

**VARIOUS REBUTTALS TO THE TRANSPORT CANADA 1984 CRASH TEST
KNOWN AS THE CANADIAN STUDY**

STATE OF VERMONT

Department of Education
Montpelier 05602-2703

To: School Bus and Passenger Safety Advocates
From: John L. Harvey, Consultant, Driver and Safety Education, Pupil Transportation
Subject: Rebuttal of the Canadian Study

Date: April 1, 1986

I've compiled various rebuttals to the Transport Canada 1984 crash test known as the Canadian Study. This study has been distributed throughout the United States by numerous opponents to the safety belt on school bus issue.

In helping local communities decide on a course of action, it is necessary that the decision makers have the opportunity to review the enclosed articles before making a decision on belts on buses.

The articles include the opinion of the following:

Doug Walker, Vermont Department of Education
Dr. Arthur Yeager, Physicians for Automotive Safety and Co-Chairman, National Coalition of Seatbelts on School Buses
Dr. John D. States, Rochester General Hospital
Dr. Russ Fine, National Spinal Cord Foundation
North Salem School District
Kathleen Weber and Dr. John W. Melvin, University of Michigan
National Highway Traffic Safety Administration

In addition I have enclosed a copy of the letter to the Denver Board of Education relative to liability issues of belts on buses.

Should you have specific questions on safety belts on school buses issue, please contact me.

Safety Belts on School Buses
A Closer Look at the Canadian Study

Compiled and Distributed By:

Office of Driver & Safety Educ. and Pupil Transportation Division of Basic Education Vermont
Department of Education State Office Building
Montpelier, VT 05602
(802 - 828-3126)

April 1986

January 1986

PUBLIC HEARING ON SAFETY BELTS ON SCHOOL BUSES - January 1986

Testimony For Seat Belts on School Buses

Doug Walker, Director

Division of Basic Education

Vermont Department of Education

My name is Doug Walker and I am Director of the Basic Education Division in the Vermont Department of Education. I'm here speaking on behalf of the Department in support of safety belts on school buses. The department has taken a supportive position requiring bus drivers to wear safety belts at all times, and also support the requirement that new class I buses be equipped with safety belts after January 1, 1987.

The Department of Education has studied the issue in great detail, prior to publicly supporting the use of safety belts on school buses last year. The Office of Driver and Safety Education and Transportation has studied accident reports and the research of individuals and organizations interested in school bus safety. The Department of Education has corresponded with school bus manufacturers; local, state, and federal transportation safety agencies; and consumer groups on this issue.

The Department provides a variety of educational materials to schools, school boards, administrators, parents, and teachers as schools prepare children to be responsible users of our highway transportation system. We must prepare our students to compete, contribute and cope in our modern society. When reviewing the program, objectives of traffic safety education it is evident the goals include:

- preparing every student for life-long learning
- developing necessary survival skills and the ability to cope
- developing appropriate social sensitivities on safety issues

To help concerned citizens deal with the safety belt on school bus issue, the Department has been distributing a packet of information on the use of safety belts on school buses. I would like members of the Committees to have a copy. This packet has been updated several times in the last year and a half. The Department provides this information so people can make informed, responsible decisions on the belt issue. In addition, I would like to highlight several key points for the committee's information. Last year only eight school districts had made a commitment to purchase belts on buses, however, an additional ten schools have made commitments this school year to buy belts on buses. John Harvey, the Department's Driver Safety and Transportation Consultant is here and willing to clarify specific concerns on this issue.

The three primary reasons why we support the use of seat belts in school buses are:

1) The educational value - To quote the American Academy of Pediatrics, one of the strongest advocates for seat belts on buses, "It has taken eight years, but fortunately in our country all 50 states in some way protect young motor-vehicle passengers by mandating the use of safety seats or belts in private-passenger automobiles. Many of our children are thus growing up with the habit of riding safely secured. That habit persists, enforced by law, and then on the first day of school where we literally and figuratively lose these children to an educational system that says it is proper

to ride unsecured in a moving motor vehicle. Two trips a day, every weekday, nine months of the year is a powerfully negative learning experience.”

The habit of wearing a seat belt can and will carry over into the family car and thus will be affecting the entire community. Furthermore, requiring children to ride in child restraint seats for the first four years of their lives and then putting them on a school bus to ride without a seat belt is hypocritical, as well as irresponsible. Children are vulnerable to injury on a school bus, just as they are in an automobile. We are confusing them with our double standards.

2) Better Discipline - Safety belts will keep children in their seats. This will eliminate much of the horseplay and running up and down the aisles, which presently is the major distraction for the bus driver. Drivers have reported that one of the surprising benefits of having seat belts is that children are much better behaved.

3) Safety - The use of seat belts on school buses will increase the safety of the children who are passengers. We feel that the studies which have been done and the statistics which have been gathered support this fact. Some people have drawn different conclusions on this point and have attempted to say that seat belts will not make children safer on school buses. We have been fortunate in Vermont, in that we have not experienced many tragedies. We can hope that we continue to avoid serious mishaps, but it is certain that seat belt use on school buses will increase passenger safety.

The Department of Education recommends to communities a five step process which includes:

Conduct a community meeting on the issue for parents, teachers, school bus drivers, and concerned citizens of the community.

Survey parents/community members on the seat belts on school bus issue.

Provide for training school bus drivers on safety belt education.

Establish a required use policy for bus drivers, field trips, when students are being transported in school buses equipped with safety belts, and other similar situations.

Commit the school to provide continued safety belt education by:

- 1) insuring that safety belts are properly installed and maintained
- 2) instructing students on how to use them
- 3) informing students of their importance
- 4) encouraging and monitoring use of safety belts on school buses

We are not suggesting that the proper use of seat belts on school buses can be implemented without some cost or related problems. It will require some changes for bus drivers and children riding buses. But we feel that when all of the factors involved are weighed against the positive outcomes, that the decision to require belts on school buses is a reasonable, prudent and responsible thing to do.

Thank you for the opportunity to share this information. I will try to answer any questions the Committee members may have.

Dr. Arthur L. Yeager, Chairman, Physicians for Automotive Safety
Co-Chairman, National Coalition of Seatbelts on School Buses

May 1985

ANALYSIS OF THE CANADIAN STUDY

The January 1985 Transport Canada report of school bus crash tests has been widely publicized as proving that seat belts should not be used on the large (Type 1) school bus and that the so called “compartmentalized” school bus seat without a seat belt offers better protection for children. Nothing could be further from the truth.

In the Canadian tests a large, a mid-size and a van type bus were subjected to severe 30 mph front end barrier crashes. On each bus there were six 5th percentile adult female anthropometric dummies, three belted and three unrestrained. From previous studies at UCLA and at East Liberty, Ohio it was learned that in such high force front end crashes belted dummies tend to pivot over their seat belts and strike their foreheads on the padded seat backs in front of them. Unbelted dummies on the other hand are thrown forward violently by the crash forces into the seat backs which they face. When measuring devices are placed by the researchers in the head and chest of these dummies, the belted dummies produce higher head readings and the unbelted higher chest readings. Experimentally, Head Injury Criteria (HIC) levels of greater than 1000 and Chest Accelerations of greater than 60 g. are generally accepted as sufficient to produce severe injury or death.

TEST RESULTS

Dummy Number	Location in bus	Seat Spacing	Belted	Unbelted	HIC	Chest Accel (g)
1	Front LH	533			*	60.4
2	Front RH	533			649	40.8
3	Centre LH	690			629	28.1
4	Centre RH	690			220	34.2
5	Rear LH	610			205	48.2
6	Rear RH	610			731	25.0
Large Bus – Bluebird - 66 Passenger						
Vehicle Wt			8147 kg			
Vehicle Velocity			48.8 km/h			
Vehicle Decel.			15 g			
Dynamic Crush			1371 mm			
Body Slide			775 mm			
* Data not valid due to technical problems						

The results of the Canadian test of the large bus are above. In this test crash of a 66 passenger bus the only dummy experiencing life threatening forces was dummy number 1 seated unbelted in the front left hand seat with a chest reading of 60.4 g. All belted dummies were well within acceptable limits. The bus met all current federal standards including Standard 222 for school buses.

Since it is well known that the Federal 222 seat offers no protection at all for passengers in side impact and no “whiplash” protection for taller riders in rear end crashes, and that the seat was developed primarily to protect against injury in front end crashes, the failure to protect dummy number one without a seat belt is of particular concern.

In this type of front-end test crash, as explained above, belted dummies will produce somewhat higher HIC levels than the unbelted dummies. In addition, the selection of the 5th percentile female which is just the right height to target the dummies head to the area of the seat back where the padding narrowly covers the metal bars of the seat and the use of the type 572 dummy which has been widely criticized for excessive HIC readings in crash tests severely prejudices these tests against seat belt use. In spite of all these test induced disadvantages, the dummies with the seat belt on the Bluebird Bus did remarkably well. On the other hand, in spite of the large area of the seat back to spread the forces, the unbelted dummy in the front seat would have experienced serious or fatal injury.

When film of the crash is viewed, dummy number 4, unbelted in the center seat, is seen to fly forward until its throat strikes the top of the seat back. In a high force frontal crash such as this the resulting throat injury would have been severe or fatal. It is conceivable that the HIC and chest readings were lower on this passenger because the throat and neck absorbed so much of the crash energy. Just how much force was so absorbed was not determined because, unfortunately, the researchers decided not to instrument the necks of the dummies.

Not unexpectedly, HIC levels in the mid size and van were higher. As the size of the vehicle crashed gets smaller, the crash pulse becomes greater. The forces on the dummies increase. As a result of these higher forces coupled with the stiff, targeted 572 dummy, HIC levels were increased. Further, it has been documented in the 1978 testing of school bus 222 seats in East Liberty that seats manufactured by the Thomas Bus Company consistently registered HIC levels 2.4 times greater than seats produced by the Ward Bus Company in comparative tests. Thomas seats were used in the mid size and van tests in Canada. The Coalition is convinced that the higher HIC readings in the smaller vehicles was the result of the high crash pulse, the height of the dummy, the stiffness of the type 572, and the use of a Thomas seat.

Investigation of real world accidents in van type vehicles with passengers wearing seat belts in 222 seats and forces approximating those used in Canada have not produced injuries of the head anticipated by the test data. The researchers themselves admit that they were confused by the head and chest reading in two of the three belted dummies on the van, calling their own results “inexplicable.”

When Canada implemented their standard 222, seat belts were not ordered on smaller vehicles as was done in the United States because of pressure from those who operate school buses. The Coalition believes that the protocol of these tests was influenced by a desire to support the decision not to place seat belts on small buses. No assessment by crash testing of the safety provided by the 222 seat can be considered a valid measure of passenger protecting ability (compartmentalization) unless the tests include side and rear impacts to simulate the real world of school bus accidents. Any test which measures frontal collisions only must be considered self serving.

The 222 seat was designed to protect in front end crashes, a job which it does reasonably well. The Canadian tests were designed to demonstrate this 222 seat in the best possible way, and, because of the high crash forces, the dummy height and stiffness, the Thomas seat, to show the use of seat belts on school buses in the worst possible way. In spite of these efforts, the results clearly indicate that the use of seat belts on large (Type 1) school buses as advocated by the coalition, provides superior protection to school children in front end crashes as tested in Canada as well as in all other accidents experienced by children in school buses.

LETTER TO SENATOR LEVY
CHAIRMAN, NEW YORK STATE SENATE

John D. States, M.D.
Chairman and Professor, Department of Orthopaedics
Rochester General Hospital
Rochester, NY 14621

December 23, 1985

The Honorable Norman J. Levy
Chairman, New York State Senate Committee on Transportation
The Capitol
Albany, New York 12248

Dear Senator Levy:

I appreciated being asked to participate in the 12/16/85 Hearing on Safety Belts in School Buses conducted by the New York State Senate Committee on Transportation. The focus of the hearing was on the relevance of the 1984 Canadian Crash Tests in which lap type safety belts were used to restrain one half of the anthropomorphic dummies seated in their experimentally crashed buses.

After review of the written report of these tests conducted by Transport Canada under the direction of Mr. William Gardner, and of the video tape widely distributed in the United States, I have concluded that the Canadian tests are not relevant to the United States and, particularly New York State. My reasons are as follows:

1. Anthropomorphic dummies as specified in Part 572 of the United States Department of Transportation Federal Motor Vehicle Safety Standards were used. These dummies do not accurately model the flexibility of the human spine, and particularly the spine of a child. The stiffness of the dummy spine induces excess velocity in the head by the time the head contacts the seat in front of a belted dummy. -The additional stiffness also prevents contact of the chest, shoulders and upper extremities with the seat in front. This contact would share loading and reduce the head accelerations and the Head Injury Criterion (HIC). The Part 572 dummy was recognized in the FMVSS in 1972 and has not been upgraded in spite of the availability of much more representative dummies: i.e. the Hybrid 3 dummy.

2. Adult injury criteria were used. The HIC of 1000 is almost certainly not applicable to children. Experimental studies have demonstrated that arterial vessel walls in the brain of children are significantly more resistant to tearing than similar adult tissues. The skulls of children are more flexible and elastic and better able to tolerate impact trauma than the adults. No consensus exists concerning a child's HIC but it is my personal impression that it is greater than 1500 and 2000 rather than the 1000 used for adult.

3.Children are more resistant than adults to impact injury in all parts of their body. Experimental and accident investigation studies reveal that the bones of children have greater tensile strength and are more resistant to fractures, that ligaments, muscles, and blood vessels of the peripheri have greater tensile strength. Field accident experience bears this out. Spinal cord injury is virtually unknown in children under age 14.

4.Seat backs used in New York State school buses are 28 inches high, 4 inches higher than seat back required under Federal Motor Vehicle Safety Standard 222. The additional height insures that the 5th Percentile dummies used in the Canadian tests will impact the vertical surface on the back of the seat rather than the top of the seat bark as occurred in the Canadian tests. The top of the seat backs of the Thomas buses used in the test are particularly stiff because of the presence of a pipe placed crosswise in the seat. This was mentioned by Mr. Gardner of Transports Canada at the 12/16/85 hearing.

5.The Canadian tests ignored the spectrum of accident configurations experienced by school buses in the real world. While completely reliable accident statistics do not exist for school buses because of the infrequency of school bus accidents, it is reasonable to conclude that approximately half of injury producing school buses are head on impacts, another third are rollovers and side impacts, and the remainder rear end impacts. Safety belts will give excellent protection to occupants in rollovers and side impact accidents. The belts will hold the occupant in place and prevent them from striking the roof or opposite side of the bus. In addition, safety belts will provide protection in head on impacts when pitch occurs. In the real world, occupants are frequently pitched upward as well as forward and thrown from their seats. This happened in the recent fatal accident which occurred Mahopac, New York on 10/15/85 when Paul Goodrow, Jr., was killed. This was an accident of minor impact severity and he was the only occupant to sustain significant injury. If he had been wearing a belt, he would have been held in place and not thrown out of his seat.

In conclusion, I believe that the installation of lap belts in New York State school buses will not increase the risk of injury for school children using the lap belts, but will actually reduce the risk. The educational benefits to the school children are the principal reason for the installation of seat belts in school buses. It is essential that children learn this habit, which in the future will almost certainly protect them from a disabling injury and, possibly, save their lives. Children are now entering school having worn child restraints while travelling in their parents cars. It is essential, that they can continue this habit while riding in our school buses.

I want to express my gratitude to you for carrying on the pioneering traditions of the NYS Senate Committee on Transportation in traffic safety legislation. I also worked with Senator Edward Spino and more recently with Senator John Cammerer. Enactment of the New York State Safety Belt Use law is a product of your leadership and the traditional dedication of the committee to highway safety for New York State and the nation as a whole.

Sincerely,

John D. States, M.D.
Chairnian, New York Coalition for Safety Belt Use, Inc.

Reference: Re - Child Injury Tolerances M. Degeammes, et al, "Exploration of Biomechanical Data Towards a Better Evaluation of Tolerance for Children Involved in Automobile Accidents", 1983 STAPP Car Crash Conference, Society of Automotive Engineers,
M.. Degeammes, et al, "Road Accident Epidemiology Among Children – Investigation at Marseille's Hospital", Society of Automotive Engineers #831667.

FORMAT

1. Transport Canada Video on school bus crashes
 2. Presentation by William Gardner, Head of Crash Worthiness Engineering, Transport Canada
 3. Comments by Jerry Palisi, Supervisory Highway Safety Management Specialist, National Highway Traffic Safety Administration
 4. Proponents of seat belts on school buses Five minute statement each Questions of Transport Canada
 - a. Dr. John States, Professor of Orthopedics, Univer'sity of Rochester School of Medicine
 - b. Carol Fast, School Bus Resource Person, New York State PTA
 - c. Dr. Joseph Greensher, Chairman, Accident & Poison Prevention Committee, American Academy of Pediatrics
 - d. Dr. Art Yeager, President, Physicians for Automotive Safety
 5. Questions by Commission members and staff
 6. Questions by Committee members
 7. Questions by those opposed to seat belts on school buses and agency questions
- State Education Department
- a. Robert Daggett, Executive-Assistant to the Commissioner of Education
 - b. Francis O'Connor, Coordinator, Educational Finance and Management Services, SED
 - c. Dr. Brian Walsh, Administrative]Director for Facilities Planning, SED
- Association for Pupil Transportation
- a. Michael Joyce, N.Y.S. Association for Pupil Transportation
- New York State Department of Transportation
- a. Raymond Gardesky, Director, Traffic & Safety, DOT
 - b. Martin Chauvin, Chief, Carrier Safety Bureau, DOT
- New York State Department of Motor Vehicles
- a. Jacob Ferro, Deputy Commissioner for Traffic Safety, DMV
 - b. William Rourke, Executive Director, Governor's Traffic Safety Committee
8. Five Minute Break
 9. Five minute closing statement by Bill Gardner and Dr. States

The University of Alabama at Birmingham
Department of Rehabilitation Medicine
Spain Rehabilitation Center
University of Alabama at Birmingham
Birmingham, Alabama

June 25 ,1985

MEMORANDUM

TO: Ms. Gloria Molina
Assemblywoman, Fifty-sixth District

FROM: Dr. Russ Fine
Professor and Co-Director, National Spinal Cord Foundation

RE: Canadian School Bus Safety Study

> Based upon all that is known about deceleration injuries and the inherent protection possible from proper restraint systems and appropriate packaging of motor vehicle occupants, it is absurd to dignify the contention that unbelted occupants (specifically children) are at lesser risk of physical injury than belted occupants. Of course, the three-point (viz. lap-shoulder type) passenger belt is safer than the two-point because the fulcrum and arc of upper torso travel (with fixed anchors or inertia reels) is markedly reduced. However, we must reject, summarily, the conclusions of this or any other study that concludes it is safer to be unrestrained than restrained in a vehicular collision... irrespective of "differences" between motor cars and buses.

> The ostensible comparisons are, in our opinion, of the apples and oranges genre'. The question as to whether to restrain or not restrain is ludicrous and those responsible for its promulgation simply know better... and, if they don't, they need to get out of the safety engineering business

That which constitutes the most appropriate restraint system and seat design (configuration, etc.) is the only appropriate question. The former question does an extreme disservice to automotive safety engineering as a discipline. It is an embarrassment irrespective of the veil of pseudo-scientific credibility in which it is clad.

The issues seized on but only casually alluded to by the anti-restraint advocates are clearly economic and pertain to such things as (1) "existing designs" [and the industry's interest in maintaining them as they are at present for economic reasons], (2) the larger question of responsibility for ensuring that students wear the seatbelts - especially small children [to escape the culpability/negligence issue], etc.

> The authors have, in our opinion, developed a 'logical sounding argument that is, in reality, predicated upon absurdities.

Moreover, the inquiry restricted the type of crash/collision to one described as a "severe frontal collision." Clearly, data from a singular type crash (which according to their own admission constituted barely more than half the crashes by type) should not and cannot be legitimately generalized to the spectrum of collision types in which any vehicle can be involved.

Their argument against belts flies in the face of the accepted practice of restraining airline passengers who are also very scrupulously "compartmentalized" (in keeping with the author's definition of compartmentalization) and who also are at risk of experiencing a deceleration type injury that is almost without exception, of the "severe frontal collision." variety (i.e. nose of fuselage into the ground or water).

Enormous attention within the flight-safety engineering community has been devoted to perfecting and mandating the use of lap type restraint systems for aircraft passengers (including children) who are subject to even more severe g loads and greater decelerative forces than those achieved by school buses traveling not at or near terminal velocity, but rather at or below a ground speed limit twelve to fifteen orders of magnitude below aircraft speed.

> It is our educated guess that a rather strong manufacturer's lobby has engaged the services of a consultant engineer... and since many of us have served as consultants, from time-to-time, we are painfully aware of the realities that consultants "prove, verify, demonstrate, document or determine" precisely that which they are paid to prove, verify, demonstrate, etc. It is the nature of the consulting game.

> If one reads the article carefully it becomes apparent the conclusions are equivocal and, based on the data, could have been opposite those espoused. It is merely a matter of interpreting data, accepting or rejecting design premises, previously documented research findings, dismissing as unimportant or inconsequential failed instrumentation, ignoring shortcomings associated with the ATDS, with the HIC, ignoring associated injuries, etc.

Unfortunately, it appears that a generation of excellent, scientific achievement - an entire body of information - has been conveniently ignored ... and in a word, "that ain't kosher." In my humble opinion, giants in the field such as John Swearingen, former Chief of the Civil Aeromedical Research Institutes Protection and Survival Section and Colonel John Stapp would not be amused that their pioneering efforts in this field have been dismissed without due consideration.

> We agree that current passenger packaging can and should be improved, because the basic design configuration of the school bus has changed very little, if any, since the first ones appeared many years ago. There is little doubt that recent design modifications have improved the inherent safety (i.e. have reduced risk of injury) of school buses. However, this should not be misconstrued to negate the need for the long-overdue re-design of passenger compartments, seats, seating arrangements, interior configurations), restraint systems (passive and active), etc.

> We enclose a copy of an article from this morning's Birmingham Post-Herald and one from the afternoon's Birmingham News. I spoke personally with the Chief of Police who stated unequivocally that most, if not all, of the injuries that occurred in this strangely coincidental crash would have been prevented (or their seriousness reduced) had the passengers been properly restrained with seat belts.

> There are other areas of the report that warrant criticism, but after a while it's more like beating a dead horse.

We are hopeful you and your fellow seatbelt/viz. lifebelt advocates will be aided by the information contained herein.

Good Luck ... you'll need it.

Concerned Parent Committee
No. Salem School District
No. Salem, NY

Nancy Bogel
Angela Eidelman (Design Eng.)
Box 72, No. Salem, NY 10560
Eileen Mendelsohn
Allan Mendelsohn

Fall of 1985

This report is prepared at the request of Dr. Stanley Toll, Superintendent of the North Salem School District. It is also intended as an appendage to the "Comprehensive Study of Ways to Increase the Safety of School Children in School Buses".

It is important to point out that the Canadian Government Report included three sections: A literature review, a field investigation and the crash test. The portion of the report which reviewed the available literature draws no conclusions. The authors of the report considered existing studies to contain insufficient data and documentation. The study's investigators researched the experiences of school districts who had installed seat belts on their school buses. They concluded that this evidence supported the use of seat belts. The third and central section consists of an analysis of the crash tests which had been conducted.

We shall address the Arvin/Calspan Crash Test Results by focusing on the actual data itself rather than the Report's conclusions. We shall examine all the information not just isolated portions of the data. We shall provide a fresh look at the material.

The dummies were placed in three buses; eight in a Type A and six each in a medium size and van conversion bus. Sensors were placed on the heads and chests of the dummies to record velocities and impacts. There was a suspicion that belting the dummies would increase the velocity of the heads of the dummies, so that in a crash they would receive head injuries that would be life threatening. Therefore, a formula was worked out that purported to indicate the threshold of such injury; proposing that numbers which exceed a 1000 HIC (Head Injury Criterion) would indicate such a traumatic injury. However, as the report itself indicated, "Certainly, a HIC of 1000 is probably not the best value for a limit of human tolerance for children. Unfortunately, the fundamental research necessary to provide a reliable head injury criterion for children had not been completed." (page 14)

Among the oddities of this test's circumstances we note that none of the belted dummies were placed in original equipment. All seating was reinforced and fitted at the site. All belted dummies were seated on one side, with unbelted ones across the aisle, at front, center and rear locations. "The use of one ATD per seat in these tests somewhat limits the scope of the results since different ATD kinematics may have occurred if two or three had been placed in each seat." (Canadian Report, page 51) Six dummies were of a size comparable to a small adult female and two, included in the Type A bus only, were the size of a six year old child.

The data includes an apologia for the possible or probably inadequacy of using the adult configuration for the tests, noting the probably difference in results of calculations due to the different “geometry” of children's bodies. Also noted was the inability to account, in the dummies, for the flexibility of human necks. The difference this makes in calculations, wherein the velocity of the movement of the head is very definitely concerned with flex and reaction, is not mentioned. It would seem that a thorough analysis of results would concern itself with such details. The engineers appear to be aware of this inadequacy, though they rather leave it alone, preferring to couch their conclusions in words of possibility such as may, might and could. They do state on page 70, under Conclusions, #8, “Further collection and analysis of such data should be pursued. In particular, the direction of impact with the bus and the type of injuries encountered should be documented more fully.”

The spacing of the seats is in three increments; 533 mm (approximately 22”), 610 mm (approximately 24 1/4”) and 690 mm (approximately 27 1/4”). The actual belting process is not described. The belted dummies experienced an almost universal “slide” of 254 mm (appx. 10 1/8”) during impact. One wonders whether the testing personnel thought it safe to assume that no occupant would position the seat belt in a good or normal fit. These were not retractable belts and the slide factor was built into the test, but not described or explained except as a description of the dummies behavior during impact. The close seating situations make this slide a considerable factor in the impact sensor reports. Again altering the calculations and therefore, logically, demanding some reservation in evaluating the oft quoted HIC values.

These often quoted conclusions of the tests largely ignore all other indications of injury presented by the test's data. Ignored are such factors as neck and chin contact with, “the area of the barrier or seat in front containing the structural steel tubing.” Also ignored are instances of the unrestrained dummies' neck, forehead ' chest and knees hitting the seats in front with force sufficient to break either the seatbacks or legs and to dislodge either the cushion in front or the seats themselves. Also ignored is the ultimate “disposition” of the unrestrained dummies. For example: 11 ... ended up laying in aisle-” (page 54) “The dummy then rotated to an upside down position and ended up resting on the door operating mechanism., (page 59) “ ... dummy was rotated to the right and rebounded into the centre aisle.” (page 61) “ ... the dummy ended up laying partially in the aisle.” (page 63) Where are the sensors determining the extent of internal and other serious injuries to these unrestrained dummies? The report of the disposition of the dummies is eloquent and seeing the film, invaluable, in demonstrating what actually happens in an accident!

A. Blue Bird Bus -- Type A

Two out of the five (40%) unrestrained dummies suffered probable serious injury from the compartment itself or from failure of the compartment to contain them.

B. Thomas Mid-Size Bus

100% of the unrestrained dummies suffered probable serious injury from the compartment itself or from failure of the compartment to contain them.

C. Campwagon Bus

100% of the unrestrained dummies suffered probable serious injury from the compartment itself or from failure of the compartment to contain them.

In summary, 8 out of the 11 unrestrained dummies (appx. 73%) suffered probable serious injury. We submit that the “Canadian” tests are, when taken in full, clear proof that by itself the

compartmentalization concept is inadequate to provide protection from serious or life threatening injury.

Researchers note the inadequacies of HIC values and other elements of the tests. No such apologia accompanies the actual description of the dispositions of the dummies, and we may safely draw our own conclusions simply by employing a reasonable understanding of the English language.

In conclusion, the time for testing the compartmentalization theory on our children has come to an end. The original intent of the 1977 safety regulations was to implement both the compartmentalization theory and Beat restraints. The AMA, the National PTA, the American Academy of Pediatrics and Physicians for Automotive Safety and other interested and informed groups support the belting of children in school buses. As concerned parents we urge the North Salem Board of Education not only to join in this support for seat belts on school buses but to implement their immediate installation.

Kathleen Weber, MA
John W. Melvin, PhD
The University of Michigan
College of Engineering
Department of Mechanical Eng. and Applied Mechanics
321 W. E. Lay Automotive Lab. N.C.
Ann Arbor, Michigan 48109-2121

Memorandum on Transport Canada School Bus Safety Study

January 23, 1986

TO: Colleagues concerned about Child Passenger Safety

The School Bus Safety Study, conducted by Transport Canada in 1984 and reported to the public in January 1985, is being used by opponents of belts on school buses to 'prove' that such belts would be dangerous for school bus occupants. We do not agree with the interpretation of the results presented by the authors nor with the secondary interpretations that are being widely communicated to the public. We believe that our collective experience of over twenty years in the occupant protection field makes us qualified to offer our opinions on the topic.

Although there are many questions related to the motivation for the study, the test procedures, the dummies, the significance of the measurements taken, and the validity of the judgements made, we will address primarily the problems of head and neck injury prediction as related to the dummies used. Our discussion will also be limited to the test and results of the large school bus crash.

By way of background, a single crash test using a large Blue Bird school bus was conducted. The bus was occupied by six 5th-percentile female dummies, which approximate the size and weight of a 14-year-old child, and two 6-year-old size dummies. Half the 5th-percentiles were restrained by lap belts and half were unrestrained, but both 6-year-olds were unrestrained. According to a spokesperson for the Road and Motor Vehicle Safety Branch of Transport Canada, the selection of

the larger dummy as the primary test device was due to the fact that teenagers were receiving the majority of the injuries in Canadian school bus crashes. The reason given for not including restrained 6-year-olds in the test was that more dummies were not available. Thus we have a situation in which it was known that unrestrained teenagers were already being injured in school buses, and an effort was being made to improve that situation. It is therefore curious that a conclusion from the study that “the passive occupant protection of the seating system ... functions as intended during frontal impacts and provides excellent protection for occupants” could be taken as closing the issue. Clearly the conclusion, if valid, is very limited in its real-world application. It is also unfortunate that one of the 6-year-old dummies was not restrained for comparison purposes, and it should be noted that the bus itself suffered some serious structural failures that affected the test results.

HEAD INJURY. The injury measure used is called the Head Injury Criterion (HIC), and the report correctly states that there is some question “as to whether or not a HIC value of 1000 is a conclusive measure of serious head injury, particularly for children.” Although the belted dummies did measure higher HIC values than the unbelted dummies, the highest HIC value was only 731, which is well below the-1000 limit and in the range found with the very best child restraint systems tested at the same impact speed. The reason for the higher values among the restrained dummies is also quite clear and supports the need for occupant restraints on buses. While the restrained dummy heads contacted the padded seatbacks (which, as the report indicates, could have been better padded), the unrestrained dummies hit the top of the seatbacks with their necks instead, where no load cells or accelerometers were mounted. It is interesting that one of the unrestrained dummies “rolled inboard and fell in the aisle, striking its head on the instrumentation box mounted on the floor.” This type of uncontrolled occupant motion cannot be tolerated in any public school transportation system. It should also be noted that a shorter belted dummy, such as one representing a 6-year-old child, would probably have missed the seatback entirely while still being safely retained in its seating position.

NECK INJURY. Because of the different interactions with the seatbacks between the restrained and unrestrained dummies, the neck was affected in different ways. As noted above, the unrestrained dummy necks interacted directly with the tops of the seatbacks, but the dummies were not equipped to measure the resulting loads and thus no reliable injury prediction can be made. When the restrained dummy heads hit the seatbacks, the heads rotated rearward causing neck extension (rearward bending) of varying amounts. The dummy in the seat with normal spacing experienced slight bending of the neck. The neck of the dummy in a more narrowly spaced rear seat bent approximately 75 degrees. Finally, the neck of the dummy in the front seat, which was even more narrowly spaced initially from a forward restraining barrier and was pushed considerably closer due to bus structural failure, bent rearward approximately 90 degrees. The report claims in its summary that “The neck extension of several restrained dummies was judged to be life threatening.” Nowhere in the report, however, is there any discussion of or reference to the biomechanical justification for this judgement. Furthermore, the analysis section, in referring incorrectly to “neck flexure’ and *flexion” (forward bending), states “There is, however, no criteria available to judge the possible severity of injury that could result from this bending.” The report points out that the dummy neck is unrealistically stiff but fails to also recognize that the torso is rigid. This has the effect of transferring the entire upper-body bending motion to the only flexible unit, the neck. The rearward bending of the head observed in these tests is also routinely observed in interactions of dummies with HPR windshields and certain airbag designs. We know from field experience that humans bond differently than these stiff dummies and do not tend to suffer “life threatening” neck injuries in these situations. Finally, the biomechanical research of H..J. Mertz

and L.M. Patrick indicates that the human neck can withstand neck extension of at least 80 degrees without injury.

CONCLUSION. We do not believe that the Canadian School Bus Safety Study can be used to draw the conclusion that the use of belts on recent-nodal large school buses poses a potential danger to the occupants. No cast can be made from the results of this test program that belted children will have an increased likelihood of severe head and neck injuries in frontal crashes. Although the best possible occupant restraint system would include a shoulder belt as well as a lap belt, which is the approach now being pursued by Transport Canada, this possibility is probably far in the future. In the absence of any definitive evidence to the contrary, we firmly believe that newly purchased large school buses should be equipped with lap belts to provide their occupants with protection similar to that available in the rear seats of automobiles.

CURRICULUM VITAE

Kathleen Weber, M.A.

Masters Library Science, University of Wisconsin.

16 years automotive safety, University of Michigan

10 years in charge of Research Library Automotive Safety 6 years research in occupant protection and child restraints

Dr. Melvin, PHD

PHD Theoretical and applied mechanics University of Illinois Research Human impact tolerance and occupant protection

Senior Research Associate University of Michigan

Associate Professor University of Michigan

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SAFETY BELTS IN SCHOOL BUSES

National Highway Traffic Safety Administration

Traffic Safety Programs

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In 1984, Transport Canada (the Canadian Ministry or Department of Transportation) conducted an extensive study of school bus safety which included a frontal crash test program for three different size school buses, comparable to post-1977 buses in the U.S. (Reference #12).

An excerpt from the report summary follows:

“This School Bus Safety Study indicates that careful deliberation must be exercised before deciding whether or not to add lap belts to existing designs of occupant protection systems found in today's school buses. The barrier crash test results showed that the potential for head injury in frontal collisions increased, when lap belts were employed.”

This conclusion was reached after the subject of school bus safety was investigated in considerable detail. The investigation included a review of existing literature, discussions with bus manufacturers and operators, and a dynamic barrier crash program. The crash program provided data and photographic evidence, not before available, to compare the reaction of belted and unbelted test dummies in a frontal collision.”

NHTSA has analyzed the results of the Canadian test and found them to be in general agreement with laboratory testing conducted within the United States. It should be recognized that the “compartmentalization” countermeasure was specifically designed to protect the occupant in frontal barrier tests, similar to those conducted by the Canadians. The low head injury readings for the unbelted dummies is indicative that compartmentalization performs as well in production buses as it did in the research tests which perfected the concept. The lap belted dummies also performed in a predictable manner in the Canadian tests. In NHTSA sponsored research on lap belted dummies in the automobile environment, lap belted dummies typically have higher head injury measurements than unbelted dummies.

In examining the Canadian tests, several factors must be considered. A 30 mph barrier crash force for a large bus is an unlikely occurrence. For example, a head-on crash between a large school bus and a full-size car, both traveling at 55 mph, would be less severe to bus occupants than the 30 mph barrier test. Also, only one size dummy was used which typically represents a junior high school student. The geometry for younger children would be significantly different with likely different results. Taken together, the results of the Canadian tests should be viewed with caution.