THREE-POINT RESTRAINT SCHOOL BUS SEATS IN NORTH CAROLINA

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A. Background

North Carolina Public Schools operate over 13,700 school buses transporting over 750,000 public school students daily (enrollment of 1.37 million). The state provides over 90% of the school transportation funding. The initial purchase of school buses is paid by the Local Education Agency (LEA) and the state pays for the replacement cost. The replacement cycle of a school bus is 165,000 or 200,000 miles (depending on the model year of the bus) or a maximum of 20 years. The average school bus replacement cost was approximately $65,000 in September, 2006 with an anticipated increase of at least $6000 for 2007 due to more stringent EPA diesel engine requirements.

California, Florida, New York, and New Jersey have state laws requiring safety belts in school buses. New York and New Jersey had school bus safety belt laws for many years, but the laws required that the school buses be equipped only with lap belts. Florida passed a state law in 1999, but the law did not specify whether a lap belt or lap/shoulder belt was required. (State regulations require lap belts on new school buses.) California is the only state with a law that specifies that lap/shoulder belts be part of all new school buses. New Jersey, Florida and California law requires students to buckle up. The New York law leaves the usage requirements and enforcement up to the individual school districts. A fifth state, Louisiana has a law on the books requiring occupant restraint systems, subject to the appropriation of funds. Due to the lack of appropriation, implementation has not taken place.

In January 2003, eleven North Carolina Local Education Agencies (LEAs) took delivery of 13 buses equipped with three-point restraint seats (lap/shoulder belt). These eleven LEAs volunteered to receive these buses in order to gain real-world experiences.

The LEAs which received these school buses are:

- Beaufort County Schools
- Brunswick County Schools
- Burke County Schools
- Cabarrus County Schools
- Caldwell County Schools
- Charlotte-Mecklenburg County Schools (2 buses)
- Johnston County Schools
- Lee County Schools
- New Hanover County Schools
- Stokes County Schools
- Wake County Public Schools (2 buses)

B. Equipment Cost

The thirteen school buses equipped lap/shoulder belts were purchased from Thomas Built Buses of High Pont, North Carolina. In 2003, the only school bus seat manufacturer of seats with “3/2 lap/shoulder belt seating” for conventional school buses was the C. E. White company. The combined additional cost for the thirteen buses was roughly $100,000 or $7,700 for each bus.

It is cost prohibitive and structurally problematic to replace seats on existing school buses with lap/shoulder belt seats. Seats with lap/shoulder belts and their anchoring components are designed to withstand higher load than the conventional seats without lap/shoulder belts. Additional engineering enforcements required make retrofitting unfeasible.

C. Bus Configurations

Most current school buses are equipped with 39-inch wide seats on either side of the aisle. This seat is designed to accommodate three elementary-age students in each seat or six students per row. At the time of the procurement, Indiana Mills and Manufacturing, Inc. (IMMI) offered the Safeguard Seat with two lap/shoulder belt seating positions on a 39-inch seat. The C.E.White Company offered a 45-inch seat with three lap/shoulder belt seating positions and either a 30-inch or 39-inch seat, each equipped with two lap/shoulder belt seating positions. North Carolina officials had two options regarding capacity:

1. Keep the 39-inch seat with two lap/shoulder belt-equipped seating positions on either side of the aisle. This would insure that students in all grades can be accommodated because it utilizes the same 19.5 inches currently available to high school students and actually provides 6.5 inches more seating space for younger riders.

2. Use 45-inch seats on one side of the isle and 30-inch seats on the other side of the aisle. This would allow five seating positions with lap/shoulder belts to be provided on each row – two on the 30-inch seat and three on the 45-inch seat. Each passenger, no matter what age, would have 15 inches of seating space – this is 3 more inches that what younger students have on a 39-inch seat, but 4.5 inches less than high school students have on a 39-inch seat.

In order to preserve as much elementary capacity as possible, the second option was chosen. This "3/2" seat configuration creates an aisle that is off-center compared with the traditional bus (see Figure1). Also note that because the seat restraint system must accommodate the shoulder harness anchoring location, the seatback height must be increased from 24" to 28". In fact, the seats provided in this study were actually 32".

Real world experience quickly showed that even though a 45" three-point restraint seat has three harnesses and is designed to seat three students, it is not possible to seat three high school-age students. Table 1 illustrates operating capacity changes for all grade levels when compared with conventional bus seats. For these thirteen buses, the elementary-age school capacity is reduced by twelve from 71 to 59. The middle school capacity may not be impacted if there can be three students seated in the 45" seat and two students seated in the 30" seat. If so, the capacity is unchanged at 59; if not the actual operating capacity may be reduced by 24 from 59 to 35. Because of the "tight" seating space, high school students choose to sit two (rather than three) students in the 45" seat and one (instead of two) in the 30" seat as long as the bus is under-loaded to allow this flexibility. When high school students sit 2/1 instead of 3/2, the capacity is reduced by 24 from the designed capacity of 59 to 35, and is reduced by 13 from the traditional non-belted bus capacity of 48.

The resulting operating capacity, which is below the number of seating positions for older students in the "3/2" configuration, is one of the major findings of this study, as shown below. Note, however, that utilizing "2/2" seating in order to preserve a workable middle and high school seating capacity sacrifices elementary capacity significantly. If buses are to be dedicated to schools of one grade level, then the seating configuration should be made accordingly. But, in order to share buses among schools serving multiple age levels, "2/2" is the most viable option..

Figure 1 - North Carolina school bus with 3-point restraint seats ("3/2 seating")

Table 1 - 3-point school bus seating capacity comparison for elementary, middle, and high school-age students - "3/2 seating".

Age Group	Conventional Bus without 3-pt. seats	Equivalent Bus with 3/2. seats	"Real World" Operating Seating Capacity (3/2)	Equivalent Bus with 2/2 seats	"Real World" Operating Seating Capacity (2/2)
Elementary	71	59	59	48	48
Middle	59	59	59 or 35	48	48
High	48	59	35	48	48

D. Parent and Student Initial Survey

A survey was conducted by the Center for Urban Affairs and Community Studies, North Carolina State University, one month after the thirteen buses were put in service. Below are findings from 148 respondents from fourteen schools:

- 58% of the parents were more positive after their children rode buses with lap/shoulder belts.
- Some parents noted that the (seat belt) laws that apply to cars should also apply to school buses.
- Parents expressed positive views as well as concerns with respect to the ability of belts to decrease the incidence of bullying on the bus.
- A few parents were concerned that the taller seats and narrower isles might create problems for larger children or make it difficult for the driver to see to the back of the bus.
- The vast majority of children expressed positive attitudes toward all aspects of lap/shoulder belt usage after participating in the pilot project.

- Teenage children were likely to experience somewhat lower levels of enjoyment from their ride to and from school than younger children with respect to the use of lap/shoulder belts.
- Girls were somewhat more likely than boys to agree that lap/shoulder belts would make them feel safer on the bus with respect to bullying.

E. Bus Driver and Administrator Interviews

Follow-up visits were made by the Institute for Transportation Research and Education, North Carolina State University, during the spring, 2005, to interview school bus drivers and school administrators after these buses were in operation for two years. Below are the issues brought up during these interviews:

- Drivers estimated that 50% to 75% of the elementary school-age students used the lap/shoulder belts.
- Lap/shoulder belt usage is nearly zero for middle to high school age students.
- Drivers generally liked the lap/shoulder belts. Most noted the longitudinal activities (fore/aft) were totally absent. However, they could not discern if this was due to the higher seatbacks or was attributable to the students being buckled in.
- It will be an added distraction for drivers to monitor and to enforce lap/shoulder belt usage.
- It is possible to enforce and to inspect lap/shoulder belt usage before the afternoon bus route prior to school departure. However, it is not possible for a single driver to enforce usage during the morning routes.
- Due to the higher seatback, drivers cannot see but the tallest students. This was especially a concern for drivers who transport middle and high school students.
- School principals saw a reduction in bus discipline problems.
- School principals do not think lap shoulder belts in the bus will increase school bus ridership.
- School district transportation directors assign these buses mostly to elementary schools due to capacity.
- Some transportation directors assign these buses strategically to address onboard discipline issues.
- LEA transportation directors did not report any incidents when the belts were used as weapon. There was one report of vandalism where a belt was cut.

F. Utilization, Behavior, and Enforcement Comparisons

Because it was difficult for drivers to monitor and to enforce lap/shoulder belt usage during the routes, additional controlled studies were conducted using an onboard camera to study out-of-seat activities and enforcement levels while swapping buses with and without lap/shoulder bets.. The findings were as follows:

- With enforcement, elementary students switched from buses with conventional seats to buses with lap/shoulder belt experienced significant reduction in out-of-seat behaviors. This reduction may reflect belt usage during the bus route.
- There were no significant differences in passenger behavior whether the lap/shoulder belt use was enforced by school administration or enforced by the driver alone.
- There was insignificant change in passenger behavior when students switched from a bus with lap/shoulder belts to a bus with conventional seats. This may be evidence that

passenger behavior is influenced as much by the driver as by the use of lap/shoulder belts.

G. Impact on Operations

Seating capacity as defined by the North Carolina Department of Public Instruction (NCDPI) is based on the number of seats available for an elementary-age student. Note that in this context 'capacity' refers to the total number of individual students that a bus can hold, each bus being fully seated with no 'standees.' 'Seat' refers to a single bench type seat that will accommodate a varying number of students depending on their relative sizes. Therefore, bus capacity is diminished when transporting middle and high school-age students due to their size.

It was clear from the interviews among LEAs participated in the pilot study that the 3/2 seating configuration was not conducive for transportation of high school-age students and not conducive for most middle school-age students. As described above, the current seating configuration for seats with 3-point restraints favors a 2/2 configuration if buses are to be shared among schools. The 2/2 seating configuration provides 48 seating spaces for all age students. The following analyses compare impacts to capacity, riders and fleet size assuming this capacity.

Using a combination of data from NCDPI, Transportation Information Management System (TIMS) and bus ridership data from the LEAs, ITRE evaluated school bus operating data from Beaufort County Schools, Chapel Hill-Carrboro City Schools, Cumberland County Schools, Lenoir County Schools, and Lincoln County Schools. These four school districts represent a good mixture of rural, urban, and rural/suburban areas.

(1) Impact to capacity:
In order to calculate the decrease in capacity between the NCDPI defined capacity of a traditional bus and the capacity of a school bus with lap/shoulder belt seats, school assignments for each bus had to be considered because the seat capacity varies among school age groups. The following assumptions were made in this analysis:

Table 2 – Maximum Single-Seat Riders

Age Group	Maximum per seat per DPI	Maximum per seat, 2/2 seating
Elementary	3	2
Elementary & Middle	2.75	2
Middle	2.5	2
Middle & High	2.25	2
High	2	2

Using the above assumptions and maintaining bus to school assignment, Table 3 illustrates the capacity loss if ALL buses in the four LEAs are replaced by 2/2 seating with lap/shoulder belts:

Table 3 – Capacity Loss

LEA	% Capacity Loss
Beaufort	26%
Chapel Hill-Carrboro	29%
Cumberland	24%
Lenoir	23%
Lincoln	26%
AVERAGE	25.6%

(2) Impact to riders:

Because not all buses transporting students are at their full capacity, the 25.6% average capacity loss reflects only capacity from the designed perspective. In order to assess the number of riders who will lose seats if their bus is switched to a bus with 2/2 seating equipped with lap/shoulder belt, ridership for each bus is studied. The resulting percentage of students who would lose seats for each LEA is shown below:

Table 4 – Seat Loss

LEA	% Utilization to DPI Capacity	% Rider Seat Loss
Beaufort	61	5.17%
Chapel Hill-Carrboro	60	6.61%
Cumberland	53	5.2%
Lenoir	64	6.5%
Lincoln	76	8%

These numbers are quite different from the percentage of capacity loss shown above because not all buses are filled to capacity. It is easy to see that a district with higher seat utilization will experience the most rider seat loss.

(3) Impact to fleet size:

LEAs use buses serving multiple schools. A traditional bus with sufficient capacity to serve an elementary school route may not be able to serve middle or high school routes due to the student per seat ratio being lower. With the school bus equipped with 2/2 seats with lap/shoulder belts, the bus is capable of carrying 48 students for all ages. This is a reduction of 23 elementary riders and 11 middle school riders. In order to analyze impact to school bus fleet size for LEAs, analyses were conducted to study the extent to which LEAs use buses among schools across grade levels and, all things remaining constant, to determine how many additional buses LEAs must purchase if all buses are changed to buses with 3-pt restraint seats.

Table 5 – Additional Buses Needed

LEA	# of Bus	Runs per Bus	# Additional Buses	% Fleet Increase
Beaufort	89	1.16	4.4	4.9%
Chapel Hill-Carrboro	41	2.76	6.27	15.3%
Cumberland	428	1.65	31.02	7.3%
Lenoir	129	1.16	8.08	6.3%
Lincoln	95	1.23	8.98	9.5%

If Beaufort and Lenoir represent typical rural North Carolina LEAs with a moderate number of buses being staggered or shared among schools, and also at a similar level of seat utilization, we would assume roughly a 5% to 6% increase in fleet size if ALL buses are replaced with buses with 2/2 configuration of with lap/shoulder belts.

If Chapel Hill-Carrboro represents small urban North Carolina LEAs with a high number of buses having staggered routes or being shared among schools and also with similar seat utilization, we foresee a potential fleet increase of 15% if ALL buses are replaced with buses with 2/2 configuration of with lap/shoulder belts.

In this analysis, Cumberland County will require the greatest number of additional buses due to the size of the existing fleet. It is important to note that urban districts such as Cumberland County comprise the majority of the state school bus fleet.

H. Estimated Replacement Bus Cost in North Carolina

In spring 2007, both Thomas Built Buses and IC Corporation provided estimates that a bus with the 2/2 three-point restraint seats will cost approximately $10,000 more than a bus with traditional seats. According to NCDPI, North Carolina is replacing 1,200 school buses during the 2007 state fiscal year and the projected annual bus replacement averages 860 buses for the next ten years. Based on these data, the cost impact for NCDPI to replace all new buses with 2/2 three-point restraint seats would be an additional $8.6 million dollars per year without considering the capacity loss.

Because in North Carolina, LEAs purchase new buses and NCDPI purchases replacement buses, the additional $8.6 million dollar per year cost does not include new buses LEAs will have to purchase in order to recover capacity loss. Most LEAs should able to recover loss in capacity initially by assigning new buses with 2/2 three-point restraint seats to routes with low riders. As years progress and the number of buses with 2/2 three-point restraints seat become more abundant, LEAs will face more challenges maintaining the same level of service without additional new buses. At that time, LEAs' ability to design efficient bus routes will determine the number of new buses they will need.