TRANSPORT CANADA ROAD SAFETY

Review of Bus Safety Issues
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School Bus Operations

School buses are specifically designed and equipped to carry students to and from school and represent the most numerous type of bus[1]. There is access to good information on school bus crashes since Transport Canada and provincial governments examine most in detail[2]. They are defined in the Motor Vehicle Safety Regulations and in U.S. federal regulations.

School buses have unique safety considerations related to their design and operation. They are mostly dedicated vehicles carrying young people of many ages, sizes and stages of development. They make multiple stops, short runs in city environments and long runs on rural highways and side roads. They need to be examined very carefully when applying passenger protection standards.

Countries outside the U.S. and Canada do not have large fleets of dedicated school buses as we understand them in North America. The majority of useful experience with school bus operation is therefore local. This has led to comprehensive CMVSSs and FMVSSs specifically addressing school buses.

Provincial governments, the school bus operating industry, school boards and parents' associations have important roles in the development of those standards. The school bus operating industry consists of some large companies, 83 with revenues over $2 million[3], and many smaller companies. Most operate under contract to school boards, which therefore have a significant influence on school bus specifications. Operating companies and school boards operate under provincial/territorial regulations.

In crashes involving school buses during the ten years 1987-1996 there were eight school bus passengers killed. In the same ten year period there were three school bus drivers and 42 pedestrians killed.

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Embarking/Disembarking – Current Situation

School bus embarkation/disembarkation safety has been progressively addressed over the years. In 1993 and in 1994 there was only one pedestrian fatality, compared with seven, eight and eight respectively in the previous three years. In 1995 there were two but in 1996 there were five[4]. In 1996 and 1997 new related vehicle standards have come into effect, notably the stop arm and a comprehensive mirror arrangement to help drivers observe movement around the bus.

A new standard, CMVSS 131 (July 1996), requires stop arms on school buses. This complements the long-standing flashing red lights[5] and provincial traffic regulations that require other vehicles to stop when a school bus is embarking or disembarking passengers. CMVSS & FMVSS 131 are in harmony.

The four flashing red lights that warn other vehicles to stop are sometimes complemented by four flashing amber lamps to provide warning when a school bus is slowing down to embark or disembark passengers. There is an issue among school bus communities whether or not buses should be equipped with the eight lamp system. A recent Transport Canada Transportation Development Centre study evaluates four and eight lamp systems[6].

There is also discussion of installing reflective tape on school buses, as on large trucks, to help dark hour recognition by drivers of other vehicles.

An October 1997 amendment to CMVSS 111 has a new, much more comprehensive section on school bus mirror systems. A six-mirror system with defined fields of view is designed to help drivers see pedestrians close to the vehicle front and sides. The standard requires both flat-nose and long-nose buses to provide the specified field of view. The specifications are unique to Canada although there is a parallel new U.S. standard. It will take time to know the standard's effectiveness and how well it is accepted in use.

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Other Devices Developed for Safety Around School Buses

There are many other devices addressing the safe environment around school buses, some of them widely installed because of school board and operator interest in safety solutions. With the small number of casualties it is difficult to evaluate the effectiveness of individual solutions. Two major types of device can be identified – physical barriers and driver warning systems.

"Crossing control arms" are, according to a manufacturer, installed on half of all school buses in Canada/U.S. and are mandated in some states[7]. An arm rests along the front bumper until the bus stops. When the door is opened, the arm extends forward to form a barrier perpendicular to the front of the bus, preventing pedestrians from crossing out of view of the driver.

There are ideas for other kinds of physical barriers intended to help prevent children from falling under buses and being struck by wheels.

The second broad type of device warns bus drivers of pedestrians or obstructions close to the front and sides of the bus. Included are motion detectors, video cameras and other sensors coupled with warning systems and logic to minimize false alarms.

No existing or possible device is certain, by itself, to achieve a reduction in embarking/disembarking passenger injuries. The simpler ones may be useful in helping bus operators to take the best precautions. Ultimately the persons on the spot must take responsibility and any devices should serve to help in that exercise.

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School Bus Occupant Protection

In the ten year period 1987 to 1996 there were eight child (aged 18 or under) passengers of school buses killed in Canada[8]. Over the same period there were 3510 injuries[8], the majority being low severity[2].

The small number of incidents makes it possible to examine many of them in detail. A draft internal paper "Canadian School Bus Collision Summary 1989 – 1997" is based on reports by the multi-disciplinary collision investigation teams under contract with Transport Canada as well as on other information. The reports address significant school bus crashes that come to the attention of the teams, almost all major crashes in Canada. Similar comprehensive information is available from the U.S.[9].

A major conclusion is that occupant protection mechanisms provided in school buses according to CMVSS 220 "roof strength", CMVSS 221 "joint strength" and CMVSS 222 "passenger protection" function as designed. The seats are spaced and the seat backs sized to resist occupants being thrown around in an impact. A barrier is provided in front of the first row of seats. The seat backs and barrier are designed with a balance of energy absorption and strength.

A head impact area is defined together with a head impact protection standard that precludes, for example, simple overhead luggage racks. In other possible impact areas the joint strength standard reduces the possibility of sharp edges. The result is very few injuries inside school buses, even in severe crashes and those involving rollover.

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School Bus Structural Integrity

There are more structural integrity standards applicable to school buses than to other buses or other vehicles except passenger cars[10]. These standards work well according to available information[2]. They are, however, standards addressing typical bus construction. Continuing review of school bus performance is required to ensure that the safety intent is maintained with evolving bus design.

Modern buses have no difficulty complying with CMVSS 220 "roof strength" and with CMVSS 301 "fuel system integrity". Both seem to perform well[10]. The two other standards directly involving body structure, part of CMVSS 217 "bus window retention" and CMVSS 221 "school bus joint strength" also perform as intended but are relative rather than absolute standards and their importance can change with different bus designs. All these standards are in harmony with U.S. FMVSS.

Under part of CMVSS 217, school bus window frames must withstand an outward force representing possible ejection. The test is complete when the window glass, specified by CMVSS 205 "glazing", breaks, since there is no advantage in having a frame significantly stronger than the glass it holds. Not specified by standard, most Canadian school buses have opening windows with mid-height aluminium bars that help prevent ejection in the event of glass breakage.

CMVSS 217 also addresses emergency exits. Forces to open emergency exits from inside or outside are verified before and after the window frame test referred to above. The integrity of the surrounding body is affected by the standard up to the same point as the window frame, usually limited by window glass strength.

The strength of attaching hinges and latches is specified for only double rear doors, addressing van-type school buses with cargo-type doors, now rarely used in Canada[11]. In one recent crash involving a small school bus, not a van-type, the emergency door and frame were distorted and the emergency exit opened, allowing a passenger to be ejected[12].

The joint strength standard CMVSS 221 requires body joint tensile strength to be at least 60% of the strength of the surrounding material. In recent crashes there are few sharp edges of the kind potentially produced when joints separate[2]. Small buses, less than 4536 kg GVWR, are not subject to CMVSS 221 and there are other exceptions, such as ventilation, door and maintenance panels, that still, in rare cases, result in sharp edges[11].

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School Bus Emergency Exits

There are isolated fire incidents where exiting school bus passengers have had difficulty. There is a particular concern with respect to younger or disabled persons.

Both U.S. FMVSS 217 and CSA D250 have emergency exit requirements that go beyond CMVSS 217. Exiting in the event of fire involves both the emergency exit capability and flame retarding specifications for bus interior materials.

Flammability of interior materials, addressed by CMVSS & FMVSS 302 in harmony, has the objective of slowing burning to give occupants opportunity to safely exit a vehicle exposed to fire.

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Seat Belts in School Buses

There are few instances where seat belts would prevent injury in school buses. Even in those few instances it is not clear that seat belts are the answer. Good information for parents and other interested persons is necessary to support discussion on seat belts for school buses.

Seat belts for school buses have been a public issue since seat belts were widely accepted as a major safety solution for cars, occupants of which were, in the early 1970s, being killed at the rate of nearly 7000 per year in Canada. Many parents, parents' associations and interested people promote school bus seat belts consistent with mandatory use of child restraints and seat belts in cars, which have contributed to the reduction of car occupant deaths to less than 3000 per year.

In many instances seat belts would not have prevented the serious injuries that occurred in school buses. These involve direct intrusion into the bus of an object such as another vehicle or, for example, a steel plate from a passing truck. There are, however, individual instances where seat belts could have prevented injury. They involve rollover, ejection and impact with other passengers or the bus interior[2].

There are, then, cases where seat belts could enhance safety. The U.S. has installed seat belts in small school buses (less than 4536 Kg GVWR) since the mid 1970s. U.S. states New York and New Jersey install seat belts in all buses and Etobicoke in Canada also has them in all buses. New Jersey has specific requirements for seat belt use as well as their installation.

The opportunity for a decision whether to install seat belts arose in the mid 1970s when car seat belt use was becoming mandatory in Canada and school bus occupant protection standards MVSS 217, 220, 221, 222 and 301 were being developed. Wide based consultation led to the conclusion that it would not be practical for Transport Canada to require seat belts to be installed in school buses. This conclusion included small school buses (less than 4536 Kg GVWR)[13] even though the U.S. did then, and does now, require seat belts in those small buses.

Why have seat belts not been required in Canadian school buses?

Firstly the target cases for safety benefit are few, on average less than one fatality and possibly two or three serious injuries per year[14]. Seat belts are not necessarily the solution for those cases. The findings of the U.S. National Transportation Safety Board[15] and the National Academy of Science in late 1980s studies[16] could not support seat belts, despite some years of experience with small school buses so equipped and large school buses not. The NHTSA concludes that "School bus crash data show that a Federal requirement for belts on buses would provide little, if any, added protection in a crash" [16].

Secondly, the comprehensively designed passenger protection system introduced in 1980 by CMVSS 217, 220, 221, 222 and 301 works[2]. Transport Canada testing shows that superimposed seat belts introduce different potential hazards, such as neck and facial injury, unless seats are redesigned for a different dynamic[17]. The testing carried out to date has not considered all ages, sizes and physical developments of children riding in

school buses, the smaller and younger of whom would be recommended to use child restraints in cars. This becomes more of an issue as preschool children seem to be increasingly using school bus transport.

Seat belts could possibly diminish the existing passenger protection by being a potential cause of injury in a severe impact, for which the present passive passenger protection was designed and is effective. Some advocate three point seat belts to minimize such potential. Three point seat belts are significantly more complex and have their own safety problems, such as ease of use, which is necessary to encourage wearing, and safe fit for a wide variety of passengers.

Thirdly, even the best seat belts enhance safety only if properly worn. The feasibility of overall seat belt management is therefore a safety issue. A local school board deciding to install seat belts without a comprehensive program to ensure their proper use would, in the event of a potentially tragic crash happening in that jurisdiction, fail to realize the intended benefit.

Experience where seat belts are available, such as in Etobicoke, suggests that very young children will use them as instructed but that use diminishes into the secondary school age. New Jersey, with its mandated seat belt use, believes its use rate to be better than 50%. One major school bus crash since requiring seat belt use was inconclusive in providing information about the benefits of seat belts[18].

Cost of initial seat belt installation is almost certainly a minor factor compared with the cost of a new bus. Operational implications are more significant[19].

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Transport Canada's Approach to School Bus Safety

School buses are funded, specified and their operations regulated by provincial governments. In many cases more than one government department is involved. Transport Canada, with its regulatory responsibility for new school bus safety standards, seeks to develop school bus regulatory policy in consultation with provincial governments and provincial government stakeholders as well as with its own stakeholders, school bus manufacturers and the Canadian public.

Good public information is necessary to maintain an objective debate about school bus safety. There is already considerable information provided to an interested public by governments, school boards and the transportation industry. Because of the interest, distribution is potentially effective. Transport Canada seeks to contribute to the information available to parents and their organizations.

Harmony with U.S. standards needs to be considered in view of comparable safety experiences in both countries and a certain amount of industry integration. The U.S. NHTSA is launching a million dollar program to study school bus occupant protection. Phase 1 "Problem Definition", Phase 2 "Test Procedure Development" and Phase 3 "Testing and Validation" will lead to a report in the Summer of 2000. Transport Canada intends to participate with the U.S. program to ensure that Canadian standards are

maintained at the highest level based on a good fundamental understanding of the available knowledge of school bus occupant protection.

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Transport Canada Program – School Bus Passenger Protection

1. School buses are a Transport Canada priority for collision investigation. There are comprehensive reports on significant school bus crashes and summary reports at various intervals.
2. Transport Canada reviews its dedicated school bus standards and those of other agencies, particularly the U.S. NHTSA which regulates comparable school bus operations.
3. The Department participates on the long standing CSA D250 School Bus Committee which develops school bus standards and specifications that are adopted by many provinces.
4. Transport Canada defect investigators and standards engineers examine every individual school bus safety question for possible solutions.
5. School bus operator associations participate in regular National Public Safety Organizations consultation meetings with Transport Canada.
6. Transport Canada produces, along with other governments and public interest groups, school bus public information programs.
7. The Department participates with the U.S. in school bus passenger protection research and is planning involvement with the new program recently announced by NHTSA.

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Footnotes

1. Table 2: 1996 Canadian Bus Industry Information

2. Transport Canada draft paper "Canadian School Bus Collision Summary 1989-1997"

3. Statistics Canada "Passenger Bus and Urban Transit Statistics" 53-215-XPB 1996

4. Extact from TRAID, November 1998

5. Required for school buses by CMVSS 108

6. «Évaluation à bord des autobus scolaires de la sécurité de deux dispositifs de pré-signalement d'arrêt.» 1998, in final preparation.

7. "Safety Guard Crossing Control Arms", Specialty Manufacturing Company, 1998.

8. Transport Canada leaflet CL9801(E) "School Bus Collisions 1986-1995"

9. For example: NTSB/SS-87/01 "Crashworthiness of Large Poststandard Schoolbuses"; NTSB/SS-89/02 "Crashworthiness of Small Poststandard Schoolbuses"

10. See comment under "Crashworthiness".

11. Technical Memorandum "School Bus Emergency Door Retention Testing TM-ASFBE 97-01"

12. Transport Canada Case No: ASF2-1308

13. CMVSS 222 requires the same seat designs in small school buses as in large school buses.

14. The one fatality is from the TC leaflet CL9801(E). The injury number is derived from the leaflet and information in the "Canadian School Bus Collision Summary 1989-1997"

15. NTSB/SS-87/01 "Crashworthiness of Large Poststandard Schoolbuses" NTSB/SS-89/02 "Crashworthiness of Small Poststandard Schoolbuses"

16. US NHTSA information Seatbelts On School Buses (http://www.nhtsa.dot.gov/people/injury/buses/pub/seatbelt.hmp.html)

17. Transport Canada "Background Paper on School Bus Occupant Protection in Canada" TP8013 - 1989

18. These comments are based on information obtained in informal discussion.

19. Transport Canada "School Bus Seat Development Study" (TP8445) 1989.

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