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ABSTRACT

This study has been undertaken to assess the magnitude of the school bus safety problem and to develop a plan to improve pupil transportation safety. The resulting report provides estimates of school bus population and daily usage, gives an account of injuries and fatalities that occur annually, and compares the safety records of school buses to passenger cars. Also provided is an analysis of the school bus vehicle, which reveals that three aspects of school bus design and construction are in need of improvement. These improvement needs are in the vehicle brakes, the structural integrity of the vehicle, and the seats. The operational aspect of State safety programs for pupil transportation including the driver, his training, the program administration, uniform State laws, and the use of buses for extracurricular activities are also reviewed. A series of recommendations concludes the report. (Author/MLF)

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PUPIL TRANSPORTATION SAFETY PROGRAM PLAN

PREPARED BY:
SCHOOL BUS TASK FORCE

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MAY 1973

U.S. DEPARTMENT OF TRANSPORTATION
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SUMMARY

School bus transportation is one of the safest available modes of transportation; it is approximately eight times safer than the family passenger car. Each year, however, approximately 85 children are killed in or around school buses. Catastrophic accidents such as the high speed rollover accident at Monarch Pass in Colorado in September 1971 and the school bus-train collision at Congers, New York, in March 1972 continue to focus attention on school bus safety.

The purpose of this study is to assess the school bus safety problem and to develop a program plan to increase the safety of pupils transported by bus.

Available data is fragmentary, but the information is sufficient to develop a reasonably accurate estimate of the number of children killed and injured both inside and outside of the bus.

A number of in-depth, multidisciplinary investigations of school bus accidents were analyzed. These provided information on the cause of accidents, cause of injuries and possible design modifications needed to improve bus safety.

The operational and human aspects of the pupil transportation system were also analyzed. These factors include the driver, fleet supervisor, pupil passengers, administrators and motorists.

The School Bus Task Force recommends the following:*

1. Seating standard be expedited.
2. Standard on the strength of structural joints of school buses be promulgated.
3. Standards No. 105 and 121 on brakes be implemented as soon as possible on school buses.
4. Compliance testing of school buses be performed.
5. School bus safety improvement project be initiated.
6. School bus data collection and analysis be required.
7. State safety program for pupil transportation be defined and supported by National Highway Traffic Safety Administration (NHTSA).

The program requires an eight man technical level of effort plus a contract support program of $260,000 for the next two years and $210,000 and $130,000 for the third and fourth years, respectively.

*See page 33 for more detailed discussion of recommendations.

STATISTICAL FINDINGS

Data collected by the Task Force show a summary of school bus accident statistics which include:

- Although school bus safety can and should be improved, school buses are 8 times safer than passenger cars—the school bus injury rate is 1 injury per 8 million passenger miles compared to 1 injury per million passenger miles for passenger cars.
- 19 million students are transported daily in approximately 260,000 school buses.
- School buses are involved in approximately 40,000 accidents during a one year period.
- Most of these accidents are property damage accidents but some do result in injuries.
- There are an estimated 8,200 injuries associated with school buses. Of these, 5,150 are to pupils while the remaining 3,050 are to occupants of other vehicles.
- Of the 5,150 pupils injured annually, only a small portion (7%) are injured as pedestrians while the remaining (93%) are injured inside the bus.
- By far the most frequent type of injuries inside the bus are facial injuries which account for over one-fourth of the injuries and are severe enough to require the services of an oral surgeon.
- Approximately 158 people are fatally injured in school bus accidents annually. Of these, 83 are pupils, 5 bus drivers and 70 occupants of other vehicles.
- Over two thirds of the pupil fatalities are classified as pedestrians, and the remainder as bus occupants.
- Half of the pupils killed as pedestrians were struck by school buses and the other half by other vehicles.

TABLE 1

Year	No. of Pupils	No. of Buses	Operating Cost	Cost Pupil $/Year	Consumer Price Index	Normalized Cost
70-71	19,191,483	245,608	$1,178,910,190	$61.4	–	–
69-70	18,752,735	239,973	966,135,767	51.52	1.277	$40.4
68-69	18,467,944	238,102	901,353,107	48.81	1.212	40.3
67-68	17,271,718	230,578	822,595,699	47.63	1.163	41.0
66-67	16,684,922	221,722	763,600,617	45.77	1.131	40.5
65-66	16,423,396	210,692	696,325,421	42.40	1.099	38.5
64-65	15,413,000	206,000	642,627,000	41.69	1.081	38.5
63-64	15,559,524	200,116	612,310,333	39.35	1.067	36.9
62-63	14,24[illegible]753	195,397	578,017,634	40.57	1.053	38.5
61-62	13,6[illegible],547	191,160	540,168,114	39.46	1.040	38.0
60-61	13[illegible]6,779	185,869	505,754,515	38.59	1.031	37.3
59-60	12[illegible]00,989	179,780	474,202,128	37.34	1.010	36.9
58-59	12,[illegible]21,372	176,222	441,402,595	36.72	.995	36.8
57-58	11,343,132	170,689	419,539,863	36.98	.975	38.0
56-57	10,683,643	164,853	382,751,975	35.83	.952	37.6
55-56	10,199,276	159,764	356,349,783	34.94	.933	37.5
54-55	9,509,699	154,057	329,035,047	34.60	.915	37.9
53-54	8,906,126	147,425	308,704,303	34.66	.895	38.7
51-52	7,697,130	N.A.	268,827,000	34.93	.860	40.6
49-50	6,980,689	115,202	204,611,283	29.31	.800	36.7
47-48	5,854,041	N.A.	176,265,000	30.11	.720	41.8
45-46	5,056,966	89,299	129,756,375	25.65	.627	41.0
43-44	4,512,412	N.A.	107,754,000	23.88	.560	42.5
41-42	4,503,081	92,516	92,921,805	20.64	.510	40.5
39-40	4,144,161	N.A.	82,283,000	20.10	.480	41.8
37-38	3,769,724	92,152	75,636,956	20.01	.470	42.5
35-36	3,250,658	N.A.	62,653,000	19.27	.478	40.3
33-34	2,794,724	77,042	53,907,774	19.28	.520	37.0
31-32	2,419,173	N.A.	58,078,000	24.01	.560	43.0
29-30	1,902,826	58,016	54,823,143	28.81	.590	48.9
25-26	1,111,553	N.A.	35,052,680	31.53	.611	51.4
21-22	594,000	N.A.	N.A.	N.A.	N.A.	N.A.

1.0 Pupil Transportation Background Facts

Pupil transportation is the largest transportation system in the country. In the second half of the 19th century, States started to require that all children receive some education and the need arose for the consolidation of school attendance centers. The first State law which authorized the use of public funds for pupil transportation was passed in Massachusetts in 1869. By the year 1900, eighteen States had enacted pupil transportation laws and by 1919 this type of transportation at public expense was legal in all States.

Some of the statistics on pupil transportation extend as far back as the 1921-22 school year. These statistics are in the form of the number of pupils transported at public expense, number of vehicles used and the amount of public funds expended in the operation of the pupil transportation system. Table 1 indicates an overview of the trends which these statistics have experienced over the years. In Table 1 the total cost of operation has been supplemented with the average cost of operation per pupil transported, which is a better indicator of the economics of the system.

The data show the system has experienced a steady growth through the years. The rate of growth for pupils transported remained constant at 200,000 pupils per year until 1947, when a sharp increase brought the rate to 600,000 per year. The rate has remained at this level since 1947 with a slight decline during the last three years.

The school bus population appears to have a very similar pattern of growth, at a somewhat lower rate, however, due to the continuous increase in the capacity (size) of buses used.

The chart (Figure 1) also indicates the yearly cost per pupil transported. The figures show that after an initial decrease, the cost per pupil has steadily increased from $19.28 in 1934 to $51.52 in 1970. However, when adjustments are made based on the consumer indexes for these two years and all years in between, this increase in unit cost becomes quite negligible. In fact, it suggests that the cost of pupil transportation has generally remained constant relative to the value of the dollar.

1.1 Pupil Transportation System And Its Uses

Table 1 clearly indicates the dimensions of today's pupil transportation system: it involves buses with an annual operating cost well in excess of one billion dollars.

1.1.1 Bus Registrations

The total number of school buses in use nationwide is not a well defined figure. This is due to the gross classification used in many States in registering buses, and also to the multiple uses of many of the vehicles. For the year 1970, the "Highway Statistics" publication of the Federal Highway Administration shows that there were 379,021 buses registered in all States; of these 90,271 were classified as commercial and Federal buses and 288,750 were classified as school buses and others. The National Safety Council publishes a figure of 290,000 school buses (*Accident Facts 1972*) while the National Association of State Directors of Pupil Transportation Services sets the total at 245,608 for the same period. There is no data available at the present time that provides an acceptable explanation for the difference of approximately 45,000 buses.

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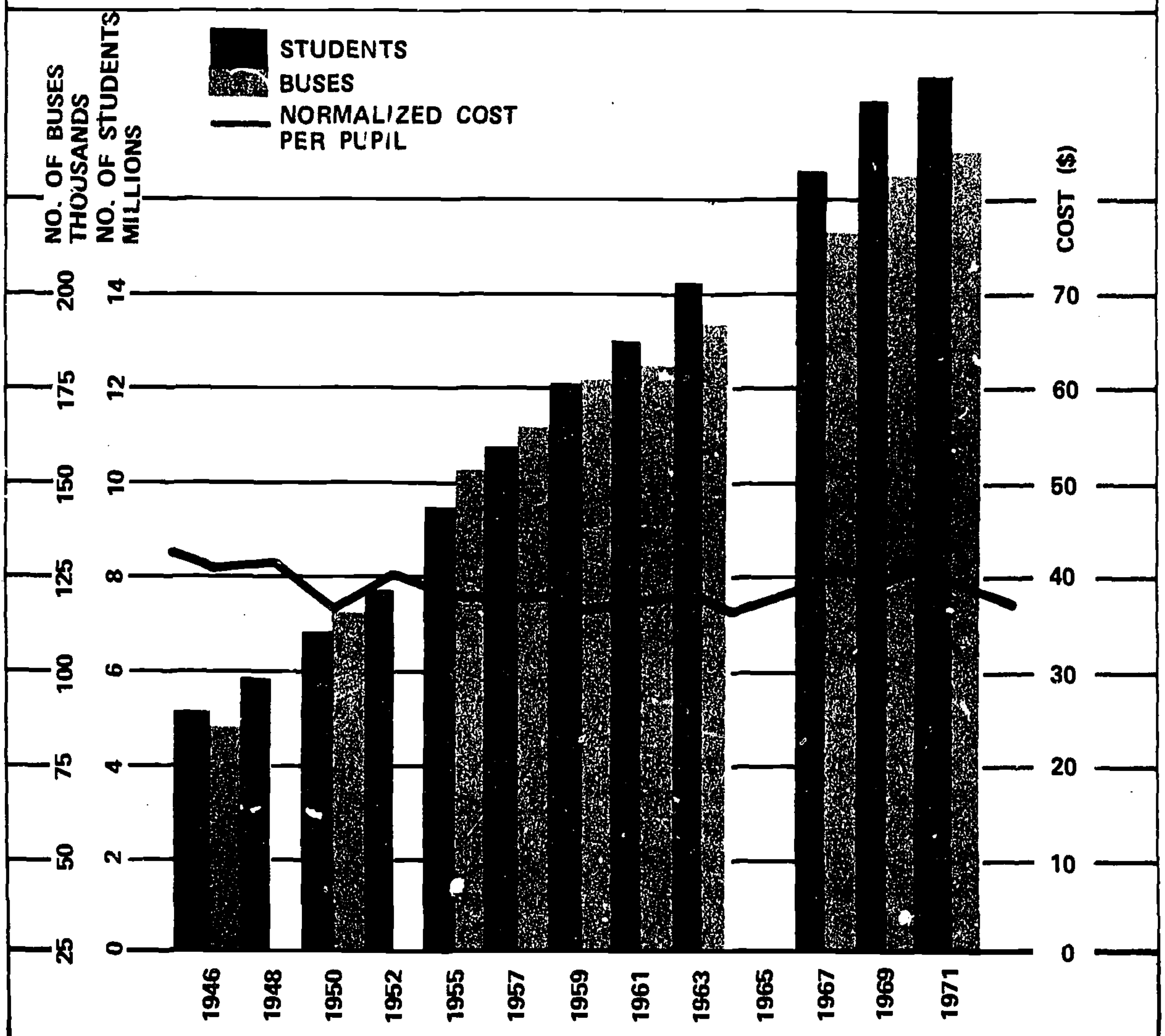
FIGURE 1. Pupil Transportation Growth and Cost



From these statistics we estimate that school buses account for approximately 262,000 units or 70% of all registered buses. Of these, 6,000 units are transit buses used for pupil transportation and 5,000 are buses used by parochial and private schools. The remaining 250,000-plus school buses constitute the fleet used for public schools. They fall under the direct responsibility of State and school authorities.

1.1.2 The Users

The users of the pupil transportation system are all the primary and secondary school children who qualify for this type of subsidized transportation. Figure 2 and Table 2 provide some pertinent statistics on this group of students.

Thus we learn that there are over 19 million students using pupil transportation. This constitutes approximately 38% of the student population and comes close to the total number of students who walk or use their bicycles to get to school (20,000,000).

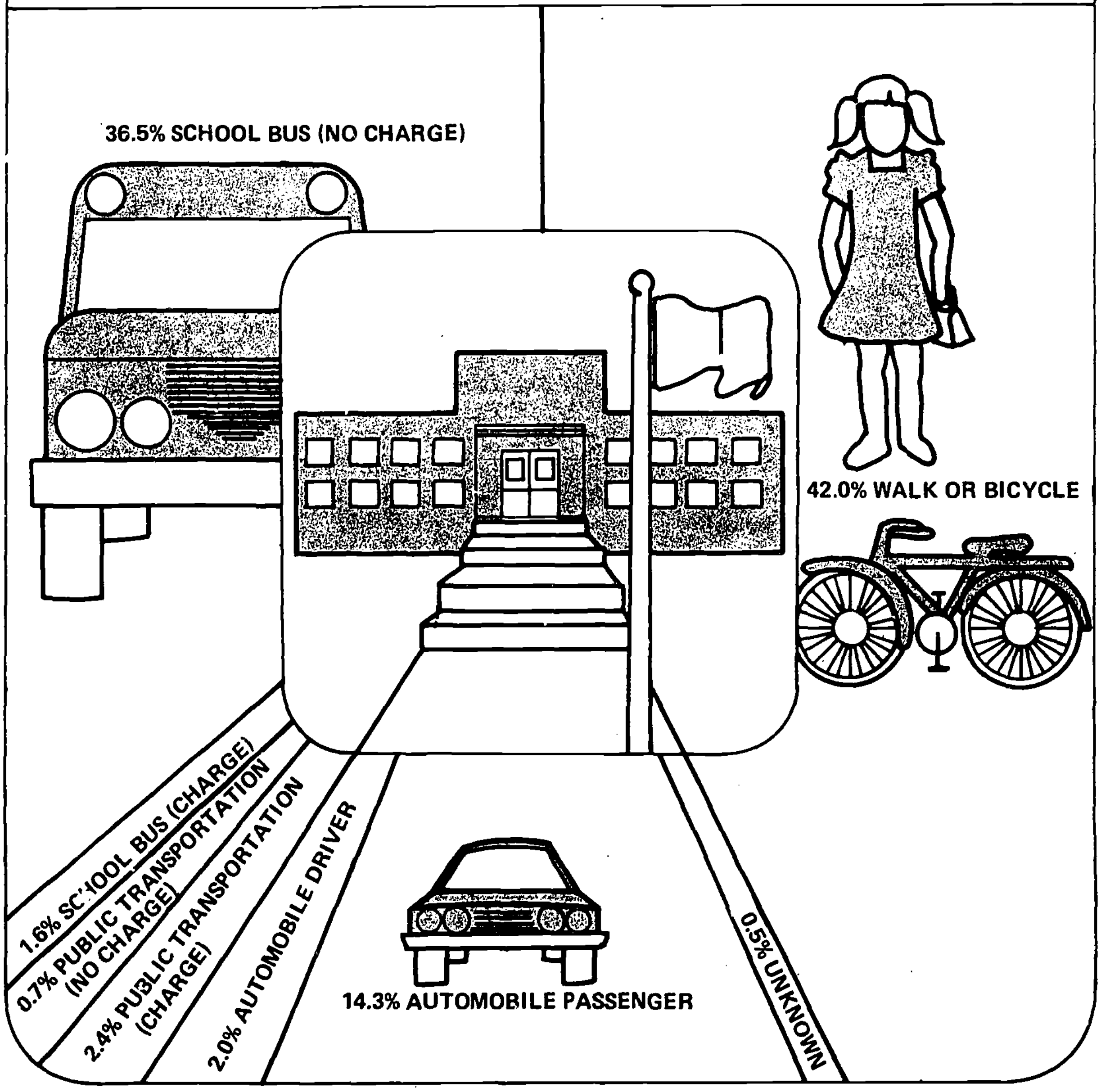
When these riding students are separated by grade level we find that 57% are in the elementary grades (K thru 6th), 17% belong to the intermediate grades (7th and 8th), and the remaining 26% belong to the senior grades (9th thru 12th).

When the same students, who ride school buses are classified by distance to school, we find that 4% live less than one mile and 63% live more than three miles from school. To better estimate the total travel of students in school buses, it was necessary to perform an extrapolation of the data contained in the

TABLE 2. No. of Students by Mode of Transportation & Distance From School (in thousands)

Distance From School (Miles)	MODES OF TRANSPORTATION School Bus	Public Transportation	Private Automobile	Walk/ Bicycle	Other Modes	Total
Less than 1	796	52	1,350	15,059	52	17,309
1.0 to 1.9	2,479	131	1,746	4,304	70	8,730
2.0 to 2.9	3,753	485	1,971	1,312	61	7,582
3.0 and over	12,002	846	3,073	276	65	16,262
TOTAL	19,030	1,514	8,140	20,951	248	49,883

FIGURE 2. Modes of Transportation Used by All Students



first and last columns of Table 2. We thus obtained the distribution of school children and distance to school which is presented in Table 3.

A graphic presentation of the contents of Table 3 is seen in Figures 3 and 4. These charts can be summarized as follows:

- There are nearly 50 million students enrolled in the primary and secondary schools.
- Thirty-eight percent, or approximately 19 million students, are transported at public expense in school buses.
- When school bus students are grouped on the basis of distance to school, the distribution has the characteristics of a normal curve with a range of one to six-plus miles, a mean of 3.6 miles and a standard deviation of 1.5 miles.

TABLE 3. Distance from School for Bus Riders

Distance From School (Miles)	ALL STUDENTS Number (000)	Percent	SCHOOL BUS RIDERS Number (000)	Percent	% Usage
0 – 1	17,309	34.7	796	4.2	4.6
1 – 2	8,730	17.5	2,479	13.1	28.4
2 – 3	7,582	15.2	3,753	19.7	49.5
3 – 4	6,285	12.6E	4,400E	23.0E	70.0
4 – 5	4,490	9.0E	4,000E	20.5E	89.1
5 – 6	3,741	7.5E	2,500E	13.9E	66.8
6 +	1,746	3.5E	1,102E	5.7E	63.1
TOTAL	49,883	100	19,030	100	38.1

E = Estimated.

FIGURE 3. Cumulative Distribution of
•All Students
•School Bus Students by Distance from School

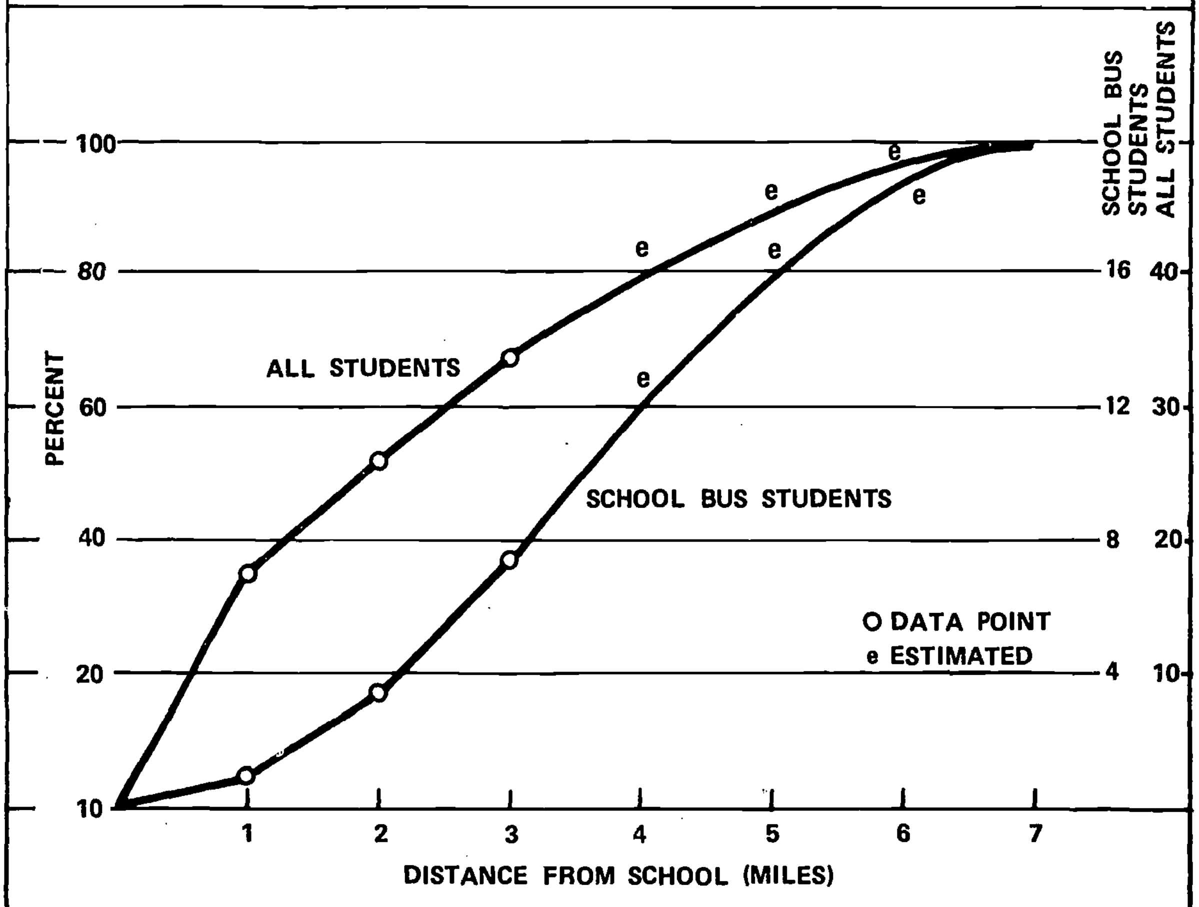
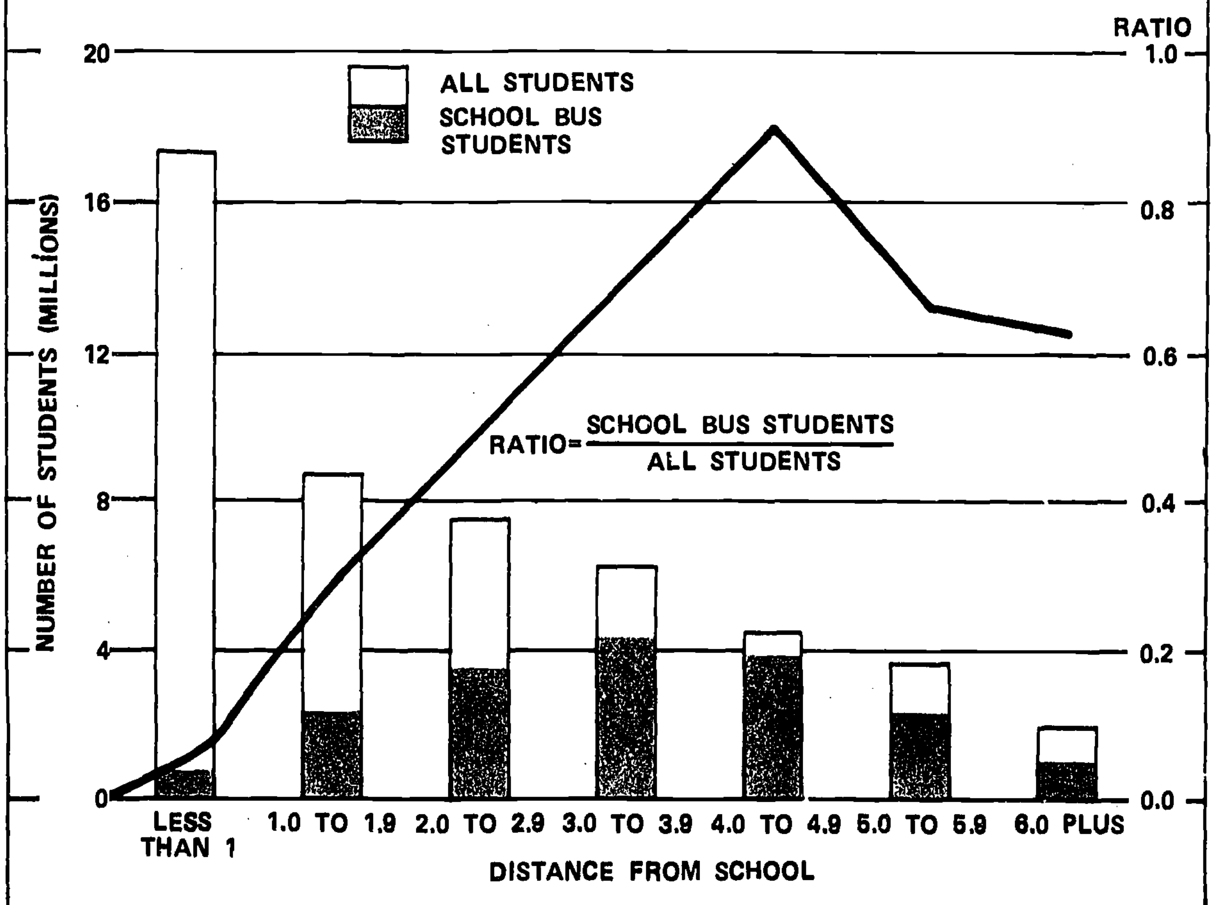


FIGURE 4. Number of Students Versus Distance
(Level of School Bus Usage Versus Distance)



1.2 ESTIMATES OF EXPOSURE

Exposure constitutes, in general, the reference base from which a measure of performance of a given system can be taken. Based on the system and on the type of performance that requires evaluation, a given set of exposure measures is selected which best satisfies the needs.

For the pupil transportation system, the safety performance of the entire system requires evaluation. Here we want to know what the safety performance level of this system is in absolute terms and relative to other modes of transportation. To accomplish this evaluation at the very general level, a minimum set of exposure measurements (estimated) must be obtained.

This minimum set consists of the following items:

- Number of school bus vehicles used.
- Total mileage driven (vehicle miles).
- Number of pupils carried.
- Total miles of travel by pupils (passenger miles).

Based on these exposure measurements the following performance type values can be obtained:

- Probability of a school bus becoming involved in an accident.
- Probability of a school bus accident occurring in a mile of travel.
- Probability of a pupil rider being injured in a school bus.
- Probability of pupil being injured in one mile of travel.

This set of gross statistics permits an overall safety performance evaluation of the school bus system. By obtaining similar measurements for other modes of transportation the safety performance of the school bus system can be described in terms relative to these other systems.

TOTAL MILEAGE – MEASURE OF EXPOSURE

The estimated number of school buses has been placed at 250,000 units, 20,000 of which are classified as station wagons, cars and vans (Type II).

In order to estimate the total mileage traveled by the school buses it is reasonable to assume that:

- Both types of vehicles (Type I & II) either service similar routes or are present in similar proportions in many States.
- A national estimate can be obtained from the data available in some of the States. (Table 4)

Based on the figure of 9,266 average annual miles per school vehicle for the 81,051 units available, we can estimate that the total vehicle mileage figure for the entire fleet is close to 2.31 billion vehicle miles and the total number of pupils is approximately 19,000,000. This mileage figure happens to coincide with the one published by the NSC (*Accident Facts 1972*) even though a discrepancy exists in the number of vehicles used by the system.

One other empirical verification of these estimates comes from the fact that the number of pupils transported, obtained by extrapolating the total in Table 4, is very close to the total number published by FHWA National Personal Transportation Study and based on census data (19,000,000).

DISTANCE TRAVELED – MEASURE OF EXPOSURE

The source of data for this estimate is the portion of the National Transportation Study which deals with the transportation characteristics of school children. Figure 3 and Table 3 represent a summary (in both graphical and numerical form) of the data contained in this report with some necessary extrapolations.

The procedure adopted in arriving at an estimate of the total distance traveled by all pupils on school buses is to:

- Estimate the average distance from school for pupils (3.6 miles).
- Multiply this estimate by a routing factor (1.6) which is used in converting this distance into miles of travel.
- Finally multiply by the number of pupils (19×10^6) and the number of trips (trips = 2×180 school days = 360).

TABLE 4.

	No. of Pupils	No. of Buses	Vehicle Mileage	Average Miles/Bus
Virginia	618,690	6,808	54,954,507	8,072
Michigan	775,407	8,825	86,205,572	9,768
Arizona	133,666	1,434	16,821,540	11,730
New Jersey	509,564	8,294	87,603,480	10,562
Iowa	282,288	6,483	55,535,763	8,566
New Mexico	109,702	1,629	14,350,500	8,806
Ohio	1,189,883	11,286	103,642,560	9,183
Wisconsin	421,008	7,007	81,511,081	11,632
Massachusetts	480,395	5,190	34,374,000	6,623
Pennsylvania	1,364,048	14,114	148,121,993	10,494
North Carolina	683,413	9,981	67,942,164	6,807
	6,568,070	81,051	751,063,160	9,266.5

By carrying out this procedure we have:

Pupil miles = 3.6 miles X 1.6 routing factor X (19 X 10^6) pupils X 360 trips = 40 X 19^9.

The value of 3.6 miles average distance from school was obtained by computing the weighted mean of the "Distance from School" column in Table 3. The estimate of the routing factor (1.6) is somewhat more complex and requires further clarification.

This value was derived by first estimating that the average number of routes serviced by one bus is 1.4. This estimate is based on very little data but its value appears very reasonable, because it leads to an acceptable average number of pupils per route of 54 and an average route length of about 18 miles. A higher value than 1.4 would lead to a lower number of pupils per route and a shorter average route.

Based on the utilization value of 1.4 and the number of buses estimated at 250,000, the total number of school bus routes can be estimated at 350,000. The total yearly bus mileage (2.3X10^9) is used to arrive at the 18 mile average route length, while the total number of pupils 19X10^6 is used to obtain the ave age number of 54 pupils per route.

TABLE 5. School Bus Statistics (As Published in N.S.C. Accident Facts)

Year	No. of School Buses	Annual Bus Miles (10^6)	No. of School Bus Pupils (10^6)	No. of Bus Accidents	FATALITIES				INJURIES		
					Pupils on Bus	Pupils Pedest	Others	Total	Pupils	Others	Total
1971	290,000	2,300	20.0	47,000	35	50	65	150	4200	1400	5600
1970	280,000	2,200	19.5	42,000	25	50	65	140	3900	1500	5400
1969	275,000	2,150	19.0	39,000	25	50	65	140	3900	1500	5400
1968	260,000	1,950	18.0	37,000	25	50	65	140	3600	1400	5000
1967	250,000	1,900	17.2	33,000	25	35	60	120	3200	800	4000
1966	225,000	1,800	16.5	34,000	15	35	80	130	3800	1200	5000
1965	220,000	1,750	16.0	32,000	15	35	80	130	3700	1300	5000
1964	200,000	1,700	16.0	10,700	15	35	40	90	3700	1100	4800
1963	192,389	1,675	15.1	9,969	11	30	37	78	3533	1067	4600
1962	190,753	1,650	13.4	9,246	17	32	53	102	2906	1356	4262
1961	186,765	––	12.8	9,279	38	27	NA	NA	2153	NA	NA
1960	175,000	––	12.5	9,908	19	31	NA	NA	2067	NA	NA

By analyzing the present routing procedure, the empirical conclusion was reached that pupils are being transported only during 60% of the route trip mileage. This would place the furthest students at a distance of 10.8 route miles from school. The ratio of 10.8 route miles to the 6.8 distance miles from school is what yielded the value of 1.6 for the routing factor.

SUMMARY OF EXPOSURE ESTIMATES

- Number of Buses = 250,000
- Number of Pupils = 19,093,000
- School Bus Mileage = 2.3 billion
- Pupil Miles = 40.0 billion

1.3 School Bus Accidents

Accident data are by far the most important information that must be obtained in order to perform a comprehensive review and evaluation of the safety performance of the pupil transportation system.

Generally, a report is filed on each motor vehicle accident which results in an injury or produces damages in excess of a minimum limit.

School bus accidents are no exception. In fact, every time a school bus is involved in an accident, two reports are filed, one by the police, the other by the school authorities.

Based on the amount of available information on school bus accidents, we can see that very little has and is being done with these reports. A few States do attempt some type of analysis but in all instances the reports reflect the low level of effort which is placed on such analyses.

In 1968, the Southwest Research Institute (SRI), under a Government contract, attempted to compile a "Statistical Summary of School Bus Accident Data." SRI's efforts yielded only an incomplete set of very general information. The inability of SRI to accomplish the task was entirely due to the unavailability of existing data. The contractor was fully aware of the existence of school bus accident report files and ultimately learned that most of the information contained in these files was not and could not be made available for national use. Two of the strongest recommendations in the final report were:

- The development and adoption of a uniform accident reporting procedure, and
- The yearly compilation, by each State, of a Standard School Bus Summary Report similar to the one suggested by the contractor.

Unfortunately, neither recommendation has been carried out, therefore preventing any substantial improvement in the availability of facts in the area of school bus transportation.

Under these circumstances, we find that the only source of national statistics on school buses is *Accident Facts* published annually by NSC. The data contained in these booklets have been used to compile the information in Table 5 and the graphs in Figure 5. Table 5 shows that in 1971 school buses were involved in 47,000 accidents, resulting in 150 fatalities and 5,600 injuries. The fatalities are classified as pupils on buses (35), pupils as pedestrians (50), other nonpupil (65). The injuries (5,600) are subdivided into pupils (4,200) and others (1,400).

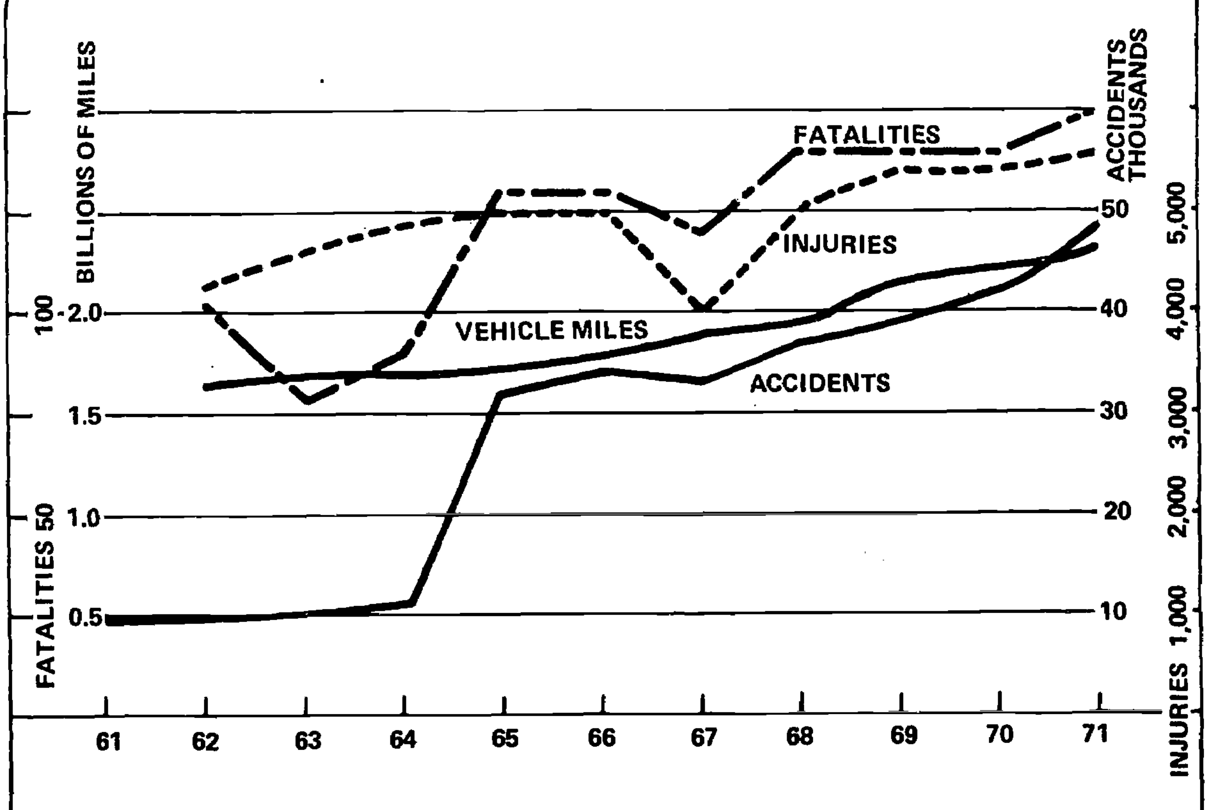
All of these figures are estimates and are subject to questioning. The total number of school bus accidents (47,000) was presumably obtained by extending to the entire country the same rates (per bus) found in those States in which complete reporting of school bus accidents takes place. Some of these States are California, North Carolina, Kentucky and Ohio. In these four States we find that 16% of the school buses are involved in accidents. The approach of extending this rate to all buses nationwide is quite acceptable, but since we differ with the NSC estimate of total number of buses in use, our estimate for total number of accidents in 1971 is 40,000.

There is less disagreement with the estimate on fatalities even though our estimate is 158. When we classify the school bus fatalities for the school year 70–71 we find that of the 158 fatalities 17 were pupils on the bus, 33 were pupils who were run over by the bus, 33 were pupils who were run over by other vehicles, 5 were bus drivers and 70 were occupants of other vehicles involved.

Reliable statistics on injuries are not as readily available on a national basis.

It appears that the estimate of 5,600 total injuries in accidents involving school buses, as published in *Accident Facts*, is lower than the

FIGURE 5. School Bus Accidents, Vehicle Miles, Injuries and Fatalities by Year



sum of the actual partial count of reporting States. In fact, by using fairly reliable estimates of injuries for those six large States that did not report to NSC, we can actually count approximately 8,200 nationally reported total injuries, 5,150 of which are pupils.

There is some doubt that this total represents all injuries. The problem of under-reporting, so evident in the totals for all types of accidents, is certainly present, on a lower scale, in injury data. Different approaches could be used to estimate the overall total and different results would be obtained. Since there is no sound basis for arriving at this estimate, we prefer to accept the figure of 8,200 with the implied acknowledgment that the actual figure is higher. Of the 5,150-plus pupils who are injured in school bus accidents, no nationwide information is available on the source of injury or level of injury. Fortunately, summary reports were found for every school bus injury accident which occurred in the State of New York during the 1966-67 school year. These accidents accounted for 650 injuries, 300 of which were suffered by pupils. By focusing on the injured pupils, we find that only 21 (7%) were pedestrians while the remaining 282 (93%) were bus occupants. If we were to extend the same proportion to the estimated national totals, we would obtain a national estimate of 360-plus pedestrian injuries with the remaining 4,800-plus injured inside the bus. As to the type of injuries that occurs in the bus, a survey conducted by the American Society of Oral Surgeons established that 1,350 school children in school buses required the services of an oral surgeon during one school year.

At this point we can summarize the school bus accident statistics as follows:

- School buses are involved in approximately 40,000 accidents during a one year period.
- Most of these accidents are property damage accidents but some do result in injuries.
- There are an estimated 8,200 injuries associated with school buses. Of these, 5,150 are to pupils while the remaining 3,050 are to occupants of other vehicles.
- Of the 5,150 pupils injured annually, only a small portion (7%) are injured as pedestrians while the remaining (93%) are injured inside the bus.
- By far the most frequent type of injuries inside the bus are facial injuries which account for over one-fourth of the injuries and are severe enough to require the services of an oral surgeon.
- Approximately 158 people are fatally injured in school bus accidents annually. Of these, 83 are pupils, 5 bus drivers and 70 occupants of other vehicles.
- Over two thirds of the pupil fatalities are classified as pedestrians, and the remainder as bus occupants.
- Half of the pupils killed as pedestrians were struck by school buses and the other half by other vehicles.

By combining these accident statistics with the previously stated estimates on exposure, we can obtain a general measure of the safety performance of the pupil transportation system.

The first measure to be considered is the probability of a school bus being involved in an accident. The ratio of accidents (40,000) to number of buses (261,000) shows that 16% of the buses are involved in accidents, or one in six. All vehicles combined show that one in four is likely to be involved in an accident.

The ratio of accidents to vehicle (bus) mileage, yields an accident involvement rate for buses of 1.75 involvements for every 100,000 miles of travel. The same rate for all types of vehicles combined is approximately 2.4.

The second measure listed was the rate of injury to the pupil. This rate can be expressed both in terms of number of pupils and number of miles. By dividing the number of pupils injured (5,150) by the total number of pupils using school buses (19 million) we find that one pupil out of 3,700 is likely to be injured in a school bus during a school year. The same rate for all vehicles combined is one person out of 100.

The estimated number of annual pupil miles is 40 billion. Using this estimate, a rate of one injury per 8.0 million pupil miles is computed. Based on an average vehicle occupancy (FHWA estimate) of 2.2 passengers per car we find that the same rate for cars is about one injury per 1.0 million passenger miles.

Arriving at similar comparative rates for fatalities is more difficult because the fatalities associated with school buses have completely different characteristics than those for other types of vehicles.

The number of 1970-71 school year fatalities experienced inside the buses is low (17) when compared to the number of pedestrians (66) and other vehicle occupants killed. We shall refrain from computing fatality rates for school buses for two important reasons:

- The numbers are small and subject to large variations.
- These rates would not provide a reasonable measure of performance of school buses relative to other vehicles.

We shall therefore limit the analysis of school bus fatalities to the actual count and with the general interpretation that pedestrian fatalities account for most of the pupils killed in pupil transportation. (Table 6 summarizes all of these statistics.)

We should also mention the type of collisions in which school buses are usually involved. The four major types of collisions and the relative frequency of each is shown below:

1. Collision with other motor vehicle in traffic – 75%.
2. Collision with parked motor vehicle – 11%.
3. Collision with fixed object and run-off road – 12%.
4. Collision with pedestrian – 2%.

The trends followed by the school bus accident statistics are presented in Figure 5. This figure shows that the correlation between accident, injuries, fatalities, and vehicle miles has remained constant in the last few years. This implies that the steady increase in the number of accidents, injuries, and fatalities is mostly explained by the increase in the utilization of the system.

TABLE 6. Summary of Accident Statistics

	SCHOOL BUSES	ALL VEHICLES
ACCIDENT INVOLVED VEHICLES	40,000	28,000,000
NUMBER OF VEHICLES	250,000	113,000,000
ACCIDENT INVOLVEMENT RATE/VEHICLE	0.16	0.25
NUMBER OF VEHICLE MILES	2.3×10^{9}	1.2×10^{12}
ACCIDENT INVOLVEMENT RATE/V.M.	1.75×10^{-5}	2.4×10^{-5}
NUMBER OF INJURED OCCUPANTS	4,800	2,000,000
NUMBER OF USERS	19×10^{6}	200×10^{6}
INJURY RATE/USER	2.5×10^{-4}	100×10^{-4}
NUMBER OF PASSENGER MILES	40×10^{9}	2.4×10^{12}
INJURY RATE/PASSENGER MILES	1.2×10^{-7}	8.3×10^{-7}
VEHICLE OCCUPANT FATALITIES	17 (20%)	44,100 (80%)
PEDESTRIAN FATALITIES	66 (80%)	10,600 (20%)

2.0 The School Bus

2.1 Vehicle Structure

In its report of a gradecrossing accident at Waterloo, Nebraska, the National Transportation Safety Board (NTSB) concluded that the structural assembly of school bus bodies might be inadequate. That accident which occurred on October 2, 1967, showed that major elements of the school bus body had clearly separated under severe crash forces resulting from a collision with a train. The separations occurred at points where fasteners used to assemble many elements of the school bus were few and widely spaced.

A second accident investigated by the NTSB occurred at Decatur, Alabama, April 23, 1968. In this accident, the school bus brakes failed at the top of a long hill. The driver was unable to control the bus and ran off the shoulder at a turn at the bottom of the hill into a deep, eroded gully. The forward upper right-hand section of the bus body was destroyed as it struck exposed tree roots, rocks and a fencepost. Four fatal injuries occurred, two near the collapsed forward portion of the bus structure, two at unknown seat locations.

In addition, several passengers suffered lacerations attributed to contact with exposed sharp edges of the bus interior sheet metal. The distortion of the upper right-hand front structure of the bus caused the interior sheet metal, particularly the ceiling panels, to fail at the joints, exposing sharp metal edges which may have contributed to some of the reported injuries.

The exposure of the sharp edges of the interior roof panels was made possible by the very wide spacing of the securing screws which are used to fasten the sheet metal edges to each other and to the roof bows. This wide spacing of fasteners does not allow the sheet metal to transfer the loads developed in a crash to the main body structure. Consequently. as the structure collapses, sharp edges of the sheet metal panels are exposed. The NTSB report implied that the collapse of the bus body might not have been so complete had all the ceiling panel joints held.

Another accident occurred on November 19, 1968, in Huntsville, Alabama, when the brakes failed as a school bus was descending a hill. The bus ran off the road after failing to negotiate a turn and rolled over. The rear portion of the body struck a tree which penetrated the passenger compartment at the last row of seats. The right rear seat was torn out killing one occupant and seriously injuring the other.

The rear section of the bus body separated neatly from the forward section, with very little deformation. There was a very wide spacing of rivets used in the construction of the body shell. Close observation of the accident showed that rivets had pulled through the parent material or through the panel edge. Analysis of this bus indicates that the penetration of the tree into the rear section of the bus would have been reduced if the fasteners had been sufficient to transfer a significant portion of the load into the next section.

In a runaway crash at Monarch Pass near Gunnison, Colorado, on September 11, 1971, driver inexperience, unfamiliarity with the vehicle, and lack of proper emergency training were the major causes. The bus uncontrollably careened down a steep grade and eventually overtook the slower moving traffic that occupied both lanes of a two-lane highway. To avoid an impending crash with this traffic, the driver veered the bus into a gas station driveway, traveling at a calculated speed of 70+ mph. The bus spun sideways and then rolled over two and a half times before coming to rest.

Structural damage was severe. All supporting side posts failed and the roof collapsed to the level of the seat backs. Two passengers were ejected at the beginning of the second complete rollover, and 37 of the remaining 46 occupants were ejected during the final one-half roll of the bus. Eight members of the Gunnison High School junior varsity football team and their assistant coach were killed, and 29 others were injured in the accident. All fatally injured occupants were either totally or partially ejected from the bus.

A number of possible structural modifications were recommended in the Monarch Pass report, including:

a) Add two body/roof bows, one forward of the front door, and the second at the rear of the bus around the emergency exit, to increase the structural strength and protect the door egress passages.

b) Specify minimum requirements for the method of anchoring the bus body to the frame.

c) Modify construction techniques which reduce the load carrying strength of structural members through improper welding.

d) Increase the section modulus of side/roof bows.

e) Extend side bows below the floor level and secure with a gusset to increase the torsional rigidity of the bus superstructure and protect the gas tanks.

f) Mount the outboard side of the seat to the sidewall of the bus so that the seat will act as a gusset between the floor and the sidewall thereby increasing the rigidity of the superstructure.

g) Adhere to the NTSB recommendation to increase joint efficiency if body manufacturers continue to use numerous short longitudinal panel sections.

h) Other school bus design recommendations were made with regard to fuel tank location, prevention of fuel leakage, the securing of seat cushions and removable panels.

The National Transportation Safety Board is investigating an accident involving the collision between a train and a school bus at Congers, New York, on March 24, 1972. This accident resulted in five fatalities and injuries to forty-five bus occupants.

Failure of the driver to stop at the crossing (apparently unaware of the oncoming train) was the fundamental cause of the accident. The 83 car freight train powered by three diesel locomotives impacted the school bus at an estimated speed of 25 to 30 mph and carried the bus 927 feet from the crossing before it stopped. This impact resulted in gross disintegration of the school bus and left the bus wrapped around the front of the locomotive. Twenty-three occupants were ejected when the rear section separated immediately after impact. An additional four were ejected as the train came to a halt. Two of the latter were ejected on to the tracks and fatally injured as the train passed over them. The National Transportation Safety Board concluded that "the construction method employing relatively few widely spaced rivets and other fasteners throughout the body of the school bus appears to have contributed to the large-scale disintegration of the school bus body and chassis."

In each of these accidents, two involving collision between a train and school bus and three in which the school bus rolled over, the Safety Board has indicated that the school bus structure was inadequate. Based on these accident investigations, it appears that there is definite room for improvement in the design and fabrication techniques used by the school bus industry.

One suggested modification is the NTSB rivet spacing recommendation. The rivet patterns used to join sheet metal panels do not comply with standard design procedures. Improvement in the rivet patterns could reduce the likelihood of exposing sharp edges caused by the separation of sheet metal panels during a crash and would also provide some improvement in structural integrity. This recommendation is discussed in more detail in section 2.2.

A complete evaluation of the school bus structure of today's buses is in order. While it is true that domestically produced school buses are quite similar in construction, subtle differences do exist in the basic structure between manufacturers. The section modulus of the roof bows vary as does the metal gauge or thickness of the metal structure and panels. Some bus bodies use numerous short longitudinal panel sections, others use long continuous sections. Variation in welding, high shear fasteners, rivets, bolts, etc. used in joint construction is yet another factor in body structural integrity that influences the bus design and method of manufacture.

One approach to establishing improved structure of the school bus would be to incorporate into a single unit the best of the several construction methods now practiced by the industry. Testing and evaluation of this unit would establish a level of performance which could then be translated into a meaningful federal regulation to control structural strength of school buses.

2.2 Structural Joints

The Vehicle Equipment Safety Commission, in Regulation VESC-6, Minimum Requirements of School Bus Construction and Equipment, specifies body construction requirements. Two significant sections in this specification apply to the school bus body structure. The first section:

5.3. The bus body, including all of its components and reinforcements, shall be of sufficient strength to support the entire weight of the fully loaded vehicle on its top or side if overturned. The body shall be designed and built to provide impact and penetration resistance into the passenger compartment. The deflection of the body after testing in accordance with the code must not exceed the following measurements:

A. Deflection at center of roof bow	3.00 inches
B. Deflection at each side pillar at window sill	1.00 inches
C. Deflection at center of floor	.40 inches

The second:

5.6. Strength of Structural Joints of School Bus Bodies. It is the intent of this section to insure that all structural joints within bus bodies which employ discrete fasteners, including those between heavy gauge members and those which join panels to panels or panels to heavier structures, achieve a significant proportion of the strength of the parent metal, so that all available panel materials are capable of serving as part of the structure. Accordingly, in all joints of the above named types which employ discrete fasteners such as rivets, screws or bolts, the pitch of fasteners shall not exceed 24 times the thickness of the thickest material used in the joint. Alternatively, for any method of joining such structural members, it shall be demonstrated by calculation that the strength of such joints is at least 60% of the tensile strength.

Section 5.6 is referenced in Safety Recommendation H-72-30 issued by the National Transportation Safety Board on September 22, 1972. The Safety Board has recommended the NHTSA "expeditiously" adopt this requirement for specifying strength of structural joints of school buses. It should be pointed out at this time that section 5.6 of VESC-6 presumes that the panel thickness is adequate in the first place. That is, the panel itself is capable of withstanding a certain amount of load under crash conditions. Panels are designed, in some instances, as nonstructural. Such panels have "snap" fasteners which facilitate easy and rapid removal for "quick" access to equipment. These are not intended to carry a structural load and presumably would be exempt from the standard.

Section 5.3 of the regulation addresses itself to the performance of the school bus body structure. It simulates to a very limited extent, the performance of the vehicle structure when overturned or on its side. It does not, however, simulate the dynamics of the crash condition to which the bus would be subjected in a rollover accident.

Analysis has shown that the school bus which experienced a complete roof failure in the Monarch Pass tragedy, in all probability, could meet the body structure requirement of 5.3. That is, it could support its own weight when overturned. However, the dynamic loading of the bus structure resulting from this severe rollover incident was several magnitudes higher than the loading requirements of Regulation VESC-6.

Again, joint efficiencies of 60%, 80% or even 100% would be of no avail in preventing the total roof failure of this particular bus when subjected to a crash of this type. Unless the basic structural strength of the load carrying members is adequate for the crash conditions imposed, joint efficiency is superfluous.

In summary, the improvement in the rivet pattern could reduce the likelihood of exposing sharp edges caused by separation of sheet metal panels during a crash, but it is unlikely that this requirement alone will significantly improve crashworthiness of the bus.

It may be acceptable practice to use the "snap-on" panel, which has a very low joint efficiency, provided that the panel edges are not sharp and are rounded off. Such panels would not contribute to the structural strength of the bus, but would help in reducing injury.

An important question to be answered is whether or not NHTSA should adopt section 5.6, joint strength, as a standard. As pointed out by the NTSB, Regulation VESC-6 ". . . when implemented by the States, would require that all school buses under State purchasing authority have substantially increased strength of structural joints." If adopted, this regulation would provide improved protection for children riding on school buses. Forty-four member States have endorsed Regulation VESC-6 which will apply to school buses manufactured after October 1, 1972. The regulation, however, is only a guide; individual States will have to take action to establish the requirement for buses sold in their States. It is expected that a considerable amount of time will pass before the States adopt the requirements of section 5.6 unless a Federal Motor Vehicle Safety Standard is enacted.

2.3 Pupil Seating And Restraint Systems

NHTSA has conducted studies of injury modes in school bus crashes. Full-scale crash tests were conducted by the University of California, Los Angeles, under Contract FH-11-6971, School Bus Seat Restraint. It is evident from this and other work on this problem, that by preventing ejection from the bus, and providing a passive protection system including well-padded, high-backed seats, the severity of most injury modes can be eliminated or greatly reduced.

NHTSA has already taken action to prevent ejection in the form of Federal Motor Vehicle Safety Standard No. 217, Bus Window Retention and Release. In addition, a notice of proposed rulemaking on seating systems for buses was recently issued. This standard will provide a high level of crash protection in most school bus crash situations, and will emphasize fully passive protection. The bus manufacturer however is given an option to install an alternative restraint system using seat belts equipped with a warning system. If this option is used, stringent performance requirements for the seat are reduced somewhat.

The fact that today's buses were not designed for the installation of safety belts presents a sizable problem. Most current bus seat anchorages, as well as many of the seat frames, are not structurally adequate to withstand safety belt loads. Consequently, belts cannot be attached directly to the seats. Passing the belts through the seat to the floor structure, as in automobiles, is not practical because the belts would pass through the space occupied by the feet and legs of other passengers seated to the rear.

A far greater problem in the case of school buses and certain public buses equipped with a relatively low-backed seat with a rigid frame around the top edge, has become apparent during a number of bus crash tests. Indications are that occupants wearing lap belts could be more seriously injured in a head-on collision than those not wearing belts at all. The occupant wearing a lap belt is restrained in such a manner that it is likely his face or neck will impact the top of the low-backed seat in front of him while the unrestrained occupant would more likely impact the flat back surface of the seat with his upper torso receiving the majority of the impact force.

A further problem arises because of the broad range in size of school bus occupants. No belt system has yet been designed which will accommodate either two large occupants or three smaller occupants in the same seat. Yet such alternate seat use is common where the same bus alternately or concurrently carries kindergarten and high school students.

An option to fully passive protection is being considered in the bus occupant protection standard which would require seat belts combined with a sensing and warning system to assure that the belts are used. A system of this type is probably too costly and vandalism-prone for most school bus applications.

Consideration is being given for the following:

- Incorporation of high, rear-padded seats backs;
- Strong, padded hip restraints or armrest on the aisle side of each seat and;
- Adequate fastening of the seats to the bus floor.

A program is needed to support this padded, encapsulated approach to pupil protection during interior impact. The safety benefits derived from this approach must be carefully analyzed, since reduction of seating capacity which results from higher seat backs, for example, may adversely affect the total pupil transportation system. School districts, as a consequence, would be forced to purchase additional buses, or they might have to resort to overcrowding, creating the inherent unsafe standee situation.

Seat development, therefore, is of great importance for upgrading occupant protection capability in the bus interior. A program to continue the development of an optimum seating system for school bus safety is recommended. Installation and testing of prototype seating systems could be included in other school bus testing programs as a "piggy back" test to body structure development.

2.4 Vehicle Brakes

During 1970, NHTSA conducted field surveys of school buses in several States to determine how well a recall campaign involving three chassis and twelve different body manufacturers had been carried out. The original campaign involved changes in the hydraulic master cylinder of the bus braking system. The results of this survey have shown that of the fifty-six additional safety related defects found, twenty-six were related to the brake system.

Nine recall campaigns provided for the correction of safety defects on approximately 203,600 school buses and trucks through November 1971. Brake system related defects accounted for over seventy-five percent of these corrections.

Of the seventeen school-bus-related accidents reported in depth by the various NHTSA-sponsored multidisciplinary accident investigation teams throughout the country, five were directly attributed to the failure of the buses' braking system (five were attributed to the driver error, one to faulty steering, one to failure of the heater hose and five were a result of failures in the opposing vehicle).

Had the brakes held for the driver of the runaway school bus on the morning of September 11, 1971, the nine fatalities that resulted in the Monarch Pass, Colorado tragedy, would have been averted. Clearly, the braking system of the school bus is one of the most, if not the most, important safety related vehicle system requiring our attention.

In August 1972, NHTSA issued an amendment to FMVSS No. 105 establishing new requirements for hydraulic brake and parking brake systems and extending this standard to cover all vehicles including trucks and buses so equipped, effective September 1, 1975. The amended standard specifies stopping distance, linear stability while stopping, fade resistance and fade recovery. All vehicles equipped with hydraulic brakes must have a split service brake system with partial failure or an "emergency" braking feature. The amendment also requires driver warning (lamp to light) in the event of hydraulic pressure failure or when the level of brake fluid in the master cylinder drops to an unsafe level.

Earlier, FMVSS No. 121 was issued in order to establish performance requirements for vehicles equipped with air brake systems. The standard establishes requirements to govern the braking behavior of the vehicle during application of the service brakes including minimum stopping distance, fade resistance and recovery, lateral stability and wheel lockup. A warning system must be provided to warn of brake system failure. An emergency back up brake system is also specified in the standard. This standard becomes effective for school buses on September 1, 1974.

Additional equipment standards relating to brake systems have also been established: FMVSS No. 106 Hydraulic Brake Hoses and FMVSS No. 116, Hydraulic Brake Fluids. A proposed standard, brake shoe and pad assemblies, will specify critical performance characteristics for these brake system components.

These requirements do not, however, represent the full capabilities of present braking technology. Anti-lock brake systems are needed to supplement the present brake systems and prevent undesirable skid conditions. More stringent requirements for vehicle stopping distances, pedal effort ranges, and fade characteristics are needed. "Hot" and "wet" recovery requirements need upgrading and new tests, including spike stop tests to evaluate structural integrity of the brake and chassis components, should be specified.

The present brake system standards are not effective for school buses until September 1, 1974, or September 1, 1975. Therefore, this agency should encourage manufacturers to implement the provisions of these standards on the school bus fleet as soon as possible. It is suggested that the school bus be the first to benefit by the "phasing in" of the new brake systems specified. In addition, more advanced braking systems such as "automatic emergency brakes" could be provided for school buses by the manufacturers long before the Federal government imposes such a standard on the industry.

Braking continues to be the most important single element of accident avoidance from the standpoint of vehicle performance. The full utilization of the industry's technological capability in this area is therefore of highest importance to school bus safety.

2.5 Vehicle Handling And Stability Systems

Vehicle handling and stability characteristics are critically related to school bus accident avoidance. Driver-vehicle characteristics are vital to vehicle maneuvering and are dependent upon matching driver characteristics to the vehicle (including steering, suspension, brake and acceleration system). These in turn must be compatible with roadway surface and dynamic traffic environments.

The handling characteristics of the vehicle are first identified as related to steering, suspension, center of gravity and power. As these system performance requirements are defined, the base line for the Vehicle Handling and Stability Systems will be established.

Tires and wheels have a significant effect on vehicle handling. Standards to cover tires and rims for school buses will be issued in 1974 at which time all types of new tires will be covered by standards. When these rules become effective, they will be combined with existing Standards 109 and 110 so that all new tires in 1976 will be covered by one standard.

A similar consolidation and realignment is planned for retreaded tires. Standard 117 for passenger cars has already been issued and the rule for retreading other than passenger car tires is proposed for issuance in the Spring of 1973. Included in the final rule will be regulations on casing age. Upon completion of research now underway at NHTSA, an amendment will be made to Standard 109 to include minimum performance of tires for skid and traction.

With the exception of standards on tires, it is not expected that school bus handling and stability standards will be issued in the forseeable future. Research is currently being conducted on passenger cars, trucks and buses. However, current plans do not allow for issuance of standards relating to handling and stability of passenger cars before 1976. While this may be an important area relative to school bus safety, the cost effectiveness of pushing the "state-of-the-art" of bus handling and stability is questionable at this time.

2.6 Visibility Systems

The visibility systems of a motor vehicle are concerned with all operating factors, systems and components which affect the driver's ability to see sufficiently in any direction. Visibility systems that relate to school buses include:

1. Lighting and reflectors.
2. Direct fields of view.
3. Indirect visibility.
4. Anti-glare and adverse weather visibility (includes defogging, defrosting, wiping, washing and spray protection).

In general, this area is already covered by existing standards which apply to all vehicles including school buses. Upgrading and improvement of these regulations is a continuing effort. Projected beyond 1976 is a plan to further integrate and systematize overall visibility requirements in order to ensure adequate safety performance with minimum restriction on motor vehicle design innovation and styling.

Over thirty school children are struck and killed annually by a school bus as they enter or leave. This type of accident is exemplified by the small child who walks in front of the bus and is run over because the driver mistakenly thinks that all of the children are clear. The driver simply does not see the child. Indirect visibility aids that provide visibility to all areas around the bus, including the underside, need to be developed.

2.7 Driver Environment

Accidents can be caused by inadequate human engineering. The driver's attention to the road may be diverted while looking for a control, and he may not find that control in time to avoid an accident. If he is short, he may not be able to adjust the seat for adequate visibility or for proper reach to the controls. The shoulder belt may be too uncomfortable to wear. In addition to factors affecting the man-machine interface, the critical problem of "driving while under the influence" also exists. There is also the problem of carbon monoxide build up in the driver's blood stream due to seepage of exhaust fumes into the passenger compartment. Driver fatigue is another problem.

Driver Environment Systems is the term applied to those interior elements and their interactions that influence the driver's ability to operate and control his vehicle safely and is comprised of the various internal control and display systems. The first standards establishing the beginning of the Driver Environment Systems specified requirements for locating essential controls within reach of the driver, identifying certain of the controls on the instrument panel and providing for a uniform shift sequence for the transmission lever. In addition, illumination of certain controls to ensure proper visibility at all times is necessary.

To avoid conflicts between these requirements and those of other standards, a total system approach for Driver Environment has been initiated. This approach applies to changes in current safety standards and to additional planned rulemaking actions relating to improving driver operation through interior information and control systems.

Upgrading of Standard 101 has also been proposed. New requirements would include high speed warning devices and the fail-safe aspects of the accelerator control systems to prevent engine overspeeding and loss of vehicle control in the event of linkage failure. Standard 102, Controls and Displays is also being updated to require standardized locations and a reach boundary for controls as well as the Shift Lever Sequence.

Requirements for effective alcohol countermeasures and reduction in toxic gases and noise as they relate to the driver will be established and included in a common standard.

Of special concern to school bus safety is the development of various audiovisual devices to alert the school bus driver to an approaching train at a grade crossing. Such devices need to be adequately tested and developed before further rulemaking action can be taken. Nevertheless, such development should be included in any proposed school bus testing program.

A joint effort between Federal Railroad Administration (FRA) and NHTSA was initiated in FY 1972 to improve the understanding of driver behavior in the grade-crossing environment. Based on this study, appropriate countermeasures such as improved warning systems will be developed in follow-on research programs budgeted for FY 1973-74. The application of this program to situations such as the tragic school bus-train collision at Congers, New York is obvious.

Other driver environment programs are presently underway although they primarily involve passenger cars. However, such programs have a direct correlation to the school bus safety problem and will be extended to these vehicles as successful programs are completed. Special driver environment projects applicable solely to the school bus are not recommended at this time.

2.8 Egress, Pupil Boarding and Alighting

In the post-collision area of school bus safety, occupant egress has been identified as a major safety consideration requiring Federal attention. Siegel, in his discussion of emergency exiting, recommends that roof port exits and nonoverhead hinged windows be required. Minimum door frame structure is also needed to check collapse which renders the door inoperative.[1]

FMVSS NO. 217, Bus Window Retention and Release, establishes requirements for the retention, operating forces, opening dimension, and markings for push-out bus windows and other emergency exits. The purpose of this standard is to minimize the likelihood of occupants being thrown from the bus and to provide a means of readily accessible emergency egress.

The University of Oklahoma, under contract to NHTSA, has studied the problems of egress from buses involved in crashes and in cases of fire. Major problems have been identified in this study and possible solutions are indicated. There is a need to expand the development of egress concepts through practical demonstrations of available systems.

[1] *Bus Collision Causation & Injury Patterns, Proceedings of Fifteenth Stapp Car Crash Conference 1971, SAE 710860,* Siegal and Naham.

Data is not available for school bus accidents related to boarding and alighting. However, studies performed by Booz, Allen Applied Research under contract to Urban Mass Transportation Administration (UMTA), have shown that more than one-third of those passengers injured, resulted from this mode of operation.[2]

Outward or inward opening doors seem to influence passenger injury level. Quick opening doors are advantageous under certain circumstances of egress, but present additional problems by catching hold of those entering or exiting the bus. The same can be said for quick closing doors. The accident potential of the door opening mechanism of the school bus has been cited by NTSB.[3]

NHTSA has identified front door latches as a school bus safety problem.[4] "With buses in motion, when brakes are applied, children standing in the area of the first step have been thrown against the door latch connecting rod. As a result of a child's momentum, the 'over center' latches have, in some cases, unlatched, allowing doors to open." Better operating door mechanisms are available and new ones are being developed by at least three manufacturers under contract to UMTA in its transit bus program.

A trade-off study of service door operation could be combined with emergency door studies to determine the optimum door that should be required. A demonstration of the various door concepts would be a valuable tool in determining the parameters to be traded.

2 *Transit Bus Safety – Final Report, September 1972*, DOT/UMTA, Booz, Allen Applied Research.

3 *School Bus/Automobile Collision and Fire, Near Reston, Virginia, February 29, 1972*, NTSB – HAR-72-2.

4 *School Bus Safety Problems*, DOT/NHTSA, November 1971.

3.0 State Safety Program for Pupil Transportation

3.1 School Bus Drivers

There are approximately 300,000 drivers for the Nation's 260,000 school buses. They range in age from 16 to over 75. Twenty-five States have no upper age limit for drivers. School bus driving is largely a part-time job. Drivers usually drive a school bus in addition to maintaining some other job such as farmer, gas station attendant, student, housewife, fireman, or insurance agent. However, there is a growing number of full time school bus drivers in and around the big cities.

Selection of a school bus driver must be made from a limited manpower pool, since the job requirements generally call for a part-time worker with approximately 2 free hours in the morning and 2 free hours in the afternoon. Most States require a special license to drive a school bus. All States identify some agency as responsible for training school bus drivers. In practice, however, most drivers receive no formal training. Only a few States require bus driver education by law and nine States merely "recommend" it. Most local school districts, therefore, are free to do what they wish.

NHTSA should, therefore, establish a National School Bus Driver Education program to aid the States in meeting the requirements of Standard No. 17 in this area. Such a program should include the following:

1. Develop school bus driver profile.
2. Establish driver training requirements including transportation of handicapped children.
3. Study necessary driver aids for safer and more efficient transportation.
4. Identify manpower requirements.
5. Identify the school bus driver task.

3.2 Fleet Supervisors

Of the 18,000 school districts in the U.S., 15,000 report[1] that they operate school bus fleets. Because the size of these fleets vary from one bus to over 700, many do not have full time fleet managers.

The job of a school bus fleet supervisor, in general, is to assist the school administrator in the implementation of the State pupil transportation policies. His principal duties should include at least the following:

- Chassis and body procurement (when this is not done at the State level).
- Recruiting, selecting, instructing, and supervising drivers.
- Routing and scheduling of bus.
- Investigating accidents, road failures, and other problems associated with the school transportation operations.
- Keeping records and preparing reports.

Those involved in pupil transportation believe that a fleet of 20-25 or more units requires a full time supervisor. Based on this, 4,500 full time supervisors are needed, but only slightly more than 1,000 are presently employed.

A manpower development program is needed so that the States may attain an acceptable level of competence in school bus fleet supervision.

[1] Survey of State Directors of Pupil Transportation 1970.

3.3 Mechanics

With approximately 260,000 school buses in the U.S., a large number of well-trained mechanics is needed to maintain them. The average fleet size is 17 buses. The staffing pattern frequently used is one full time mechanic for a fleet of 10 buses. A fleet of 10-20 buses calls for one full time mechanic and one assistant and for fleets over 20 vehicles, a competent mechanic for each 15-18 units with one helper for each two mechanics is required.

Currently all large school bus fleet contractors and most large school fleets have their own maintenance facilities. Most small fleets are maintained by independent garages or by the automobile agency through which the bus was purchased.

In order for the States to meet the vehicle maintenance requirement of Standard No. 17, more qualified mechanics must be made available. An estimated 8,000 mechanics are needed immediately to maintain the 260,000 buses used in pupil transportation.

3.4 Pupil Passengers

Since 1869, children have been transported to and from school at public expense. Distance and hazards to walkers are given as the main reasons for transporting children.

Behavioral problems that occur during transportation have led to requests for monitors or patrols aboard school buses. Misbehavior has been the indirect cause of accidents so should not be tolerated. The most effective means of solving this problem is to deny transportation to those whose behavior endangers the lives of other riders.

Vandalism is one of the most serious problems involving transported children. Each year, students damage many buses to such an extent that they must be taken out of service for repairs. Early attempts by body manufacturers and school boards to give greater protection to pupil passengers by providing well padded seats were largely frustrated by students who slashed the padding so severely and so often that maintenance calls became prohibitive. Manufacturers actually produced a virtually indestructible plastic seat for use where this type of vandalism was acute.

Pupil misbehavior thwarts much of the safety effort in school bus design, endangers other passengers, frustrates the driver and indirectly presents a safety hazard to others outside the bus. Such behavior cannot be tolerated. A program for pupil training and behavior control is needed to encourage the States to follow through on this important aspect, "pupil passenger behavior," of pupil transportation safety.

Related to the pupil problem is the transportation of the special education student. While this is not a discipline problem, the behavior of the handicapped child is an important consideration in that special accommodations must be provided for his transportation. A program to determine what is needed in this area should be pursued.

3.5 Administrators

Pupil transportation is primarily a State responsibility. All States use some "general funds" to support pupil transportation under one or more State statutes. In each State some official has the responsibility for this program or at least a part of it. Until the U.S. Department of Transportation was established, this individual was usually the chief State school officer. In only two States was this leadership role placed in the State Highway Department (Arizona and Kansas). Since 1967, however, several States have transferred this responsibility to their State Department of Transportation.

Some of the principal duties of the chief State school officer are as follows:

- Provide leadership in the development of a comprehensive school transportation program for statewide application.
- Develop and implement a clear, concise school transportation policy.
- Develop and implement a statewide management information system to accommodate pupil transportation statistics, such as data on costs, accident and injury data, and information on manpower availability.

No two States have identical laws governing school buses and the motoring public. Nor are all school buses manufactured to the same specifications in all States. Most regulations governing pupil transportation are issued or approved by the State board of education and implemented by the State supervisor of school transportation. Functions such as licensing of school bus drivers and school bus inspections are usually handled by other State agencies with or without the cooperation of the State school transportation director.

Standard 17 requires that there shall be a single State agency having primary administrative responsibility for pupil transportation. In addition, this agency shall furnish NHTSA a summary evaluation of its pupil transportation safety program. NHTSA must in turn advise and furnish recommendations to this State agency on the conduct of its programs. Thus, a program to monitor and review the "State Administration of Pupil Safety Programs" is required within NHTSA.

3.6 Motorists

The average motorist regards school buses with mixed emotions. A motorist who is held up by a loading or unloading school bus may become impatient and take chances with his own life as well as those of the children by illegally passing the school bus. Inattention and impatience are the two largest contributors to motorist involvement in school bus accidents.

In addition, the States do not have uniform laws governing school bus loading and unloading. Nor are there uniform laws regulating how other vehicular traffic should react to a stopped school bus. These differing laws can lead to a confusing and dangerous situation.

In 30 States, for example, the bus must be provided with special visual signals. A type of flashing light is specified in 25 States; 5 require some kind of mechanical device—such as a stop arm that can be projected from the bus like a railroad semaphore. In 19 States the requirement to stop is unrelated to any special visual signal.

In 36 States, the laws regarding stopping for a school bus apply throughout the respective States. But in 5 of the 36, the stop laws do not apply in business and residential districts.

In 17 States, the school bus must actuate its flashing signals only after coming to a stop for the purpose of receiving or discharging passengers. But in 22 States the signals must be actuated before the bus has stopped.

State traffic laws describing when drivers must stop for school buses receiving or discharging children are not reasonably uniform from State to State. Clearly, efforts must be made to achieve some degree of uniformity which will make it easier for the motoring public to obey those laws designed to safeguard transported pupils.

A program for "Model Legislation for School Buses to Control Traffic" should be provided to the States so that they may enact appropriate legislation.

3.7 Marking And Identification

The Uniform Vehicle Code states that every motor vehicle that meets certain color and identification requirements and transports children to and from school or school activities is a school bus. Marking this vehicle for easy identification sets this bus apart from all other passenger carrying vehicles.

Distinctive marking for vehicles carrying school children began in the 1920's with the words "SCHOOL BUS" placed as high as possible on the front of the vehicle. Since the average speed of traffic was well below 40 mph, the sign gave adequate warning to the motoring public that this vehicle carried young children. As traffic speed and volume increased in the 1930's, some additional means were required to alert motorists to a school bus. In 1939, following tests by the National Bureau of Standards, the National Conference on Pupil Transportation adopted National School Bus chrome yellow as the distinctive color for school buses. Following World War II the climbing accident rate again necessitated better identification and a means of controlling traffic for the safety of the transported pupils. Consequently, flashing red lights were added to the front and rear of school buses.

To date not all States have adopted these three means of uniformly identifying vehicles transporting children to and from school. Thirty-two States require or permit a stoparm as a warning or as the actual traffic control device in addition to the other items of identification. All States have added a legend on the rear of the bus to more adequately inform the motorist of the law relating to his behavior in the vicinity of a school bus. However, these legends also lack uniformity. They read, "STOP STATE LAW," "STOP WHEN BUS STOPS," "STOP WHEN LIGHTS FLASH," "STOP WHEN RED LIGHTS FLASH," "STOP ON SIGNAL" or some other wording intended to help the motorist.

With 260,000 school buses making an estimated 5,000,000 stops per school day, the need for uniformity in marking and the standardization of the stop laws becomes readily apparent. A confused motorist is a dangerous motorist. To increase the safety of transported pupils a uniform stop law and a uniform stop signal are essential.

3.8 Pupil Transportation And Extracurricular Activities

Pupil transportation evolved because of the need to help children reach educational services which were beyond a reasonable walking distance. It is an instructional tool whose potential use has not yet been fully realized.

Until the early 1930's, school buses were used primarily for transporting children to and from school. Today, they transport pupils to many points of educational opportunity both within and outside the community.

At the high school level, athletic programs make heavy demands on school bus fleets to transport teams, cheerleaders and spectators to and from games. At the elementary level, children are bused to museums, dairy farms, zoos, the planetarium, parks, nature centers and fire stations.

The field trip is usually much longer than the to-and-from school trip. Therefore, the exposure is greater. However, the hazards of this type of transportation are considered less than the to-and-from school travel because the field trip is usually direct from the school to the trip site without the need to stop for loading and unloading along the way. Data from 10 States indicate that extra curricular mileage is about 7% of total mileage or about 152,000,000 miles a year. Data on trip length, frequency, number of buses used and cost of field trips would need to be collected and analyzed to determine if there is a safety problem.

Standard 17 does not cover this type of pupil transportation. However, if the data indicate that a safety problem exists the standard could be amended to apply to pupil transportation for extra curricular activities.

3.9 School Bus Disposal And Wear Out

The national fleet of 260,000 school buses is renewed about every eight or nine years. This means approximately 25,000 school buses must be disposed of every 12 months.

Old school buses are kept by the schools and rebuilt as wreckers, turned into a "flatbed" for school floats, or given to the auto mechanics shop for training purposes. Some buses are in such poor condition that they can only be sold for junk. Others are purchased by private individuals, churches, boys clubs, PTA's, parochial schools and scouts. In some instances these buses continue to be used as school buses. The private and parochial schools are the largest purchasers of used buses.

Worn out or discarded school buses are creating new problems in traffic management. Although many are remodeled internally for camping or other use, they are often left unchanged externally and continue to carry the school bus identification characteristics. Complaints have been registered by many individuals who travel the highways—law enforcement officers, insurance agents, school bus drivers and school administrators—about the unconventional manner in which these buses operate. They create hazards and are traffic accident potentials.

The following is the law in South Carolina:

> 21-795. IDENTIFICATION MARKS TO BE REMOVED FROM FORMER SCHOOL BUSES. All school buses in this State, when no longer used for school purposes and sold to any person for private or public use, must have all marks of identification showing that these buses were used by schools and school districts removed before private or public use may be made of them. Any person violating the provisions of this section shall be subject to a fine not exceeding twenty-five dollars or imprisonment upon the public works of the county in which the offense is committed for a period of not more than thirty days.
>
> 21-795.1 FORMER SCHOOL BUSES TO BE REPAINTED BEFORE USE. Any person who purchases a used school bus must paint it a color other than yellow before operating such bus on the highway. Any person violating the provisions of this section shall be guilty of a misdemeanor and, upon conviction, shall be fined not more than one hundred dollars or imprisoned for not more than thirty days, or both, at the discretion of the court.

Such a requirement should be mandatory in every State.

The uniform vehicle code is the recommended guideline for the States to follow in drafting legislation.

4.0 Conclusions

This study has been undertaken to assess the magnitude of the school bus safety problem and to develop a plan to improve pupil transportation safety. This report provides estimates of school bus population and daily usage, the injuries and fatalities that occur annually and compares the safety records of school buses to passenger cars. It also provides an analysis of the school bus vehicle and reveals some systems which could be improved. The operational aspects of State safety programs for pupil transportation including driver training, program administration, uniform State laws, and use of buses for extracurricular activities were also reviewed. Principal findings and conclusions of the study are as follows:

- 19 million students are transported daily in approximately 260,000 school buses.
- Although school bus safety can and should be improved, school buses are 8 times safer than passenger cars—the school bus injury rate is 1 injury per 8 million passenger miles compared to 1 injury per million passenger miles for passenger cars.
- Approximately 158 school bus involved fatalities occur annually; approximately half of these are pupils.
- Over two thirds of the pupil fatalities are classified as pedestrians, and the remainder as bus occupants.
- Approximately 8,200 school bus involved injuries occur annually and slightly more than 5,000 of these are pupils.
- While only 20% of pupil fatalities occur inside the bus, 93% of the injuries occur there.
- Over one-fourth of the bus occupant injuries require the services of an oral surgeon.

It is evident from an analysis of the school bus accidents reported in depth by various multidisciplinary accident investigation teams throughout the country that three aspects of school bus design and construction are in need of improvement. These include the vehicle brakes, the structural integrity of the vehicle and the seats.

Of the 17 school bus related accidents investigated in depth by NHTSA, five were directly attributed to a failure of the buses' braking system (five were attributed to driver error, one to faulty steering, one to failure of the heater hose and five as a result of failures in the opposing vehicle). Clearly, brakes are one of the most important safety related vehicle systems requiring NHTSA attention. Standards 105 and 121, which establish new requirements for hydraulic, parking and air brake systems on buses, effective September 1, 1974 and September 1, 1975, will significantly improve brakes. However, further improvements after these effective dates should also be studied.

In the structural area, the NTSB conclusion regarding the inadequate riveting of school bus panels has been sufficiently documented. As the NTSB points out, school bus manufacturers are not complying with accepted industrial practice on the joining of panels. Compliance with the NTSB recommendation should indeed reduce school bus injuries.

Several modifications to bus design which were pointed out in the Monarch Pass report appear practical and should render the bus more crashworthy—particularly in the catastrophic accidents involving rollover. The window retention and release standard (FMVSS 217) effective on buses produced after September 1, 1973, should reduce the likelihood of passenger ejection in accidents and enhance passenger exit in emergency.

School bus seats appear to be the primary cause of over one-fourth of all injuries which occur inside the school bus. Seat backs should be made more pliable, through padding or some other means, in order to reduce facial injuries during impact. The proposed school bus seat standard, issued in February 1973, should provide a high level of injury protection in most school bus crashes.

As many children (33) are struck and killed by their own bus as are killed by other cars. Development of countermeasures, such as an improved indirect visibility system to prevent or reduce the number of children run over by their own bus, would be a high pay-off safety system. However, to date, researchers have not achieved significant breakthroughs in the development of indirect visibility systems for passenger cars, and it is not expected that an effective school bus system can be developed in the near future.

Nineteen Federal Motor Vehicle Safety Standards now apply to school buses (see Appendix A). Although there is no indication that current buses do not comply with these standards, school buses have not been included in the NHTSA compliance test program in past years. Their compliance should be verified in the future.

Vehicle safety countermeasures can be developed by the Federal Government, but the pupil transportation systems are operated by local communities under the guidance of the States. States and local communities need help and advice in upgrading their systems. Standard 17, which was issued in early 1972, will help improve the State systems, but additional NHTSA effort and financial support are needed in the areas of bus driver training, promotion of uniform school bus laws and management and administration of the States' programs.

5.0 Recommendations

The School Bus Task Force recommends the following:

1. Expedition of Seating Standard. A notice of proposed rulemaking, Bus Passenger Seating and Crash Protection, was issued in February 1973. The proposed standard would require strengthened seats and seat anchorages, seat back impact protection and increased seat back height.
2. Strength of Structural Joints. NHTSA should follow the recommendation of NTSB to "... adopt a FMVSS to control the strength of structural joints of school buses." The proposed standard could follow the Vehicle Equipment Safety Commission's requirement 5.6, body structure.[1] This would be a first step in establishing structural standards for school buses and would require that normal engineering practices be followed in their construction.
3. Implementation as soon as possible of FMVSS No. 105 (a) and FMVSS No. 121 on School Buses. Body and chassis manufacturers should be persuaded by NHTSA to implement FMVSS No. 105, Hydraulic Brake Systems, as amended, and FMVSS No. 121, Air Brake Systems, on school buses before the September 1, 1974 and September 1, 1975 effective dates. These two standards specify more stringent braking performance for school buses including stopping distance, lateral stability, fade resistance and recovery, "emergency" braking features and warning signal of system failure.
4. School Bus Compliance Test. A number of school buses can be tested for compliance with applicable Federal standards. Verification of compliance with the nineteen standards now in effect for school buses would focus attention on the public concern for the safety of pupil transportation.
5. School Bus Safety Improvement Project. The objective of this project is to demonstrate the degree of safety improvement that can be applied to contemporary school buses by proper utilization of present technology. The best features of the present day school bus would be incorporated into a modified bus. In addition the "mod" bus would have many of the "off-the-shelf" optional equipment installed to further enhance its safety performance. This demonstrated measure of improvement in school bus safety will, in turn, establish the basis for possible Federal Regulations. After completion of this project, it may be beneficial to develop additional experimental safety "prototype" school buses.
6. Data Collection and Analysis. Data on school bus accidents, their causes and school bus usage are essential. To assess the school bus accident picture on a nationwide basis, and to develop effective countermeasures based on school bus accident experience, the following data programs are required:
   a) Compile and issue annually a national report on the pupil transportation system, based on school bus accident and usage information provided by the States.

[1] Regulation VESC-6, "Minimum Requirements for School Bus Construction and Equipment," January 1971.

b) Acquire from each State and analyze a copy of each school bus accident which results in a pupil injury.
c) Annually conduct approximately five multidisciplinary investigations of high severity accidents that represent the various types of collisions which may occur—e.g., pedestrian, rollover, impact with large truck, bus or train.

7. State Safety Program for Pupil Transportation. Three critical areas have been identified which will enhance the State programs. These include: (a) the development and promotion of a school bus driver selection and training program; (b) the drafting and promotion of model legislation regarding the control of traffic by school buses and (c) providing technical and financial assistance to States to upgrade the State administration and operation of a pupil transportation system.

MANPOWER ALLOCATION

Within NHTSA, the Task Force has identified the need for eight professional personnel in fields relating to school bus safety. These are broken down by offices as follows:

A.	Motor Vehicle Programs	
	Seating and Occupant Protection	1
	Vehicle Structure & Crashworthiness	1
	Accident Avoidance (handling and stability, driver visibility, brakes and tires)	1
		3
B.	Research Institute	
	Data Analysis	1
	Accident Investigation	1
	Vehicle Performance	1
		3
C.	Traffic Safety Program	
	State Safety Program for Pupil Transportation	1
	(additional personnel needed)	1
		2
	Total personnel for school bus programs	8

Seven of these positions are already filled; one more should be added to carry out the tasks of regional and State liaison within the transportation safety program. The addition of supervisor and secretarial help would bring this allocation to a ten position level which has been recommended by congressional committee.[2]

PROPOSED PROGRAM SUMMARY

The specific projects and Resource Requirement supporting the school bus program are summarized as follows:

1. **School Bus Seating and Occupant Protection** – The objective is to develop an improved occupant seating system for school bus application.

   Resource Requirements: 1 man for seat rulemaking (MVP), $50,000 contract support.

2. **School Bus Safety Improvement Project** – This program will support rulemaking for vehicle structures and crashworthiness as well as in the area of accident avoidance. In this program, the modification of an up-to-date school bus to incorporate the best safety features of all existing buses and the addition of presently available improved safety systems will demonstrate an achievable level of safety within the present "state-of-the-art."

[2] DOT Appropriation Bill 1973, Report No. 92-1312, August 7, 1972.

Resource Requirements:

1 man for Accident Avoidance rulemaking (MVP)

1 man for Crashworthiness rulemaking (MVP)

1 man for Contract Monitoring (RI)

$150,000 contract support over 2 years

3. **Yearly Summary Report** – Acquire, compile and analyze State reports for issuance of an annual national report on Pupil Transportation Systems.

   Resource Requirements: See Injury Accident Report resource requirements below.

4. **Injury Accident Report** – Establish a national school bus injury file from the school bus accident reports from each State. Analysis of the file will contain recommendations for countermeasures.

   Resource Requirements:

   $20,000 contract support the first year, $[illegible],000 thereafter.

   1 man level of effort for data analysis for yearly Summary and Injury Accident Reports (RI)

5. **Multidisciplinary Investigations of Fatal School Bus Accidents** – Accident investigation teams to cover fatal school bus accidents as they occur.

   Resource Requirements:

   1 man level of effort (RI)

   $60,000 contract support annually to investigation teams

6. **School Bus Driver Selection and Training Program** -- The objective of this program is to develop a model driver training program for each State.

   Resource Requirements:

   1/2 man level of effort (TSP)

   $75,000 contract support annually

7. **Model Legislation** – A uniform traffic law with regard to school buses is needed so that motorists traveling from State to State are less confused.

   Resource Requirements:

   1/4 man level (TSP)

   $10,000 contract support total over three years

8. **State Administration of Pupil Transportation Safety Programs** – In support of Standard 17, monitoring of State programs and Federal assistance for such programs, with recommendations for improvements would be beneficial.

   Resource Requirements:

   1 1/4 man level of effort is required which is 1/4 man above current level (TSP)

   $5,000 contract support annually

An annual funding of $260,000 is projected for the next two years dropping down to $210,000 in the third year and leveling off at $130,000 per year thereafter. The following table, Contract Program Summary, details the required funding to support the School Bus Programs recommended by the Task Force.

CONTRACT PROGRAM SUMMARY

DATA	1974	1975	1976	1977
Yearly Summary Report	–0–	–0–	–0–	–0–
Injury Accident Report Analysis	$ 20,000	$ 15,000	$ 15,000	$ 15,000
Multidisciplinary Investigations	$ 60,000	$ 60,000	$ 60,000	$ 60,000
VEHICLE				
Bus Safety Improvement Project	$ 50,000	$100,000	–0–	–0–
Seating & Occupant Protection	$ 50,000	–0–	–0–	–0–
Other Programs	–0–	–0–	$ 50,000	$ 50,000
STATE SAFETY PROGRAM				
Driver Selection & Training	$ 75,000	$ 75,000	$ 75,000	
Model Legislation	$ 1,000	$ 4,000	$ 5,000	
State Administration of Pupil Transportation Program	$ 5,000	$ 5,000	$ 5,000	$ 5,000
TOTAL	$261,000	$259,000	$210,000	$130,000

APPENDIX A

Summary Description
Federal Motor Vehicle Safety Standards
Applicable to Buses

SUMMARY DESCRIPTION
FEDERAL MOTOR VEHICLE SAFETY STANDARDS
APPLICABLE TO BUSES

Standard No. 101 – *Control Location, Identification and Illumination*

This standard requires that the headlamps, windshield wiping and other essential controls be labeled and within the reach of the driver restrained by a lap and upper torso restraint seat belt. Purpose of the Standard is to facilitate control selection and insure accessibility. An amendment to this standard requires illumination of specified controls and extends coverage to buses effective September 1, 1972.

Standard No. 102 – *Transmission Shift Lever Sequence, Starter Interlock, and Transmission Braking Effect*

This standard requires all vehicles with automatic transmissions to have a neutral shift lever position between the forward and reverse drive positions, and whenever a park position is included to be located at the end of the shift lever sequence adjacent to the reverse drive position. If the shift lever is mounted on the steering column, the shift lever movement from neutral to forward shall be clockwise. It also requires an interlock to prevent starting the vehicle in reverse or forward drive positions, transmission braking capability and the permanent marking of the shift lever sequence. Its purpose is to reduce the likelihood of shifting errors, starter engagement with vehicle in gear and provide supplemental braking at speeds below 25 miles per hour.

Standard No. 103 – *Windshield Defrosting and Defogging Systems*

This standard requires that all buses manufactured for sale in the continental United States be equipped with windshield defrosters. The purpose of the standard is to provide visibility through the windshield during frosting and fogging conditions.

Standard No. 104 – *Windshield Wiping and Washing Systems*

This standard requires that all buses be equipped with two or more speed power-driven windshield wipers and windshield washer systems. Its purpose is to provide improved visibility through the windshield during inclement weather. The standard includes test procedures and performance requirements for the washer systems.

Standard No. 105 – *Hydraulic Brake Systems*

This revised standard requires buses utilizing hydraulic brakes to have a split brake system, incorporating service and emergency brake features that are capable of stopping the vehicle under certain specified conditions; such as "hot" and "wet" fade, partial failure, and inoperative power assist. The parking brake system must be capable of holding light vehicles on a 30 percent grade and heavy vehicles on a 20 percent grade. It also requires warning lights to indicate loss of pressure, low fluid level and antilock system failure. The effective date is September 1, 1975.

Standard No. 107 – *Reflecting Surfaces*

This standard requires that windshield wiper arms, inside windshield moldings, horn rings and the frames and brackets of inside rearview mirrors have matte surfaces which will reduce the likelihood of visual glare in the driver's eyes.

Standard No. 108 – *Lamps, Reflective Devices and Associated Equipment*

This standard specifies requirements for lamps, reflective devices, and associated equipment, for signalling and to enable safe operation in darkness and other conditions of reduced visibility. Sidemarker lights and reflectors, hazard warning lights and backup lights are included in the requirements for these vehicles. This standard has been amended several times increasing the safety performance levels of lighting systems. Several revisions were made in the standard, effective January 1, 1972, including the extension of the requirements to cover applicable replacement equipment. Another amendment, effective January 1, 1973, affects turn signal and hazard warning signal flashers.

Standard No. 112 – *Headlamp Concealment Devices*

This standard specifies that any fully opened headlamp concealment device shall remain fully opened whether either or both of the following occur: (a) any loss of power to or within the device or (b) any malfunction of wiring or electrical supply for controlling the concealment device occurs. Its purpose is to eliminate the possibility of loss of forward visibility due to malfunction of the headlamp concealment device, a problem with some such devices.

Standard No. 113 – *Hood Latch Systems*

This standard, effective January 1, 1969, specifies requirements for a hood latch system for each hood. A front ning hood, which in an open position, partially or completely obst driver's forward view through the windshield, must be provided with nd latch position on the hood latch system or with a second hood latch system.

Standard No. 116 – *Hydraulic Brake Fluids*

This standard specifies minimum physical characteristics for two grades of brake fluids, DOT 3 and DOT 4, for use in hydraulic brake systems of all motor vehicles. In addition, the standard establishes labeling requirements for all brake fluid containers.

Standard No. 121 – *Air Brake Systems*

Effective September 1, 1974, each air braked bus is required to have a service brake and a parking brake system that will result in significantly improved levels of performance over existing vehicles. Stopping capabilities are established at both loaded and unloaded conditions, and on high and low coefficient of friction surfaces. In addition, the standard provides for an emergency braking system that activates in the event of loss of air pressure. It also establishes requirements for emergency braking system in the event of a failure in the primary service braking system. It also establishes requirements for various items of equipment.

Standard No. 124 – *Accelerator Control Systems*

This standard establishes requirements for the return of a vehicle's throttle to the idle position when the driver removes the actuating force from the accelerator control, or in the event of a breakage or disconnection in the accelerator control system.

Standard No. 205 – *Glazing Materials*

This standard specifies requirements for all glazing materials used in windshields, windows, and interior partitions of motor vehicles. Its purpose is to reduce the likelihood of lacerations to the face, scalp, and neck, and to minimize the possibility of occupants penetrating the windshield in collisions. It requires, among other things, that windshields be of a type that tends to cushion those that impact them, rather than allowing head penetration and even decapitation – a problem with older windshields.

Standard No. 207 – *Seating Systems*

This standard establishes requirements for seats, their attachment assemblies, and their installation to minimize the possibility of failure as a result of forces acting on the seat on vehicle impact. This standard was amended, effective January 1, 1972, to extend applicability to the driver's seat of buses.

Standard No. 208 – *Occupant Crash Protection*

This standard, previously titled "Seat Belt Installations" specifies requirements for lap and shoulder belt installations in passenger cars, and was effective beginning January 1, 1968. The standard was amended September 23, 1970 to extend applicability to multipurpose passenger vehicles, trucks, and the driver's seat in buses. The standard was further amended and re-titled "Occupant Crash Protection" – March 3, 1971. This amendment specifies requirements for both active and passive occupant crash protection systems. Effective January 1, 1972, buses (driver's seat only) are required to have a complete passive protection system or a belt system conforming to Standard No. 209.

Standard No. 209 – *Seat Belt Assemblies*

In order to mitigate the results of an accident to a person in a motor vehicle, the standard specifies requirements for seat belt assemblies. The requirements apply to straps, webbing, or similar devices as well as all necessary buckles and other fasteners, and all hardware designed for installing the assembly in a motor vehicle. Included is a requirement for anchorages for lap and upper torso restraint belts in all forward facing outboard seats (four in standard sedans). This standard was amended to upgrade webbing abrasion, buckle crash and emergency locking retractor requirements.

Standard No. 210 – *Seat Belt Assembly Anchorages*

This standard specifies the requirements for seat belt assembly anchorages to insure effective occupant restraint and to reduce the likelihood of failure in collisions. Included is a requirement for anchorages for lap and upper torso restraint belts in all forward facing outboard seats (four in standard sedans). This standard was amended extending the requirements to driver's seats in buses and upgrading the test requirements effective January 1, 1972.

Standard No. 217 – *Bus Window Retention and Release*

This standard establishes minimum requirements for bus window retention and release to reduce the likelihood of passenger ejection in accidents and enhance passenger exit in emergencies. The effective date is September 1, 1973.

Standard No. 302 – *Flammability of Vehicle Interior Materials*

Specifies burn resistance requirements for materials used in the compartments of motor vehicles. It becomes effective September 1, 1972.