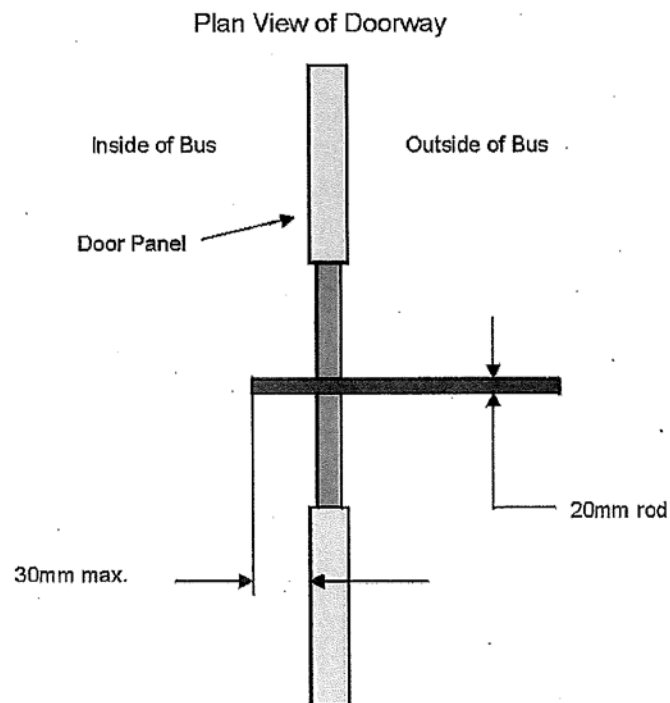
The door safety system fitted to this bus has been manufactured and installed to comply with RTA Technical Specification No. 146 "Bus Door Safety Systems"

- 4.2 Where the door safety system uses the braking system to immobilise the bus, a certification is required by an RTA approved recognised engineering signatory (see Vehicle Standards Information sheet 15, "Recognised Engineering Signatories").

Appendix A Closing force test



Appendix B Detection test



Appendix 3: Busways Safety Bulletin



Attention all Staff

03/06/2016

Bus and Passenger Safety Safety and Monitoring of 'No Standing Areas'

Bus Operators are reminded that it is Paramount that they continually monitor passenger behavior and compliance while on a Busways Vehicle, especially when in the luggage area and the 'No Standing Areas'.



In the event that a Bus Operator observes a passenger not adhering to the 'No Standing Area' requirements, the Bus Operator should:

- Stop the bus in the next safest location and 'secure' the bus by applying the Park Brake and putting the bus in neutral.
- Advise passengers that the bus cannot continue whilst passengers are standing in the 'No Standing Area'.
- Make a reasonable request of passengers to comply with the requirements.
- Contact Operations Control Centre in the event of non-compliance.
- Follow instructions given by Operations Control Centre.

Thank you,

David Collins
Director of Operations