INSURANCE INSTITUTE FOR HIGHWAY SAFETY

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National Highway Traffic Safety Administration
400 Seventh Street, S.W.
Washington, D.C. 20590

Safety Rating Program for Child Restraint Systems
Docket No. NHTSA 2001-10053, Notice 1

Dear Dr. Runge:

In response to the Transportation Recall Enhancement, Accountability, and Documentation (TREAD) Act, the National Highway Traffic Safety Administration (NHTSA) has developed a plan to establish a child restraint safety rating information program to help consumers make informed buying decisions. The proposal includes plans to evaluate forward-facing restraints at this time; the feasibility of incorporating rear-facing restraints and/or booster seats into the rating system would be the subject of further research. The Insurance Institute for Highway Safety welcomes the opportunity to comment.

NHTSA has tentatively concluded that the most effective consumer information program would consider ease of use as well as performance of child restraints in crash situations. The Institute agrees that a good case can be made for consumer information about ease of use. Reported misuse of child restraints is high (Taft et al., 1999), and failure to restrain children remains the most important problem in child occupant crash protection. In 2000, there were 528 deaths and about 67,000 injuries among passenger vehicle occupants younger than 5 (NHTSA, 2000a,b). Among those fatally injured, 35 percent were completely unrestrained. It is not known whether nonuse of child restraints and incorrect use are due to difficulties in installing the restraints, but it is clear that nonuse and, to a lesser extent, misuse contribute to child injuries. To the extent that objective information about ease of use encourages consumers to purchase more convenient seats and leads child restraint manufacturers to improve their restraint designs to make them easier to use properly, NHTSA's proposed information program may succeed in reducing the risk of child injury in crashes.

The case for rating the performance of child restraints in dynamic tests is less clear. Even though they frequently are misused, child restraints reduce fatality risk in crashes by as much as 71 percent among infants and 54 percent among toddlers (NHTSA, 2001). Crash

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tests with child restraints yield little evidence of meaningful differences among available restraints in terms of the protection they afford. Real-world performance as well as crash test data suggest that the structural integrity of the vehicle, not the child restraint, is the principal limiting factor in restraint effectiveness.

Ease-of-Use Rating

Child restraints are complicated to install and use for a number of reasons including changing size requirements as children grow, incompatibility between child restraints and vehicle seat designs, and variations among vehicle seat belts that require different methods to attach a restraint securely to a vehicle seat. The result is that many parents, in spite of their best efforts, are not using or installing child restraints correctly.

Child seat inspection stations have sprung up all over the country to provide guidance to parents. A number of surveys conducted at such stations have found that 85-90 percent of child restraints are installed improperly or used incorrectly (Eby et al., 1997; Taft et al., 1999). A primary error is that restraints are not attached to vehicles securely. The new LATCH systems required in all new vehicles and child restraints starting September 1, 2002 should make it easier for parents to securely attach the restraints to the vehicle seats, but NHTSA needs to monitor the introduction of these systems. In an Institute (2001) study of the two child restraints that were available on the market at the beginning of 2001 with universal flexible attachments, researchers found that the straps did not allow for secure installation in some vehicles. Another problem uncovered at inspection stations is that the harness strap that secures a child to the seat often is not routed properly or can be too loose to hold a child securely in a crash.

To shed light on this issue, there needs to be a more thorough understanding of the mechanisms by which children are dying or sustaining serious injuries in crashes. In an attempt to understand the contribution of different factors in the deaths and injuries of children in child restraints, Institute researchers examined crashes from the National Automotive Sampling System/Crashworthiness Data System (NASS/CDS) electronic database (NHTSA, 2000c). Included were crashes during 1997-2000 in which a child in a child restraint (rearward-facing, forward-facing, booster, or shield booster) was seriously injured (MAIS 3+) or killed. Determining after the fact whether a child seat was correctly used can be difficult, so Institute researchers evaluated crash and occupant dynamics, possible injury mechanisms, photographic evidence, and the NASS investigator’s best judgment to determine whether the seats were improperly used in the crashes.

Preliminary findings of this study, which still is under way, can provide some insight into the mechanisms of injury. Overall there were 32 qualifying crashes: 10 frontal, 8 side impacts, 8 rollovers, 5 with rear damage, and 1 sideswipe. Among the 10 frontal crashes in which a child was injured, 3 were fatal. In 2 of the 3 fatal crashes, injuries were thought to be due to vehicle intrusion. In one case (PSU 2000-11-130A), a 2000 Honda Odyssey sustained massive structural damage after hitting a gravel truck head on (Figure 1A). All four occupants in the first two seating rows were killed, including an infant in a rear-facing restraint positioned in the leftmost seat of the second row (Figure 1B) who died of head injuries. There was only one surviving occupant, an 8-year-old belted child in the third row. The second case (PSU 1997-45-14B) involved a high-severity impact (estimated delta V 44 mph) of a 1989 Subaru GL with a 1988 Ford F series pickup (Figure 2A). The infant, who was in a rear-facing restraint in the center of the rear seat (Figure 2B), died as a result of head injuries, attributed to contact with the back of the vehicle's front seat. In the third fatal case (PSU 2000-09-173B), the cause of death was not known. A 2-year-old child, believed to be in a restraint in the right rear seat, died after the 1987 Chevrolet Nova in which she was riding was in a high-severity crash (estimated delta V 40 mph) with a 1991 Lincoln Continental (Figures 3A,B). Four of the five occupants were killed. The one survivor was a 5-year-old boy seated in the center rear seat, reported by NASS investigators to have been unbelted.

In the seven nonfatal frontal crashes, preliminary examination suggests that in three cases the injuries to children may have resulted from severe crash forces; another three may have been because of child restraint misuse; and the last case involved a 5-year-old child in a shield booster who sustained head (MAIS 4) and leg (MAIS 3) injuries after hitting the dashboard. Dynamic testing of shield boosters by NHTSA has shown they can allow too much forward movement and are not recommended for use with the shield (if used, it is recommended that the shield be removed and used as a booster seat with an adult belt) (Naab, 1988; Meissner et al., 1994).

Among the three cases in which very high crash forces were thought to be responsible for the injuries, one case (PSU 2000-45-85K) involved a child restraint that seemed to have done a remarkable job of protecting the child in a very high-severity crash (estimated delta V 50 mph). A 1991 Pontiac Sunbird left the road and hit a tree, uprooting the tree (Figure 4A). The 1-year-old child in a forward-facing restraint with an overhead shield positioned in the left rear seat (Figure 4B) sustained only leg fractures (MAIS 3), likely due to contact with the intruding front seat. In the second case (PSU 2000-09-173B), an infant in a rear-facing seat sustained a cerebral hematoma and subdural hemorrhage (AIS 4) after the 1991 Lincoln Continental in which she was riding hit a 1987 Chevrolet Nova head on before rolling and coming to rest with its roof against a pole (no photos available, estimated delta V 25 mph). The injuries were thought to be due to noncontact forces. In the third case (PSU 2000-11-134K), a 1-year-old female in a forward-facing restraint with an overhead shield positioned in the center rear seat survived after sustaining spinal cord separation in a severe crash (estimated delta V 35 mph) when a 1994 Ford Tempo ran off the side of the road and hit a tree (Figures 5A,B). The shield was broken in the crash; however, the spinal injuries were believed to be the result of noncontact forces.

Among the three suspected cases of restraint misuse, one (PSU 1997-48-217K) involved a restraint that was not secured to the vehicle. The 1-year-old child in a forward-facing restraint with a T-shield in the right front seat sustained a skull fracture after she hit the windshield when the 1988 Ford Taurus struck a tree (estimated delta V 29 mph)(Figures 6A,B). In another case (PSU 2000-45-62K), a 1-year-old child in a forward-facing restraint with an overhead shield sustained head injuries (MAIS 4) after the 1994 Honda Civic in which she was riding struck a 1999 GMC Yukon head on (Figure 7)(estimated delta V 36 mph). The NASS investigator reported that the restraint was not properly anchored to the vehicle seat and attributed the head injuries to impact with the child restraint. The third case in which misuse was suspected (PSU 1998-09-48K) was a severe frontal offset crash on the driver’s side of a 1992 Ford Tempo (estimated delta V 30 mph), which hit a 1996 Jeep Cherokee. The 1-year-old child in a rear-facing convertible restraint with an overhead shield in the right rear of the vehicle sustained head injuries (AIS 4), whereas her 2-year-old brother positioned in a child restraint in the left rear of the vehicle sustained only minor injuries. The harness was routed incorrectly in the upper slots and may have allowed the child too much movement (Figure 8). The NASS investigator attributed the injuries to impact with the restraint.

From this preliminary analysis of frontal crashes, there is some evidence that improvements in the ease of child restraint installation have the potential to reduce injury severity if the improvements lead to fewer incidences of gross misuse. A similar analysis of side impact and rollover crashes suggests that gross misuse of child restraints also may be a factor in some of those fatal and serious injuries. Among all 32 NASS/CDS cases reviewed by the Institute involving serious or fatal injuries to restrained children, 18 cases were attributed to misuse; 10 involved improper attachment of the restraint to the vehicle, and 8 involved problems with securing the child in the restraint.

The agency is proposing to rate ease of use through four categories: assembly, evaluation of labels/instructions, installation in the vehicle, and securing the child. The Institute believes, based on the above NASS analysis, that the most important features of the rating system are the last two (attaching the child restraint to the vehicle and securing the child in the restraint).

Dynamic Testing
NHTSA also is proposing to rate the dynamic performance of forward-facing restraints in frontal crashes. The basis would be either sled tests or in-vehicle testing as part of the frontal crash test component of the New Car Assessment Program (NCAP). The current proposal does not include side impact testing, but such testing might be considered in the future. The rationale for rating seats based on the results of dynamic testing is that seats with good test performances should provide superior protection to children in real-world crashes. However, there is no indication from the results of the preliminary analysis of frontal crashes in NASS/CDS that improvements in child restraint design to better withstand crash forces could have prevented or mitigated any of the serious and fatal injuries. In some cases, the child restraints did an excellent job of preventing further injury, even when misuse was a factor. In other cases, crash forces were so severe that it is not clear what could have been done to prevent the injuries.

NHTSA’s own sled tests are consistent with this conclusion. NHTSA has examined three dynamic test methods for rating forward-facing restraints: a 30 mph frontal sled test (similar to the FMVSS 213 test), a frontal sled test conducted at 35 mph, and a full-scale 35 mph frontal NCAP test. The agency conducted 50 sled tests of forward-facing seats at 30 mph using the Hybrid II 3-year-old dummy. Regardless of whether a top tether was used to secure the seats, all injury measures were well below injury assessment reference values. NHTSA has proposed that compliance margins be used to rate the seats. This is problematic because currently there is no basis to conclude that a child restraint exceeding the compliance margin by, for example, 60 percent would perform any better in the real world than one that exceeded the margin by only 50 percent. Furthermore, when NHTSA conducted additional testing at a higher speed (35 mph) using the Hybrid III 3-year-old dummy, there still was little discernible difference among the nine restraints that were tested. Injury risk curves plotted using chest acceleration and head injury criterion (HIC) data indicated that all but one seat would earn five stars and the ninth would receive a borderline four/five star rating. Thus, there does not appear to be sufficient variation in the crash performances of the seats to justify a consumer crash rating program.

In some countries child restraints are included as a part of vehicle crash tests. For example, in Europe child restraints are installed in the rear seats of vehicles that are undergoing high-speed frontal offset and side impact crash tests as part of the EuroNCAP program. Based on child restraint performances, points are earned to boost a vehicle's overall score. This system may be effective in the long run in persuading vehicle manufacturers to accept greater responsibility for the performance of child restraints in their vehicles, but it does nothing to inform consumers who have different vehicles about how a specific restraint would perform in their vehicles.

Plans are afoot in Australia, a EuroNCAP partner, to go one step further and actually rate the restraints themselves based on in-vehicle crash tests. But there are a number of distinct disadvantages. One is that, because so few vehicles are tested and only one or two restraints can be installed for each test, the tests can provide useful information for only a small number of vehicle/child restraint combinations. All other combinations would remain unknown. Even more problematic is that performance of a child restraint is highly dependent on the performance of the vehicle itself. NHTSA placed child restraints in 20 NCAP tests (35 mph frontal impacts) of vehicles of varying types and sizes. Six different forward-facing restraints were evaluated using the Hybrid III 3-year-old dummy. These full-scale crash tests did reveal differences among the child restraints, but it was clear that the differences were not due solely to differing restraint performances. The performance of the same restraint varied when tested in different vehicles. For example, a Fisher Price Safe Embrace II was tested in two vehicles of the same class. The restraint performed much better in a Ford Windstar (better chest accelerations and HIC measures) than in a Dodge Grand Caravan, indicating that the vehicle can influence crash injury risk to children. This is true when a child is properly restrained. Further NHTSA analysis indicates that a vehicle's structural response (i.e., duration of crash and peak acceleration) has an important influence on child restraint performance, especially for chest injury measures.

The agency believes one advantage of this testing program would be to address the compatibility of vehicle and child restraint systems. However, the Institute believes this issue would be better addressed under the ease-of-use rating.

Conclusions

By far the biggest problem contributing to child injury and death in motor vehicle crashes is nonuse of restraints. When used, child restraint systems are doing a good job of reducing fatalities in spite of apparently high rates of misuse. However, there is preliminary evidence that gross misuse -- e.g., child restraints that are not attached, or loosely attached, to vehicles; harnesses that do not properly secure a child to the restraint -- may be contributing to injuries and deaths. Further in-depth analysis of crashes in which children in child restraints have sustained serious and fatal injuries should be undertaken to better understand the mechanisms of these injuries.

Less clear is the extent to which dynamic tests of child restraints would provide consumers with meaningful information or result in meaningful design changes. Many of the crashes in which children sustain fatal injuries are unsurvivable without major improvements to vehicle structure. The outcome of many crashes in which children sustain serious injuries also may improve with improvements to vehicle structural designs. This is supported not only by the Institute’s analysis of real-world crashes but also by NHTSA’s own in-vehicle crash tests.

The agency should consider providing consumers with a rating that evaluates the ease of use of forward-facing restraints. An ease-of-use rating may encourage manufacturers to provide clearer information on proper installation and promote better consumer understanding of the proper use of child restraint systems. In particular, a rating system could encourage manufacturers to adopt child restraint designs that will make it easier for parents to both install restraints in vehicles and secure children in the restraints. The advent of the LATCH system should go a long way toward making it easier to securely attach restraints to vehicles, but NHTSA needs to ensure that the anchorage systems being adopted are compatible across the complete spectrum of vehicles. The goal should be to enable consumers to properly install child restraints with minimal confusion. One additional possible benefit of easier-to-install child restraints might be that parents would be more willing to restrain their children.

Sincerely,

Susan A Ferguson

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cc: Docket Clerk, Docket No. NHTSA 2001-10053

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Figure 1A
NASS/CDS Case PSU 2000-11-130A: 2000 Honda Odyssey Passenger Van

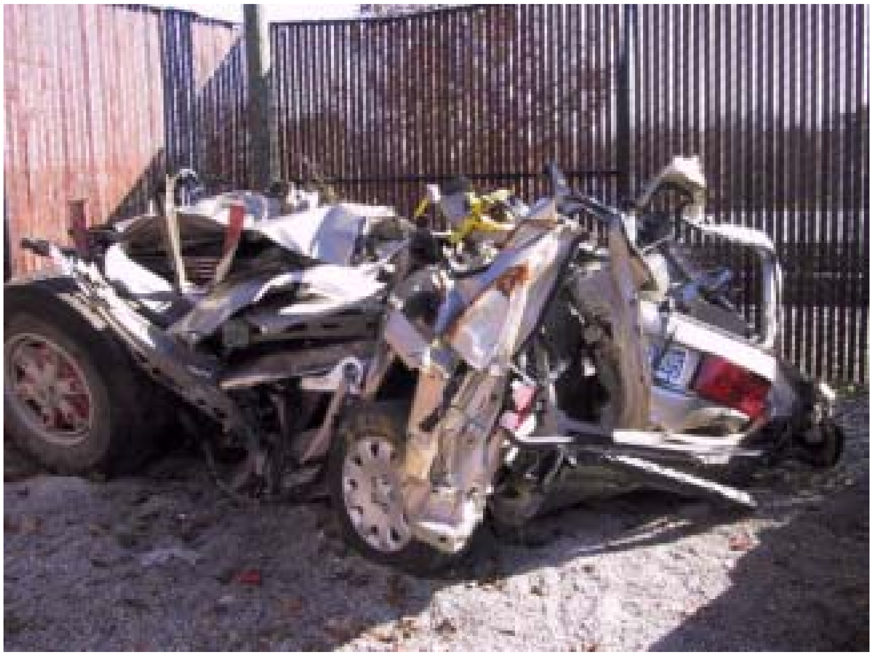

Figure 1B
NASS/CDS Case PSU 2000-11-130A: Leftmost Seat of Second Row with Child Restraint

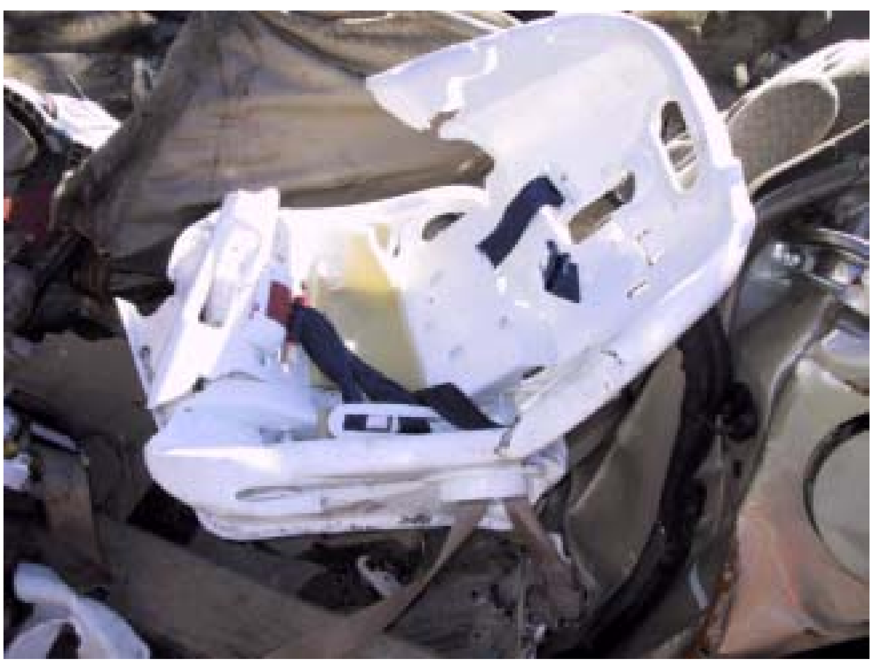

Figure 2A
NASS/CDS Case PSU 1997-45-14B: 1989 Subaru GL Four-Door Car

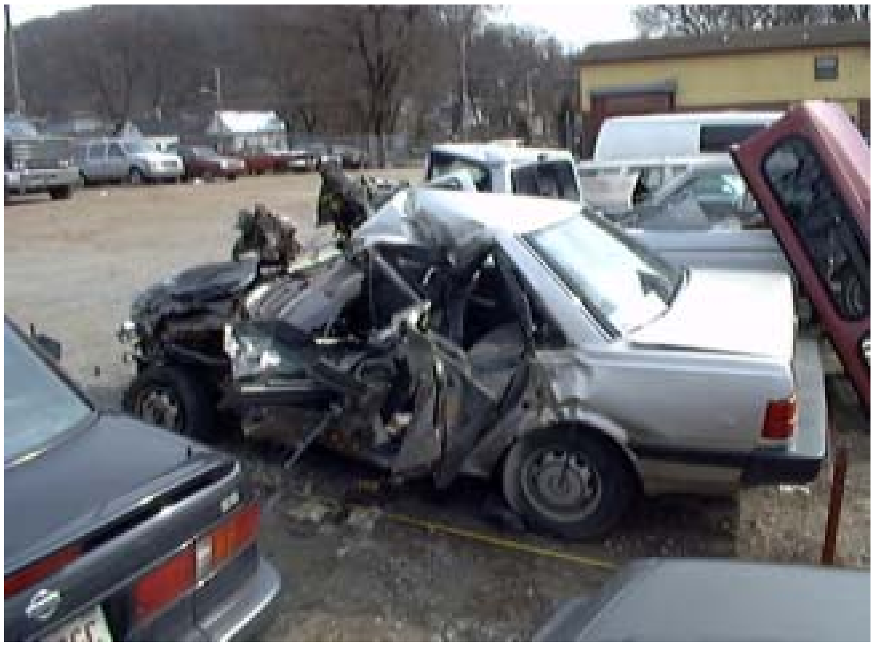

Figure 2B
NASS/CDS Case PSU 1997-45-14B: Center of Rear Seat without Child Restraint

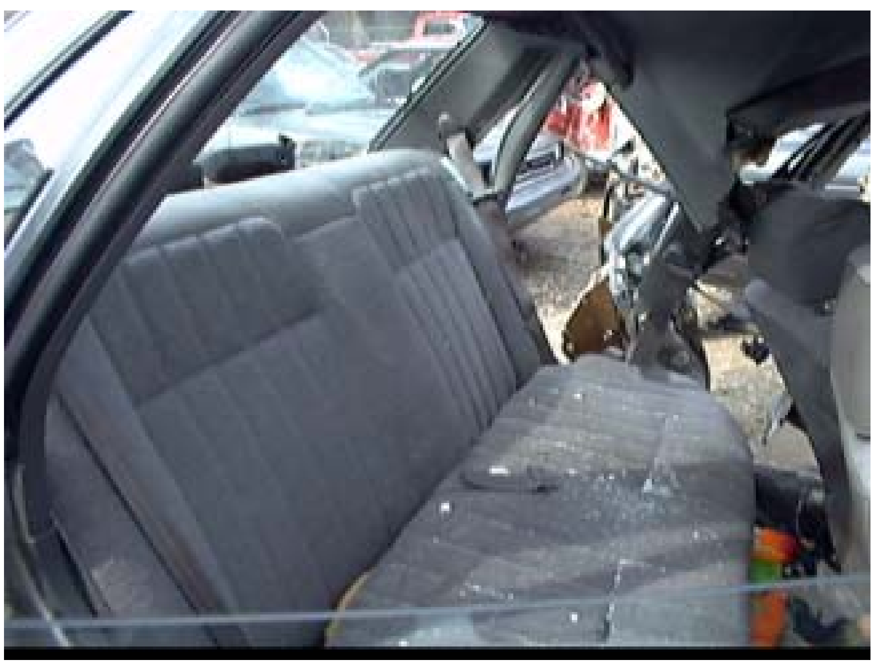

Figure 3A
NASS/CDS Case PSU 2000-09-173B: 1987 Chevrolet Nova Four-Door Car
(Other Exterior Photos Unavailable)

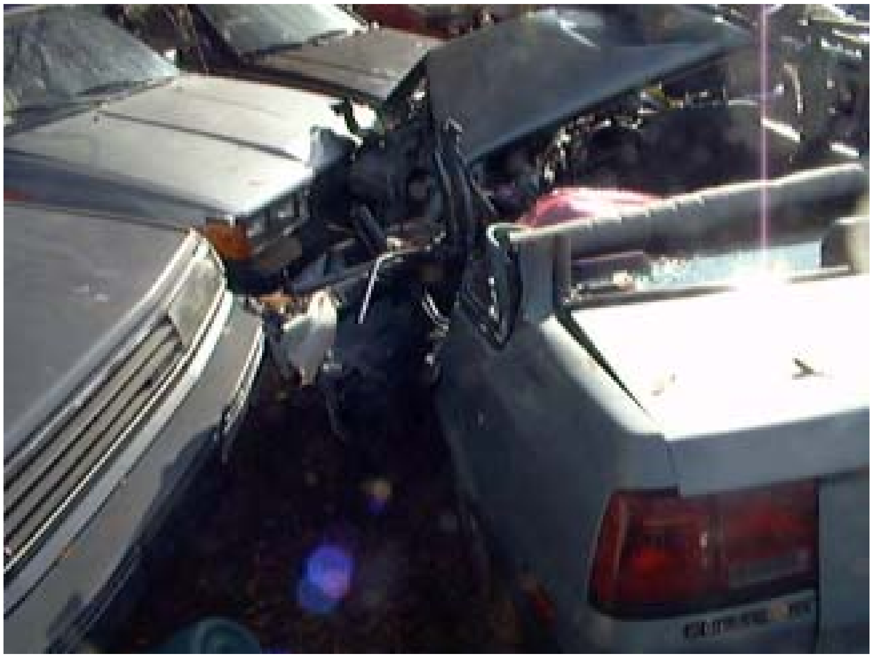

Figure 3B
NASS/CDS Case PSU 2000-09-173B: Right Rear Seat without Child Restraint

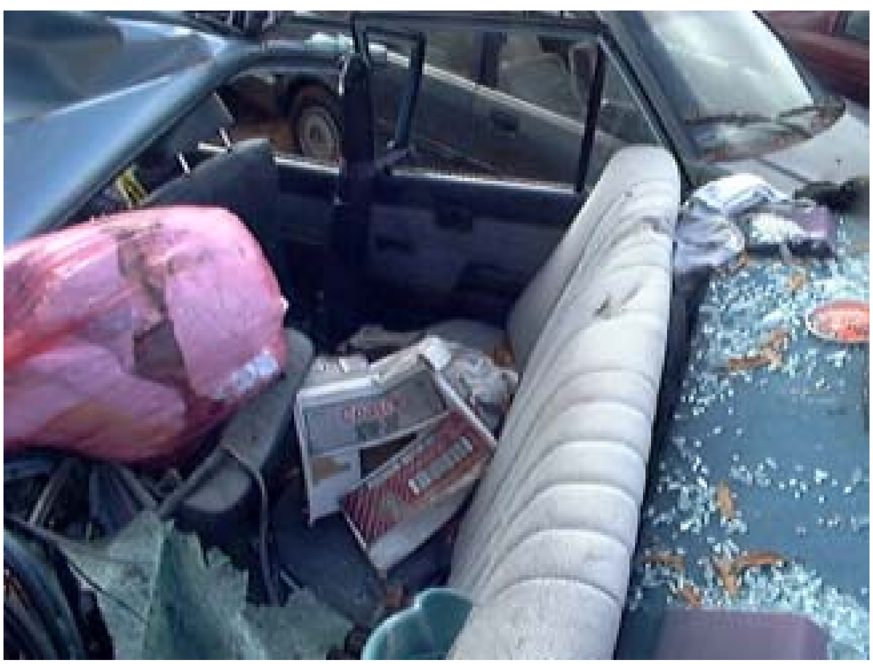

Figure 4A
NASS/CDS Case PSU 2000-45-85K: 1991 Pontiac Sunbird Two-Door Car

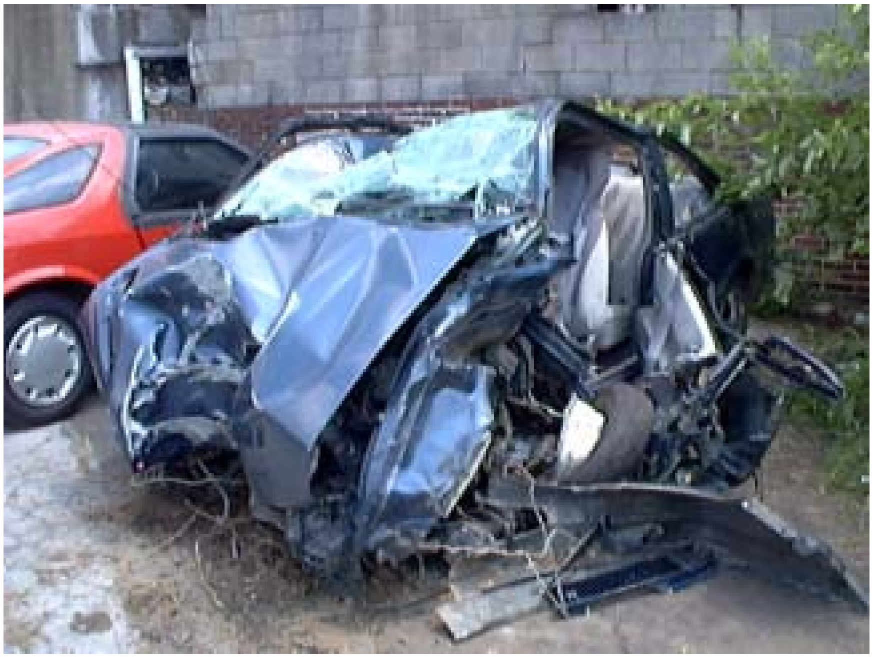

Figure 4B
NASS/CDS Case PSU 2000-45-85K: Left Rear Seat without Child Restraint

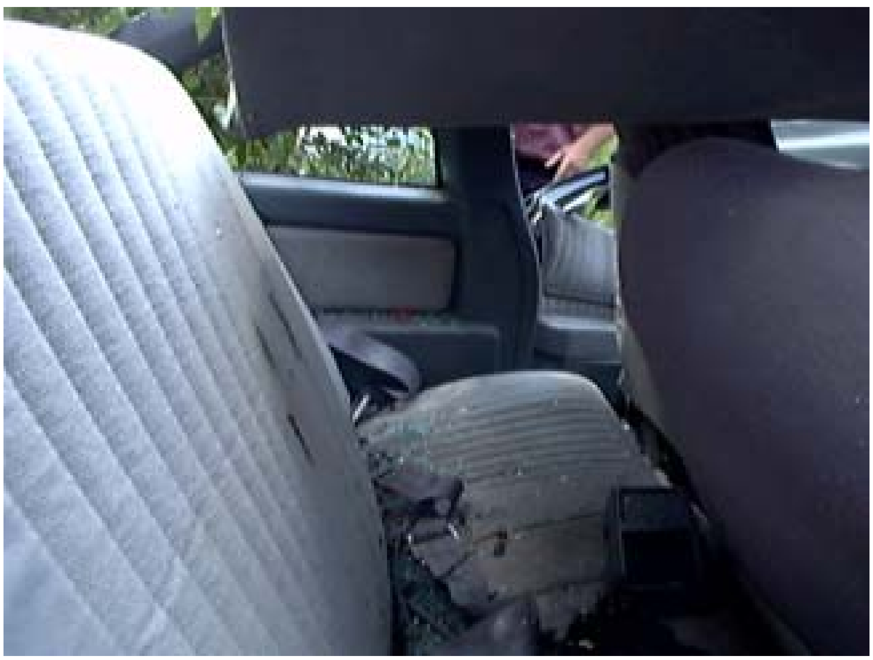

Figure 5A
NASS/CDS Case PSU 2000-11-134K: 1994 Ford Tempo Four-Door Car

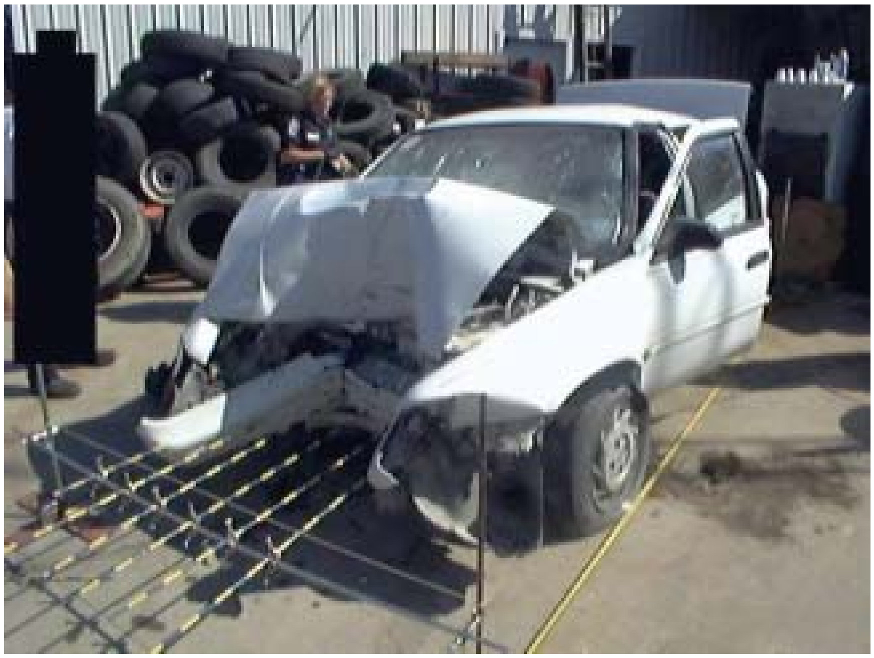

Figure 5B
NASS/CDS Case PSU 2000-11-134K: Center Rear Seat with Child Restraint

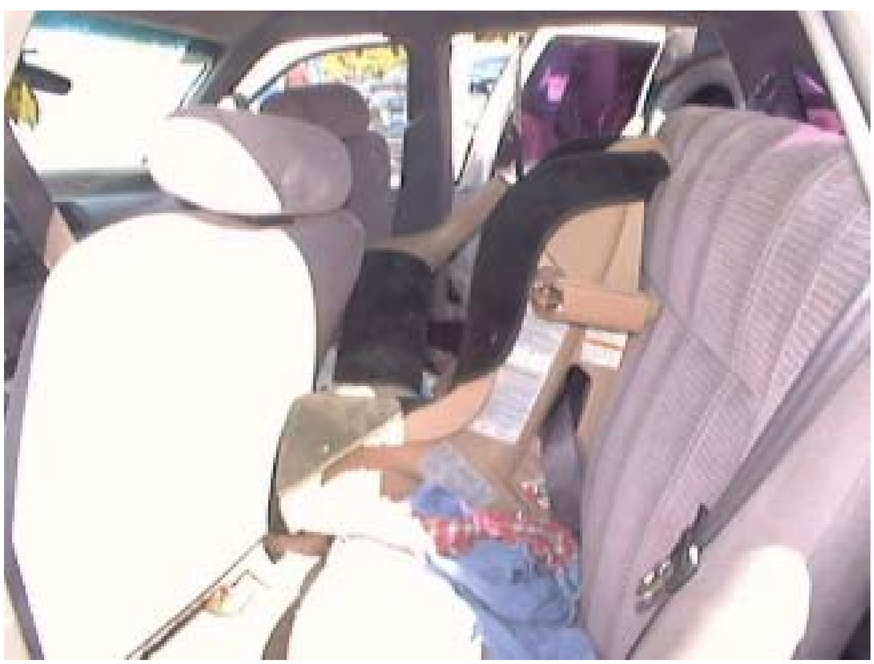

Figure 6A
NASS/CDS Case PSU 1997-48-217K: 1988 Ford Taurus Four-Door Car

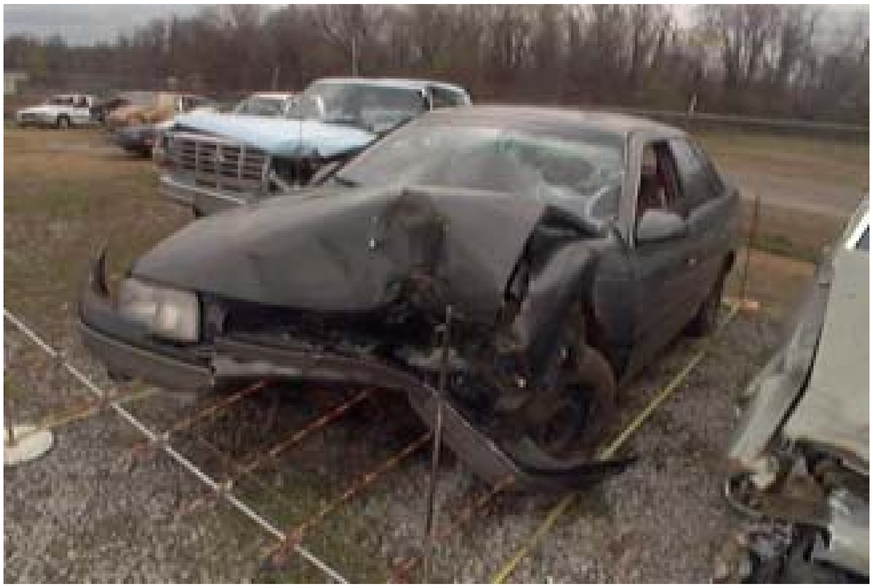

Figure 6B
NASS/CDS Case PSU 1997-48-217K: Windshield Contacted by Child

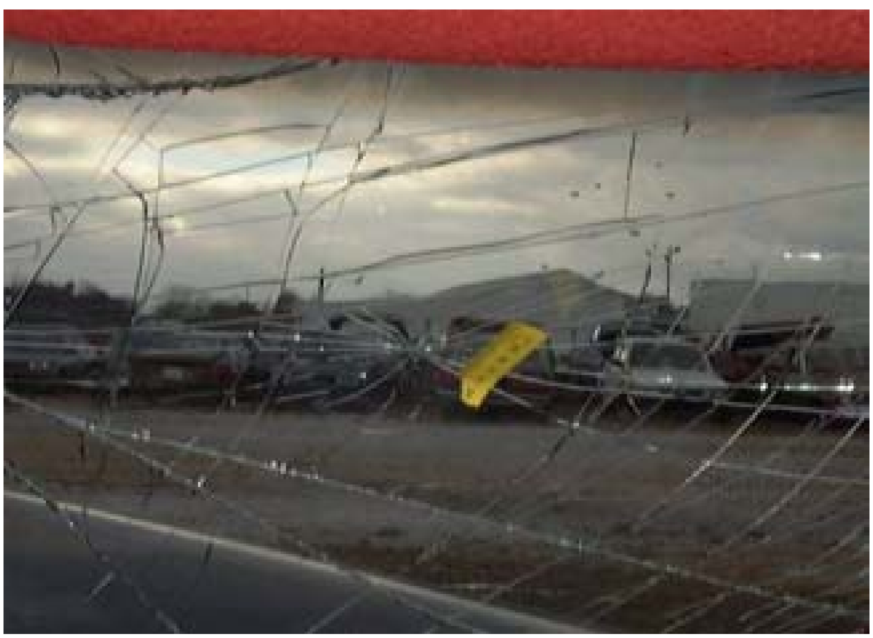

Figure 7
NASS/CDS Case PSU 2000-45-62K: 1994 Honda Civic Two-Door Hatchback

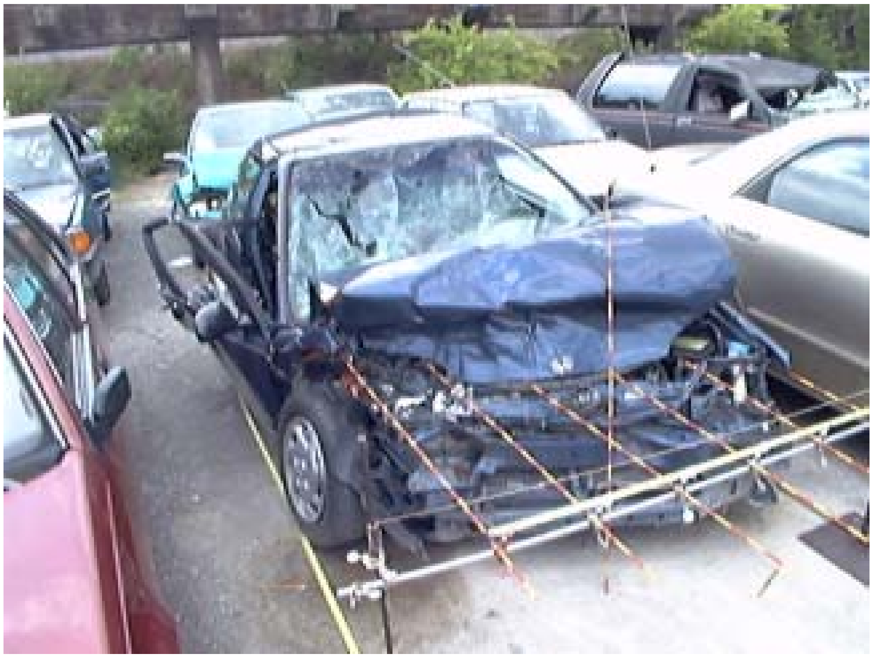

Figure 8
NASS/CDS Case PSU 1998-09-48K: Harness Misrouted in Top Slots Rather Than Middle Slots (From 1992 Ford Tempo Four-Door Car)