Conasauga, Tennessee
Railroad/Highway Grade Crossing Accident

March 28, 2000
Video camera on bus

View from video camera
Accident Simulation
Toxicology Testing

• Bus driver tested post-accident
  - Required by Federal law
  - Negative for alcohol and illicit drugs
  - Positive for substances common in over-the-counter medications

• Train crew tested post-accident
  - Not required by Federal law
  - Negative for alcohol and illicit drugs
Vehicle Simulation
Vehicle Simulation

• Developed based on the physical evidence and onboard recording devices
  ➢ Bus speed based on onboard video recorder
  ➢ Train speed based on event data recorder
  ➢ Vehicle damage patterns
  ➢ Final rest locations

• Characterizes the best fit to physical evidence
• Representative of the accident sequence but does not show the actual accident
Simulation Videos

• Dynamic camera view trailing school bus
• Static camera view detailing collision and motion to final rest
• School bus driver’s potential view
• Train engineer’s potential view
Vehicle Simulation Summary

- School bus speed at impact was about 15 mph
- Train speed at impact was about 51 mph
- Peak school bus accelerations:
  - 30 Gs lateral acceleration
  - 2500 deg/second rotational acceleration
- Peak train deceleration: less than 2 Gs
Vehicle Simulation Summary, Cont.

• Train was potentially visible for about 2 seconds from the school bus driver’s side window
• School bus was potentially visible for more than 4.6 seconds prior to impact
Issues

• Driver performance
• Passive grade crossing safety
• School district oversight
• Grade crossing databases
• Audibility
• Survival factors and occupant kinematics
• Intelligent transportation systems
Parties

• National Highway Traffic Safety Administration
• Federal Motor Carrier Safety Administration
• Federal Railroad Administration
• Tennessee Highway Patrol
• Polk County District Attorney’s Office
• Murray County, Georgia, School District
• CSX Transportation
Grade Crossing Safety
Grade Crossing Safety

- School bus drivers required to stop before crossing railroad tracks
- Driver stated she followed proper procedures
- Analysis of videotapes on bus indicated she did not stop
- Driver did not stop on at least eight previous occasions
Stop Signs at Passive Grade Crossings
Motor Carrier Safety
Murray County School District

- 74 buses
- 54 full-time bus drivers
- 7 substitute drivers
- Annual mandatory training
- Operation Lifesaver classes
Murray County School District Routing

• Grade crossings
  ➢ 18 in the school district
  ➢ 15 crossed by school buses
  ➢ Does not include accident crossing

• Changes in routing
• Recommended practices
  ➢ NHTSA’s Guideline 17
  ➢ NASDPTS’ *National School Transportation Specifications and Procedures*
  ➢ Annually plan and review school bus routes for hazards
• Murray County School District practice: no hazard identification
Murray County School District Oversight

- NASDPTS’ National School Transportation Specifications and Procedures
- Bus Drivers Manual: Procedures and Rules
- No documentation of performance evaluations
Fox River Grove, Illinois
Recommendations

• To NASDPTS:
  ➢ Encourage members to develop program for identification of school bus route hazards and
  ➢ Encourage members to routinely monitor and evaluate all bus drivers (H-96-52)

• To NASDPTS:
  ➢ Consider railroad/highway grade crossings when establishing routes (H-96-53)
Carrsville, Virginia
Recommendation

• To the States:
  ➢ Encourage local school districts to establish and enforce procedures to monitor driver compliance (H-85-4)
School Bus Routing and Driver Evaluation

• Prior to accident
  ➢ Driver failed to stop at crossing
  ➢ School district did not monitor drivers
  ➢ School district missed opportunity to identify problem
  ➢ School district did not identify route hazards

• Post-accident
  ➢ Route hazard recognition program
  ➢ Driver evaluation program
Grade Crossing Database
Federal Railroad Administration
Grade Crossing Inventory

• Maintained by the FRA
• Includes data from two sources:
  ➢ Grade Crossing Inventory (includes data from 1974 to latest records)
  ➢ Accident history (includes data from 1975 to latest records)
Grade Crossing Inventory

- Inventory of Liberty Church Road crossing:

<table>
<thead>
<tr>
<th></th>
<th>Database Entry</th>
<th>Actual</th>
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<tbody>
<tr>
<td>Subdivision</td>
<td>Knoxville</td>
<td>Etowah</td>
</tr>
<tr>
<td>Maximum speed</td>
<td>50 mph</td>
<td>60 mph</td>
</tr>
<tr>
<td>Trains per day</td>
<td>13</td>
<td>30 – 35</td>
</tr>
</tbody>
</table>

- Accident history accurate
Grade Crossing Inventory

- Inventory files provided voluntarily
- Erroneous and noncurrent data will alter accident prediction values
- FRA does not have authority to require States or railroads to update information
- Data from inventory needs to be accurate
FRA’s Web-based Accident Prediction System

- Ranks crossings by predicting number of collisions per year
- Raises awareness of potential danger at highway grade crossings
- Used in combination with other site-specific information in making decisions about crossing improvements
FRA’s Web-based Accident Prediction System

• Uses information about crossings’ physical and operational characteristics from Grade Crossing Inventory
• Uses 5 years of crossings’ accident history
FRA’s Web-based Accident Prediction System

- Helps school bus route planners become familiar with factors that affect crossing safety
- Helps route planners make decisions about school bus routing
School Bus Use and State Hazard Indexes

- Some States factor in school bus use
- Crossings may be upgraded more quickly if school bus use is part of hazard index
Train Horn Audibility
Audibility

• Driver required:
   Stop the bus
   Open loading door and driver’s window
   Turn off radio and listen
   Look both ways
   Proceed when clear

• Student did not hear train horn
• Driver did not turn off radio and open door or window
Testing

• Bus stopped, radio on, door closed: horn 4 decibels above ambient
• 10 decibels required for sound to reach alerting level
• Bus stopped, radio off, door open: horn 25 decibels above ambient
Speaker Placement

- Safety Board has made recommendations discouraging radio speaker placement near the driver
- Georgia informed local school districts
- Speakers still placed near the driver
Survival Factors and Occupant Kinematics
Survival Factors Issues

- School bus driver seat belt system anchor point locations
- School bus sidewall and seat frame exemption from Federal Motor Vehicle Safety Standard (FMVSS) 222
School Bus Driver Belt System

- Driver had been belted and was ejected
- Driver belt system anchor points spanned separated vehicle components
- Webbing failure occurred
- Potential for serious or fatal injury
Survival Factors

• FMVSS exemptions
  - Interior sidewalls
  - Other interior structures
• Serious or fatal injury to passengers in lateral collision; striking nonenergy-absorbing surfaces
• Focus on injury causation for passengers not directly in impact area
Passenger Injuries in Front Portion of School Bus

- Two front-row unbelted passengers were seriously injured and ejected; they impacted sidewalls and interior structures
- Second-row belted passenger not ejected; only passenger to sustain minor injury
Passenger Injuries in Middle Portion of School Bus

• Two unbelted passengers on right side were in area of direct impact and sustained fatal injuries
• One unbelted passenger on left side was propelled into area of intrusion and seriously injured
Passenger Injuries in Rear Portion of School Bus

• One unbelted passenger on left side in last row was outside impact area
• Propelled out of seat compartment across bus width and struck right sidewall
• Fatally injured
Serious and Fatal Injury Causation

- Passenger movement out of seat compartment
- Ejection
- Impact forces from collision
- Intrusion from locomotive into bus
- Impact into nonenergy-absorbing bus interior surfaces
Occupant Simulations
Occipant Simulations

• Developed based on crash pulse from vehicle dynamics simulation
• Known initial seating positions based on onboard video recorder
• Linear contusion pattern on passenger seated in back of bus
• Representative of occupant motion but does not show actual motion; valid for comparisons
Simulations

• Actual restraint conditions: all unrestrained except occupant in second row who was restrained with lap belt
• All occupants unrestrained
• All occupants lap belt-restrained
• All occupants lap/shoulder belt-restrained
Simulation Results
Occupant Simulation Summary

• Rear of bus:
  - High lateral and angular accelerations
  - Restraints not beneficial

• Front of bus:
  - Properly fitted restraints beneficial
  - When unbelted, occupants struck interior surfaces and were ejected
Board has investigated numerous accidents with passengers propelled out of seating compartments and injured.

Board has also found passengers who remained within seating compartments sustained serious and fatal injuries from striking nonenergy-absorbing interior surfaces in lateral impacts.
FMVSS 222

- Purpose: to reduce death and injury severity that result from impact of bus occupants against structures within vehicle during crashes and driving maneuvers
- Exempted: sidewall, window, and door structures
Intelligent Transportation Systems
In-Vehicle Warning Systems

- Alerts driver to oncoming train
- Minnesota and Illinois testing
- Previous recommendation
- DOT response
  - Not specific on guiding implementation
  - No further responses
  - No additional plans for testing
Emergency Response

- Passerby and train crew reported accident
- No delay in emergency response
- Rural area
- Driver incapacitated
Automatic Collision Notification

• ACN alerts authorities to collision
  ➢ Detects crash
  ➢ Transmits information to local 911 center

• Reduces notification time, particularly in rural areas
  ➢ From 9 minutes to 1 minute
  ➢ Could save 3,000 lives per year
Automatic Collision Notification

• Available on passenger cars
  - OnStar (GM, Acura, Saab)
  - ATX Technologies (Ford, Jaguar, Mercedes, Nissan)

• Not available on school buses

• Adequate emergency response important

• Concept same: quick and adequate response; modifications necessary