

School Bus Types



A



B



C



D



School Bus Types



A



B



•Type "A"

- Constructed utilizing a cutaway front-section vehicle with a left side driver's door
- Includes two classifications
 - Type A1, with a GVWR of 10,000 pounds or less
 - Type A2, with a GVWR greater than 10,000 pounds

•Type "B"

- Constructed utilizing a stripped chassis
- Entrance door is behind the front wheels
- Includes two classifications
 - Type B1, with a GVWR of 10,000 pounds or less
 - Type B2, with a GVWR greater than 10,000 pounds

School Bus Types



C



D

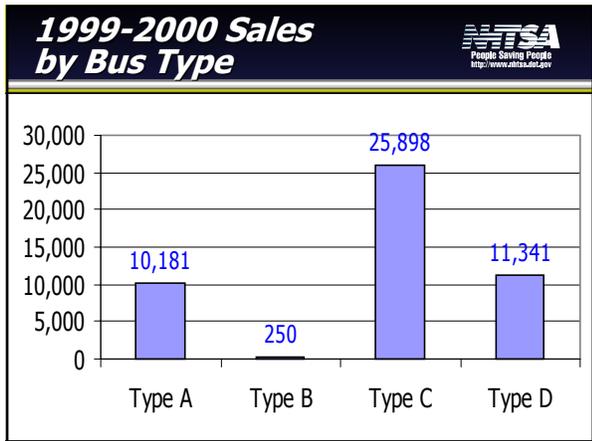


•Type "C"

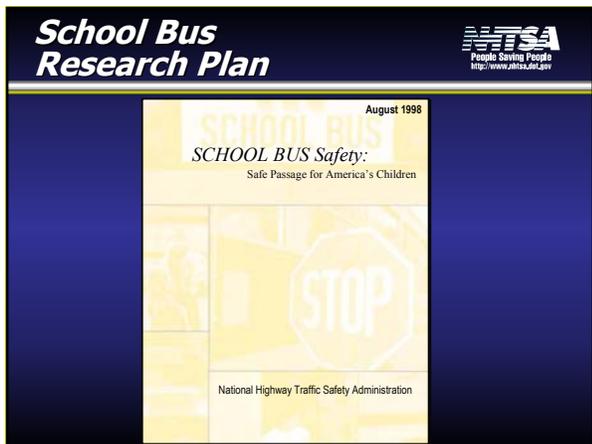
- Constructed utilizing a chassis with a hood and front fender assembly
- Entrance door is ahead of the behind the front wheels

•Type "D"

- Constructed utilizing a stripped chassis
- Entrance door is ahead of the front wheels
- Also known as "Transit style" or "Forward control vehicle"



- ### State Restraint Requirements
- **New York - Currently requires lap belts (1987)**
 - **New Jersey - Currently requires lap belts (1994)**
 - **Florida - Currently requires a "safety belt" (which is a lap belt) (2001)**
 - **Louisiana - Will require "occupant restraint systems" (June 30, 2004)**
 - **California – Will require Lap/Shoulder belts**
 - School buses (2005)
 - Small school buses (2004)





Statistical Data

The National Automotive Sampling System
General Estimates System (NASS GES)

SB Statistical Data



School bus body vehicles

- All school bus body vehicles, regardless of use
- 1977 and newer (post-standard vehicles)
- 11 Crash years – 1990 through 2000

School Bus Body Vehicles Summary



- ~26,000 Crashes per year
- ~10 SB Occupant fatalities/year
- ~9,500 SB occupant injuries/year



1990-2000

School Bus Body Vehicles Occupant Fatalities 

- **10.2 Fatalities per year**
 - 25% Drivers
 - 75% Passengers
- **School related**
 - YES – 85%
 - NO – 15%

1990-2000

Passenger Fatalities on SB 

- **55 Fatal passenger crashes**
 - 5 per year
- **83 Passenger fatalities**
 - 7.5 per/year
 - 6.0 for Full-sized school buses
 - 1.5 for Van-based school bus

1990-2000

SB Body Crash Data Summary (90-00) 

- **7.5 passenger fatalities per year**
 - ~2 Passenger fatalities in frontal crashes
 - Target for belts
 - ~2 Passenger fatalities in side crashes
 - Typically in intrusion zone (includes trains)
 - ~3.5 Include other crash and non-crash modes
 - Overturn (belts could help)
 - Rear
 - Non collision (such as, fell from vehicle)

01 School Transportation-Related Fatal Occupants

	Fatal Crashes	Fatalities	
		Drivers	Passengers
▪ School buses	8	4	9
▪ Van-based SB	2	1	1
▪ Veh used as SB	2	1	2
▪ Total ▪ (Van & Shuttle Bus)	12	6	12

▪ Source 2001 FARS Annual File

01 School Transportation-Related Fatal Passengers

▪ **10 SB passengers (school transport)**

- Side Intrusion by striking heavy trucks
 - 2 crashes, 4 passengers
- Hit guardrail, over bridge rail, dropped 60 ft, overturn
 - 1 crash, 4 passengers
- Intrusion into side of bus by snow plow blade that broke off plow
 - 1 passenger
- Infant CSS incorrectly secured in vehicle
 - 1 passenger

▪ Source 2001 FARS Annual File

01 School Bus Fatal Crash - Arkansas

NTSB

Testing

Testing Program



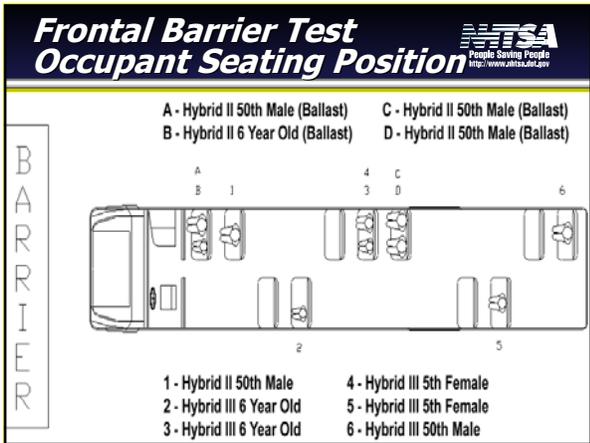
- **Vehicle Tests**
 - Full scale tests
 - Frontal
 - Side
- **Laboratory Tests**
 - Sled tests
- **Research conducted at NHTSA's Vehicle Research and Test Center (VRTC)**
 - East Liberty, OH

Full Scale Tests



- **Frontal barrier test**
 - Class "C" SB
 - Flat barrier
 - Striking speed – 30 MPH
- **Side impact test**
 - Class "D" SB
 - Striking vehicle - 22,265-lb truck
 - Striking speed – 45 mph
 - Angle - 90 degrees
 - Impact point – Left side just behind front tires on bus







**Frontal Barrier Test
Post Crash Photo**



**Side Impact Test
Pre Crash Photo**



**Side Impact Test
Occupant Seating Position**



- 1 - Hybrid II 50th Male
- 2 - Hybrid III SID 50th Male
- 3 - Hybrid III 6 Year Old
- 4 - Hybrid III 5th Female
- 5 - Hybrid III SID 50th Male
- 6 - Hybrid III 6 Year Old
- 7 - Hybrid III 5th Female



- A - Hybrid II 6 Year Old (Ballast)
- B - Hybrid II 6 Year Old (Ballast)
- C - Hybrid II 50th Male (Ballast)





Laboratory Testing

- **3 Series**
 - Buck fabricated from SB
 - Generic (Flat plate) buck
 - Recent tests
- **Hi severity**
 - 35-37 mph

A photograph of a laboratory testing setup for a school bus buck. The buck is a large, rectangular metal structure with a flat top and a base. It is mounted on a platform and is surrounded by various sensors and equipment. An arrow points to the buck from the text above.



Restraint Systems Evaluated

- **Compartmentalization**
- **Lap belts**
- **Lap/shoulder belts**
- **New systems**

Occupant Sizes

- **Small-sized student**
 - 6 year-old dummy
 - 52 lbs
- **Medium-sized**
 - 12 year-old
 - 5th percentile female dummy
 - 108 lbs
- **Large high school student**
 - 50th percentile male dummy
 - 172 lbs

Injury Assessments



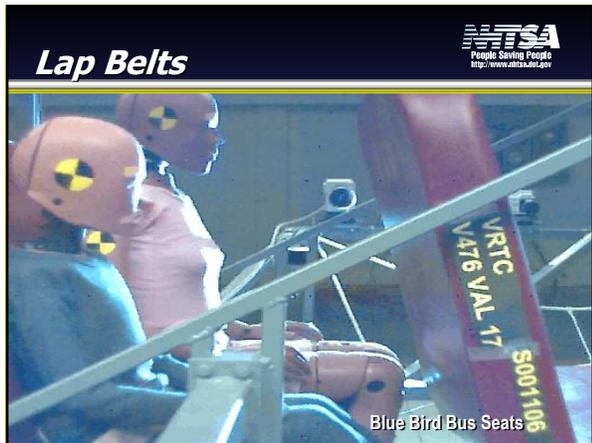
- **Head Injury Criteria (HIC)**
- **Neck injury criteria (Nij)**
- **Chest injury criteria (G's)**
- **Leg injury criteria (Femur load)**
- **Abdominal loads**
 - experimental measurement systems

Restraint Operation

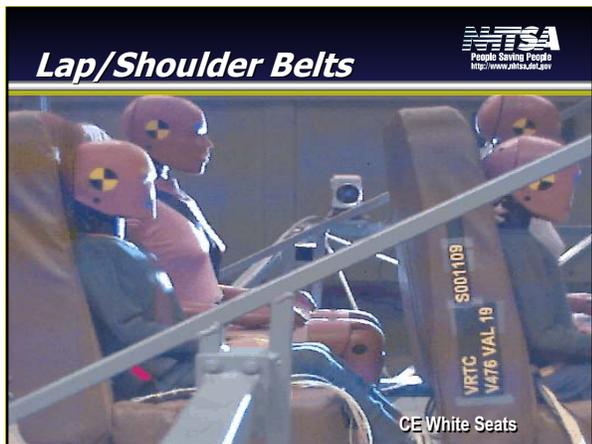
Compartmentalization



Blue Bird Bus Seats







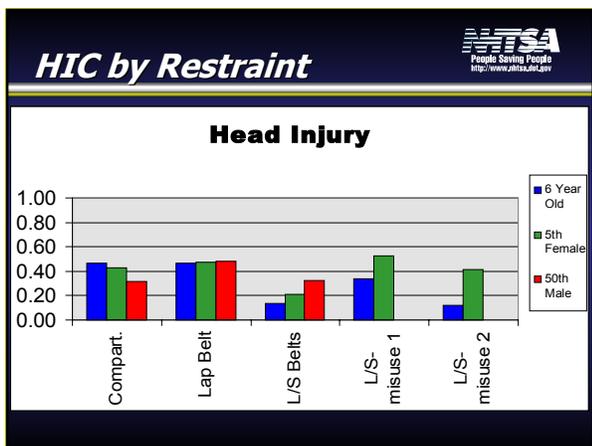
Seat Back Height Issue

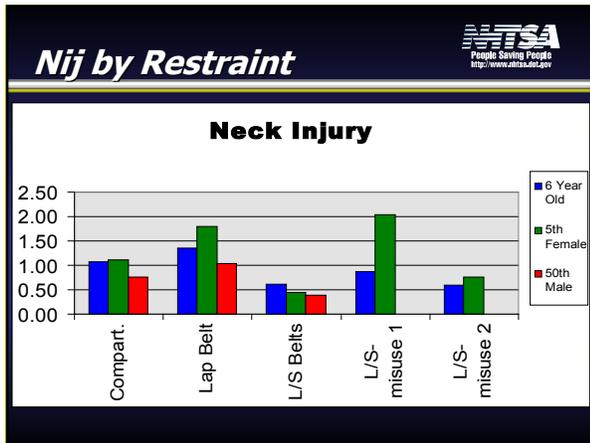


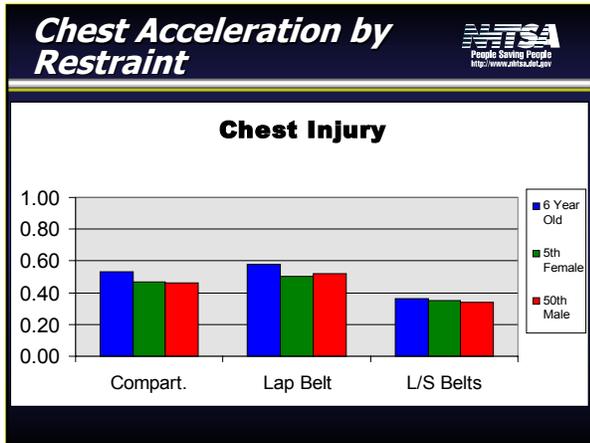












Peak Load - Abdominal Area

Dummy	Restraint	Load
6-Year-Old	Compartmentalization	100 lbs (444 N)
	Lap belt only	291 lbs (1,293 N)
	Lap/shoulder belt	164 lbs (729 N)
5th Percentile Female	Compartmentalization	135 lbs (601 N)
	Lap belt only	758 lbs (3,371 N)
	Lap/shoulder belt	308 lbs (1,372 N)

Conclusions from Data

NTSA
People Saving People
<http://www.ntsa.dot.gov>

Compartmentalization

- Low head injury values
- Medium neck injury values
- Seat back override in extreme conditions

NTSA
People Saving People
<http://www.ntsa.dot.gov>

Lap Belts

- Low head injury values
- High neck injury values
 - Nij higher than compartmentalization restraint
- Keeps passengers in their seats

Lap/Shoulder Belts



- **Low head injury values**
 - Lower than compartmentalization and lap belt results
- **Low neck injuries values**
 - Less than other restraints
- **Keeps passengers in their seats**
- **Restraint misuse can produce undesirable outcomes**
 - Becomes lap-belt-only like
- **Stiffer seat back possibly needed**
 - Could effect unbelted occupants behind

**Report to Congress
and
News Release**

Report to Congress



▪ <http://www-nrd.nhtsa.dot.gov/departments/nrd-11/SchoolBus.html>

- **April 2002**
- **Abstract**
- **Downloadable copy of full report**
- **Downloadable movies**

News Release



▫ <http://www.nhtsa.dot.gov/nhtsa/announcement/press/pressdisplay.cfm?year=2002&filename=pr37-02.html>

- **NHTSA 37-02**
- **May 7, 2002**

News Release



▪ **Agency is considering the following changes to existing federal safety regulations**

- Increase seat back height from 20 inches to 24 inches
- Require buses under 10,000 pounds to have lap/shoulder restraints
- Develop standardized test procedures for voluntarily installed lap/shoulder belts

National Academy of Sciences

NAS Report



- **The Relative Risks of School Travel: A National Perspective and Guidance for Local Community Assessment**
- **Special Report 269 (2002)**
- **Sponsored by NHTSA**
- **Performed by the National Research Council**

NAS Report - Overview



- **Purpose: To help identify the risks of school travel**
- **The report considered six transportation modes of traveling to and from school**
 - School buses
 - Transit buses
 - Motorcoach services
 - Passenger vehicles driven by individuals 19 or older
 - Passenger vehicles driven by operators under 19 YO
 - Pedestrians and bicyclists

NAS Report - Findings



- **Every year, about 800 school-age children are killed in motor vehicle crashes during normal school travel hours -- weekday mornings and afternoons during school months**
- **These fatalities account for about 14 percent of the 5,600 child deaths that occur on the nation's roadways**
- **Children are at far more risk traveling to and from school in private passenger vehicles -- especially if a teen-age driver is involved -- than in school buses**
- **Bicycling and walking also place students at greater risk than traveling by school bus**

NAS Report - Findings



- **Of these 800 deaths**
 - Most (~74 percent) occur in private passenger vehicles
 - More than half of all the child fatalities occur when a teenager is driving
 - Many (~22 percent) are the result of pedestrian or bicycle accidents
 - Very few (~2 percent) are school-bus related

NAS Report



- Detailed recommendations
- Copies of this report is available at:

www.nap.edu

Search for "The Relative Risks of School Travel: A National Perspective and Guidance for Local Community Risk Assessment -- Special Report 269 (2002)"

Additional Research

Research Plan



- VRTC – Testing Additional Restraint Systems
- VRTC – Side Impact Protection
- Mercer University’s Engineering Research Center

VRTC Testing Completed



- **Testing Additional Restraint Systems**
 - 3-point seat – multi part seat system
 - Inflatable restraint system
- **Side Impact Work**
 - In progress
 - Looking at head impacts

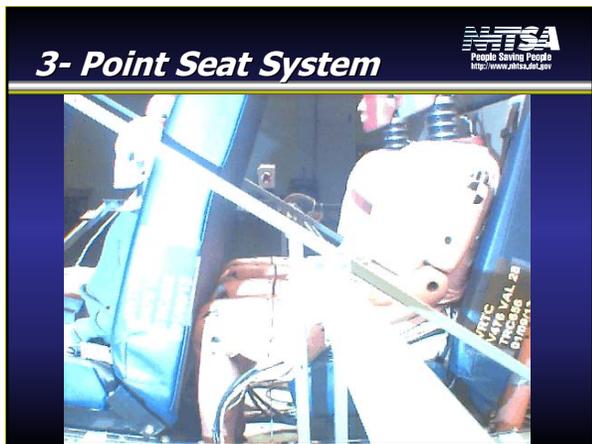
3- Point Seat System



- **I-M-M-I**
- **Integrated seat incorporating a three point (lap/shoulder) belt restraint system**
- **Protection for both belted and unbelted occupants**
- **Provides unique solution to this design/safety issue**





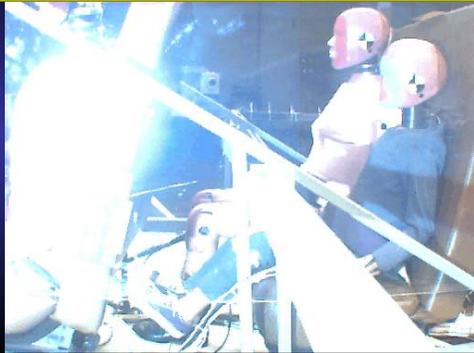


Air Bag System



- **AMSAFE Safety Restraint System**
 - Developed for use on airline passenger seats
 - Bag shape and volume fine tuned for school bus application
 - Installed in the webbing of the lap belt and deploys forward and upward into the space of the wearer and the seat back in front
- **Similar criteria response levels to those sled tests involving the lap/shoulder belt configuration**
- **Not Evaluated**
 - Out of position occupants
 - Effects of objects in the occupants lap

Air Bag System



Air Bag System



Safe-T-Bar



- Manufactured by The Majestic Companies, Ltd.
- Similar in concept to the lap bars frequently used in amusement park rides
- Padded bar rests on (or near) the lap of the occupant and locks in place during a crash
- It is not an appropriate restraint for higher severity environments

Safe-T-Bar



Mercer University's Engineering Research Center



- Developing a finite element model of a typical school bus construction
- Studying the effects of sidewall padding on occupant protection
- Developing a finite element model countermeasure to address side impact excursion
- Considerations are being given to the effect of seat pad contours and other parameters. The effectiveness of restraint systems for various size occupants is being assessed

Further Work and Documentation



- **ESV Report on SB research (5/03)**
- **Complete and document MERC's research and findings**
- **Complete side impact head injury research**

NHTSA SB Team



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