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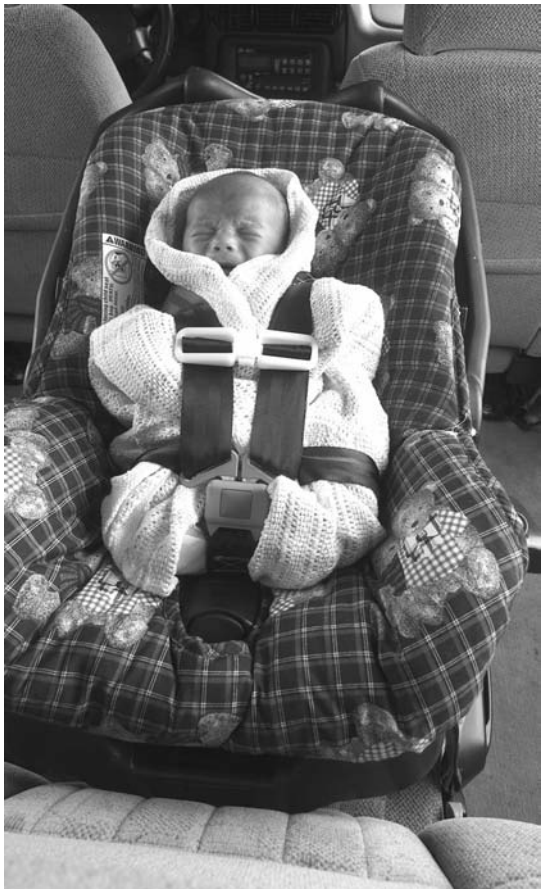
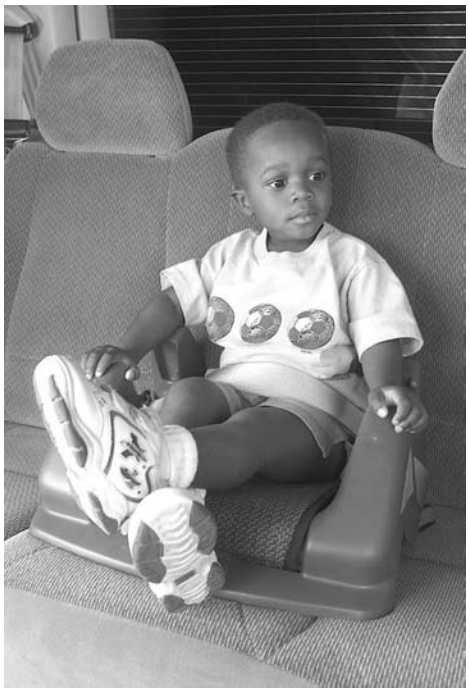
Misuse of Child Restraints





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16. Abstract

The purpose of this study was to obtain a measure of the current level of misuse of child restraint systems (CRSs) among the general public. The project focused specifically on forms of misuse that can be expected to raise the risk of injury. CRS use and critical misuse data were collected in the Fall of 2002 for 5,527 children weighing less than the driver-estimated weight of 80 lb in 4,126 vehicles in 6 States: Arizona, Florida, Mississippi, Missouri, Pennsylvania, and Washington.

Results showed that 62.3 percent of these children were restrained in a CRS; 25.9 percent were restrained in a safety belt (SB); and 11.8 percent were unrestrained. By weight class, CRS use was 97.1 percent for children less than 20 lb; 86.4 percent for children 20 to 39 lb; 41.7 percent for children 40 to 59 lb; and 10.9 percent for children 60 to 79 lb.

Overall critical CRS misuse was 72.6 percent. Most common critical misuses were loose harness straps securing the child to the CRS and loose vehicle SB attachment around the CRS. Other types of CRS misuses were also observed and recorded in the study. A positive relationship was found between drivers using safety belts and children being restrained—91.7 percent of the children who were transported by belted drivers were restrained in either a child restraint system or a safety belt, compared to 62.3 percent of the children transported by unbelted drivers. Recommendations are provided for periodic monitoring of CRS misuse, research needs, and enforcement and education.

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PREFACE

The objective of this project was to obtain a measure of the current level of misuse of child restraint systems (CRSs) among the general public. The project focused specifically on forms of misuse that can be expected to raise the risk of injury. Over 4,100 vehicles and over 5,500 children weighing less than the driver-estimated weight of 80 lb, from 6 States (Arizona, Florida, Mississippi, Missouri, Pennsylvania, and Washington), were observed in the study. Data were collected in the Fall of 2002.

The authors wish to thank many individuals and organizations for their time and effort. The authors would first like to express their appreciation to the State site coordinators (SSCs) who were responsible for field operations in their respective States. They are Nancy Avery (Tucson SAFE KIDS), Kay Brodbeck and Cynthia Huff (Mississippi Safety Services), Kathy Kruger (Washington Safety Restraint Coalition), Cathy Metzger (SAFE KIDS St. Louis), Juli McGreevy (Pennsylvania consultant), Robert Mott (South Central Pennsylvania Highway Safety Program), and Lorrie Walker (Florida Traffic Safety Resource Center, Florida Atlantic University).

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EXECUTIVE SUMMARY

This study was conducted for the National Highway Traffic Safety Administration (NHTSA). The purpose of this study was to obtain a measure of the current level of misuse of child restraint systems (CRSs) among the general public. The project focused specifically on forms of misuse that can be expected to raise the risk of injury.

RESEARCH METHODOLOGY AND DATA COLLECTION

Key research task activities included: (1) conducting a workshop with National experts on CRS misuse, injury prevention, and crash data to develop appropriate critical misuse measures; (2) selecting State sites and State site coordinators (SSCs) in six States; (3) holding a train-the-trainer workshop with SSCs and their field site managers (FSMs) to finalize CRS misuse definitions and data collection instruments, and to discuss recruitment and training techniques; (4) conducting field observations; (5) conducting data entry and analysis; and (6) preparing the final report.

A workshop was held within five months of the project start date with leading medical, bioengineering, and injury prevention experts in the field. The workshop included discussions on types of child injury severity in crashes; identification of the types of CRS misuse and their relationship to serious injury; and identification of the most important CRS misuse measures to include in data collection. Areas identified for critical CRS misuse measures in the workshop were: age and weight appropriateness of CRS; direction of CRS; placement of CRS in relation to air bags; installation of CRS to the vehicle seat; secureness/tightness of harness straps and crotch strap of the CRS; secureness/tightness of the vehicle safety belt (SB) to the CRS; locking clip use for vehicle SBs; fit of SBs across the children in belt-positioning booster seats; and damaged CRSs.

Six States (Arizona, Florida, Mississippi, Missouri, Pennsylvania, and Washington) were selected as data collection sites. States were selected based on their representing diverse geographic regions across the country; and encompassing diversity in socio-demographic and economic characteristics across field sites. The field sites included urban, suburban, and rural areas. It was critical for each State to have a qualified and experienced State Site Coordinator (SSC) who was familiar with managing field observations and could easily gain permission to conduct observations at sites in their area. State regional areas included Tucson (AZ); Boca Raton, Fort Myers, Fort Pierce, and Miami (FL); Jackson (MS); St. Louis (MO); Carlisle, and Harrisburg (PA); and Seattle and Tacoma (WA). Field observation sites were primarily parking areas at community shopping centers, child merchandise department stores, fast food restaurants, health and medical facilities, and community events.

A train-the-trainer workshop was held with SSCs and FSMs approximately one month before data collection to finalize CRS misuse definitions and data collection instruments. The workshop also covered recruitment of greeters and field observation staff; training techniques; data collection procedures; and project administration details.

Most sites conducted recruitment and training of staff in September 2002. It was required that all field observers be AAA certified CPS technicians. Data were collected from late September 2002 to early January 2003. Most of the States completed their data collection efforts by mid-November 2002. Project staff checked quality of data on a daily basis for the first two weeks and then weekly. Data entry and analysis were then conducted. A summary of the results was presented to NHTSA before the completion of the draft final report.

RESULTS

A total of 4,126 vehicles and 5,527 children weighing less than the driver-estimated weight of 80 lb were included in the study. There were 511 children weighing less than 20 lb; 2,483 children weighing 20 to 39 lb; and 2,533 children weighing 40 to 79 lb. By age category there were 676 children less than 1 year of age; 2,021 children from the ages of 1 through 3; 2,571 children from ages 4 through 8; and 259 children ages 9 and older.

For the total sample of children weighing less than 80 lb, 62.3 percent were restrained in CRSs, 25.9 percent were restrained in SBs, and 11.8 percent were unrestrained. CRS use by weight classification was as follows: 97.1 percent for children weighing less than 20 lb; 86.4 percent for children weighing 20 to 39 lb; 41.7 percent for children weighing 40 to 59 lb; and 10.9 percent for children weighing 60 to 79 lb. Safety belt (SB) use increased markedly for children 40 lb and over. SB use was 43.1 percent for children weighing 40 to 59 lb; and 64.9 percent for children weighing 60 to 79 lb. By age category, CRS use was 97.3 percent for children younger than 1 year, 90 percent for children ages 1 through 3, 37.2 percent for children ages 4 through 8, and 3.1 percent for children ages 9 and older. SB use increased markedly for children 4 through 8 years of age to 45.5 percent.

One or more critical misuses were found in 72.6 percent of all CRSs observed. Percentages of CRSs with critical misuses by seat type were as follows: infant (83.9 percent); rear-facing convertible (83.5 percent); forward-facing convertible (81.9 percent); forward-facing only (79.3 percent); belt-positioning booster (39.5 percent); and shield booster (60.5 percent).

The most common critical misuses were loose harness straps securing the child to the CRS and loose SB securing the CRS to the vehicle. Harness retainer clip misuse was also prevalent, but not deemed as a critical misuse in this study.

Other CRS misuse problem areas were also observed. They included visible damage to the CRS (e.g., cracked seat shell, torn harness strap, broken harness parts); percent of CRS base (bottom of seat) contacting the vehicle seat; and presence of aftermarket devices.

Forty-two observations of LATCH (Lower Anchors and Tethers for CHildren) were noted. Field observers found three seats with improperly used lower anchors, and three seats with improperly used tethers. Six seats were observed with both a safety belt and the lower anchors in use.

Children being transported by drivers who are restrained in SBs are more likely to be restrained than children who are being transported by unrestrained drivers. Of the observed

drivers, 77.4 percent were restrained. When drivers were wearing a SB, 91.7 percent of children were restrained in either a CRS (44.2 percent) or SB (47.5 percent). When drivers were not restrained, only 62.3 percent of children were restrained in either a CRS (43.2 percent) or SB (19.1 percent).

Air bag systems were also observed. Driver frontal air bags were noted in 83.1 percent of the vehicles; passenger frontal air bags were found in 71.8 percent of the vehicles. Side air bags protecting passengers in the front seat were observed in 4.6 percent of the vehicles, and side air bags protecting passengers in both the front and rear seats were observed in 1.3 percent of the vehicles. Only a small percentage of the vehicles (less than 5 percent) had on/off air bag switches. For 88 vehicles checked for status of this on/off switch, 51 vehicles had the switch "on" and 37 had the switch "off." Sixteen children were in the front passenger seat with an activated ("on") air bag switch; 2 of these children were in a rear-facing CRS, 4 were in a forward-facing seat, 3 were in a SB, and 7 were unrestrained.

RECOMMENDATIONS

Periodic monitoring of CRS misuse among the general public is recommended because of continuous upgrades and design changes to vehicle occupant protection systems and CRS models (e.g., LATCH systems, side air bags); frequent changes (strengthening) of occupant protection laws in States; and a perpetual supply of new parents responsible for protecting child passengers in vehicles. CRS misuse observations with the general public should be made by qualified and experienced personnel who are trained to gather CRS misuse data. Train-the-trainer workshops for supervisors, field managers and senior field observers prepare staff for field observations. At least two full days should be spent training field observers.

Continued enforcement of CPS laws is recommended, and there is general public acceptance for the enforcement of these laws. Programs need to be developed to make law enforcement agencies aware of the importance of correct CRS use, as well as keeping children in CRSs for as long as possible. Enforcement strategies need to be developed to identify booster seat law violations. Law enforcement should also continue to take an active role in community-based CRS education programs.

Education programs should continue to promote proper use of CRSs, enforcement of laws, availability of CRS inspection stations, loaner programs, and local and National CRS hotline information assistance. Programs should also provide information about LATCH systems and correct usage of the LATCH system.

1.0 INTRODUCTION

This chapter presents background information on the purpose of this study; characteristics of child restraint systems (CRSs); observational studies of CRS use and misuse; injuries associated with types of CRS misuse; and field observation techniques.

1.1 BACKGROUND

The number of young child passengers in vehicles who are either improperly placed in child restraint systems (CRSs) or moved into adult vehicle safety belts (SBs) prematurely is at an alarmingly high rate (Spurlock, Kidd, Mays, McCool, Buckner, Clatos, Rochussen, and Leach, 1998; Taft, Mickalide, and Taft, 1999; Kohn, Chausmer, and Flood 2000; and Morris, Arbogast, Durbin, and Winston 2000). In the mid-1990s, a National CRS misuse study involving random observation checks of the public found 79.5 percent CRS misuse (Decina and Knoebel, 1997). Current CRS fitting station studies, which involve more of a pre-selected sample of volunteer and safety conscious parents/guardians, report over 90 percent misuse (NHTSA, 2001).

Current research also focuses on the injury patterns associated with types of CRS misuse, especially the premature graduation of children to either booster seats or SBs. In general, these studies (Kelleher-Walsh, Walsh, and Duffy, 1995; National Transportation Safety Board, 1996; Winston, Durbin, Kallan, and Moll, 2000; and Morris, Arbogast, Durbin, and Winston, 2000) have shown that head and facial injuries are predominant regardless of impact point or seat position. There is also a high risk of abdominal injury associated with improper booster seat use or premature graduation to a SB. For children restrained in CRSs, there is a high frequency of shoulder injuries related to harness misuse. In addition, spinal cord injuries result from infants being placed in the forward direction in a CRS. As expected, there is also a significantly increased likelihood (3 times) of serious injury among unrestrained children who are involved in a crash.

Federal, State, and local governments, as well as health care providers and community safety outreach programs (e.g., SafeKids Coalitions) have made a tireless effort to educate the public on proper CRS use. National and State campaigns, as well as local programs incorporating child safety seat inspection stations, are in progress. However, CRSs and vehicle restraint systems can be complicated. Dozens of CRS makes/models exist. A different CRS may be needed for each early life stage. Many CRSs cannot fit securely in certain vehicle seats; nor can certain vehicle safety belts tighten enough to properly secure CRSs to the vehicle seat. In addition, CRS technology continues to evolve (e.g., LATCH system). To complicate this issue even more, there is always a continuous stream of new parents/guardians who need to be educated on each type of CRS (i.e., infant, convertible, and booster); and there are some economic constraints.

To address these concerns, it is important for NHTSA to periodically monitor the status of CRS misuse in the Nation. This study sought to focus specifically on CRS misuse measures that have the most practical consequence in terms of the risk of injury to a child when involved in a motor vehicle crash.

Characteristics of Child Restraint Systems (CRSs)

Child restraint system designs vary according to the size of the child they are designed to restrain, the direction the child should face, the type of internal restraining system, and the method of installation. CRSs are designed for coupling the CRS securely to the vehicle seat using the vehicle safety belt (SB) or LATCH (lower anchors and tethers for children) system if available; and properly securing the child in the CRS with a separate harness and/or other restraining surface. Securing these two links between the vehicle and the child is critical in reducing injuries or death to a child in the event of a vehicle crash (Weber, 2000).

There are five basic types of CRSs in current use; infant seats, convertible seats (converts from rear-facing to forward-facing), forward-facing only seats, booster seats, and integrated (built-in) seats. Other less common CRSs are also in use, including the Laptop car seat for children of booster-seat weight; car beds for newborns and other very small infants; harness vests for toddlers and older children; and restraint systems for children with special needs. Characteristics of these CRSs are described below.

The <u>infant seat</u> is primarily designed for children birth to 20 lb. Some infant seats have upper weight limits that range from 17 to 22 lb. Infant seats are recommended until the child is at least 1 year old and at least 20 lb. Infant seats are typically one-piece, protective molded shells. They are designed for a rear-facing installation only. The seat comes equipped with snap-in pads and slots for the vehicle safety belts (lap or lap portion of lap/shoulder belt). The infant is secured in the CRS with a harness, and, in some cases, a harness retainer (chest) clip to hold the shoulder harness together for correct pre-crash positioning. Infant seats include two to three sets of slots in the back of the seat to allow for harness adjustment to accommodate an increase in the infant's size. Harness slots should be at or below shoulder level. These seats have either a three-point harness that consists of two straps over the shoulder connecting in a "V" shape at the buckle or to a small hip pad that attaches to the buckle, or a five-point harness that also has straps coming around the hip. The angle of these seats should never be more than 45 degrees from the vertical position. The seats can be anchored in place with a vehicle safety belt or LATCH attachments. Rear-facing child restraints are not required to have top tethers (Weber, 2000; NHTSA, 2001; Stewart and Kern, 2003).

The <u>convertible seat</u> is designed for children from birth to 40 lb. The seat incorporates features to allow use for infants as well as toddlers. In the rear-facing position, it is used until the child is at least 1 year old and at least 20 lb. Some convertible seats are approved for rear-facing use up to 30 or 35 lb. For infants, the top of the child's head should be well contained within the seat's shell (no less than one inch from the top of the shell). The purpose of the harness system in rear-facing seats is to keep the infant's body, neck, and head contained within the shell. For infants, the harness slots should be at or below shoulder level (Weber, 2000; and NHTSA, 2001).

In the forward-facing position, the convertible seat carries the child until 40 lb and approximately 3 to 4 years of age. Convertible seats have either a five-point harness, three-point harness with T-shield combination, or a three-point harness with tray shield combination. The five-point harness system has straps that secure at both shoulders, across the upper thighs, and

between the legs. It can be adjusted to fit a variety of toddlers snugly and correctly. Harness/T-shield combinations secure two shoulder harness straps to a "T"- shaped shield or to a broader padded tray positioned in front of the torso and hips. The harness/tray shield combination has a crotch strap for the tray shield. It may be separate or be integrated with the shield. Convertible seat harness systems can be adjusted as the child grows. There are harness slots that accommodate changing the harness straps from the lowest slot position for an infant to the upper slots for toddlers. Most of the harness systems require a harness retainer (chest) clip, placed at the armpit level of the child. The clip is used as a pre-crash positioner holding the harness straps together for correct positioning in the event of a crash (Weber, 2000; and NHTSA, 2001).

Convertible seats also have a reclining mechanism, allowing an infant to sleep at an acceptable reclining angle (not more than 45 degrees) while facing the rear, and a toddler to sit more upright while facing forward. This seat is anchored in place with a vehicle safety belt or LATCH attachments (Weber, 2000 and NHTSA, 2001).

The forward-facing only seats are used for children weighing between 20 and 40 lb; and usually at least 1 to 4 years of age. Some models can be used for children up to 60 and 70 lb; especially those used as interchangeable booster seats. This would accommodate children through approximately 7 years of age. The harness systems are either five-point harnesses or overhead shield restraints. For these seats, the height of the shoulder strap is usually above the child's shoulders to effectively limit head excursion, and the height of the seat back should be above the child's ear to protect against rearward bending. Some models require a harness retainer (chest) clip, placed at the armpit level of the child to hold the straps in place. The seat is anchored in place with a vehicle's safety belt or LATCH attachments. Models after 1999 are equipped with top tether straps to be anchored rearward from the seat. A combination child seat/booster used with an internal harness is also manufactured. It is used with an internal harness for child securement with children up to 70 lb. Some of these models can have the internal harnesses removed and thus the seat can be transformed into a belt-positioning booster (BPB) for children weighing over 40 lb. Combination forward-facing child restraints and BPBs must have LATCH attachment systems (Weber, 2000; NHTSA, 2001; Stewart and Kern, 2003).

Children in a minimum recommended weight range of 30 to 40 lb and a maximum weight range of 60 to 100 lb should be in a booster seat. This includes most 4 to 8 year olds. Booster seats provide the transition from child seats with internal harness to vehicle lap/shoulder belts. These seats are anchored in place with a vehicle's safety belt system. Booster seats are not required to have LATCH attachment systems. They are not restraint systems by themselves, but rather positioning devices that depend entirely on the vehicle safety belts to hold the child and booster seat in place (Weber, 2000; NHTSA, 2001; Stewart and Kern, 2003). There are three types of booster seats: belt-positioning; high-back belt-positioning; and shield booster.

A belt-positioning booster raises the height of the child's body in a vehicle to allow a more secure safety belt fit across the child's torso and hips. Some of these seats are combination child seat/booster, while others come without harness and function only as backless belt-positioning boosters. Most of these types of booster seats have small handles or guides under which the lap belt and the lower end of the shoulder belt are routed. Some seats only have depressions or slots for the belt path. The guides function like a crotch strap, holding the lap belt

low and flat across the child's upper thighs, while the inboard guide also pulls the shoulder belt toward the child and makes its angle more vertical, so that the belt crosses the center of the child's chest (Weber, 2000).

High-back belt-positioning boosters can come with a removable 5- point harness system (to be used as a forward-facing child seat up to 40 lb) or come as just a vehicle lap/shoulder belt positioning device. Both provide support for the child's head and neck and help avoid whiplash injuries. Many high back boosters have a comfort clip or shoulder belt positioning strap on the side of the seat back (NHTSA, 2001)

Shield boosters are still in use today, although they are no longer being manufactured. They are designed to be used in seating positions with only a lap belt (pre-1996 vehicles); and allow for the shields to be used when a child weighs only between 30 and 40 lb. The shields can also be removed and the restraint used as a backless belt positioning booster for children who weigh between 30 and 60 lb, if both the lap and shoulder belts are available. Also, most models require the lap belt to be wrapped around the shield. In one case, the lap belt goes through the base of the seat (NHTSA, 2001).

Integrated (built-in) restraints anchor directly to the vehicle seat. Some are used with harnesses for children weighing up to 40 or 60 lb. Some use five-point harnesses; others are used as belt-positioning booster seats; and some can be used in either mode depending upon the size of the child. Integrated seats may not be used for rear-facing infants (Weber, 2000 and NHTSA, 2001).

The Laptop car seat is an energy absorbing child restraint. The device provides an alternative for those children over 40 lb that still can not sit correctly using a belt- positioning booster seat. It can be used for those children who need booster seats but are being transported in vehicles without shoulder belts in the back seat. It looks like a shield without a boosting base, but it is designed to fit snugly on the child's thighs and abdomen. The Laptop can be used with either a lap belt or a lap/shoulder belt combination. The Laptop is placed over a child already sitting in the vehicle seat. The vehicle safety belt is then threaded through the grooves in front of the laptop. The laptop can be pushed down to get a tighter fit on the child. The seat does not have head support and should be used in a seating position where the top of the child's ears are below the top of the vehicle seat back (NHTSA, 2001).

Car beds are usually for small, premature, or medically fragile infants who should ride prone or supine. The infant lies flat. The vehicle safety belt is used to anchor the car bed perpendicular to the direction of travel. The infant's head is placed toward the center of the vehicle and not next to the door. An internal harness secures the child in the car bed (NHTSA, 2001).

Harness/safety vests, often called travel vests, have a rigid back for attachment of the vehicle belt and use a five-point harness to distribute crash forces across a child's body. Although these vests differ in appearance and function from most child restraints, they meet federal law requirements. Most travel vests are for children who weigh 25 to 40 lb. They are often used on school buses to restrain children. Some require the use of a tether in conjunction with a vehicle lap belt for securement (NHTSA, 2001).

Special-needs restraint systems are used for infants, toddlers, and older children who can not be accommodated by conventional child restraint systems because of respiratory, orthopedic (hip spica and full body casts), neuromuscular, and/or behavioral conditions. These systems are also used for low birth weight and premature infants who weigh less than 5 lb. Car beds and harness vests are included in this category. These systems are secured to a vehicle safety belt system. (Talty, Sheese, Gunn, Stone, Chappelow, Wyatt, Cox, and Bull, 2000 and NHTSA, 2001).

Observational Studies of CRS Use and Misuse

Extensive observations of CRS use have been documented since the 1970s (Williams, 1976). NHTSA began conducting observational studies in 19 cities as part of periodic observation of child restraint, safety belt, and motorcycle helmet use in the early 1980s; and continued until 1991 (NHTSA, 1991). Other CRS use studies in the 1980s and 1990s were conducted in the following States or provinces: Texas (Hatfield, et al., 1986 and Womack, 1992); Michigan (Streff and Molnar, 1990); Virginia (Stoke, 1992); Ontario, Canada (Canada Market Research Ltd., 1992); and Pennsylvania (Decina, Temple, and Dorer, 1994 a,b). CRS use data were collected in four States as part of the NHTSA CRS misuse study in the mid-1990s as well (Decina and Knoebel, 1996). The most recent large-scale CRS use observation studies were conducted in 2000 and 2002 as part of the NHTSA National Occupant Protection Use Survey (NOPUS) (Glassbrenner, 2003).

By the mid- to late-1980s CRS studies collected data on the type of CRS (i.e., infant, toddler, and booster) and associated types of misuse errors. These were primarily out-of-vehicle observations (Bulger, 1983; Cynecki and Goryl, 1984; Shelness, 1984; Bull, Stroup, and Gerhart, 1988; and Streff and Molnar, 1990). CRS misuse data were often gathered by having data collectors peer into windows of vehicles stopped at signalized intersections. Other data collection techniques involved walking through shopping centers and peering into unoccupied vehicles and observing the misuse status of empty CRSs. When researchers started to review the findings across studies, it became evident that it was difficult to compare CRS misuse rates to determine "National" rates because researchers had used different data collection techniques, and their own definitions for CRS misuse errors.

In the early 1990s, the need to collect more accurate CRS misuse data was realized. Government agencies provided clearance for researchers to use more intrusive techniques to get a closer look at child occupants in vehicles. Field observers were entering vehicles (parked) and making close-up observations of children in CRSs. From these "in-the-vehicle" observations, researchers had the opportunity to identify such CRS characteristics as type/model, looseness of harness and vehicle safety belt systems, and other types of CRS misuse not easily detected from outside the vehicle. These studies provided richer data on the types of misuse errors by the types of CRS components (e.g., safety belt connection, locking clip, harness/shield, chest clip, tether strap, etc.) (Margolis, Wagenaar, and Molnar, 1992; Womack, 1992; Canada Market Research Ltd., 1992; Decina, Temple, Dorer, 1994 a,b; Frank and Ascheim, 1996; Taft, Mickalide, and Taft, 1999).

By the mid 1990s, observational studies also included more interaction with targeted drivers (Decina and Knoebel, 1996; Eby and Kostyniuk, 1999). These Federal and State-funded studies focused not only on collecting extensive CRS misuse information (i.e., CRS make/model, misuse errors by each CRS component) and vehicle characteristics (i.e., vehicle make, model, restraint systems), but also interviewing parents and other drivers to determine knowledge, attitudes and beliefs regarding child passenger protection, acquisition of CRSs (e.g., purchase, gift, loan), frequency of installing and moving CRSs, and other factors that could possibly influence proper use of CRSs.

Results of NHTSA's most comprehensive CRS misuse observation effort in the mid 1990s showed that there was very high CRS misuse overall (80 percent); and that certain types of misuse errors (e.g., locking clips, harness retainer clip, harness strap) were more common than others (Decina and Knoebel, 1996, 1997). These findings confirmed patterns of misuse that had been reported in earlier studies (Bull, et al., 1988 and Margolis, et al., 1992).

By the end of the 1990s, States and their local communities began CRS inspection/fitting stations and clinics. These programs provided individuals with the opportunity to go to a location (e.g., hospital, State police barracks, car dealership, etc.) to learn whether they were putting their children in CRSs correctly and properly installing CRSs in their vehicles. Some CRS educators and researchers used these events as good opportunities to collect CRS misuse data in a setting that would provide ample time to talk with parents/drivers, and the ability to thoroughly check all potential misuse errors (SafetyBeltSafe USA, 1994; Spurlock, Kidd, Mays, McCool, Buckner, Clatos, Rochussen, and Leach, 1998; Kohn, Chausmer, and Flood, 2000; and Morris, Arbogast, Durbin, and Winston, 2000). Results of these studies and other checkup events held across the Nation have shown higher CRS misuse rates (90 to 98 percent) than traditional observation studies, which involve randomly selected drivers with young passengers who have no prior knowledge that they will be stopped and asked to participate in a safety check of their CRS usage (NHTSA, 2001).

Injuries Associated with Types of CRS Misuse

By the mid 1990s, CRS research not only focused on determining the reasons why young children were not being restrained properly in CRSs (Decina and Knoebel, 1996,1997); and the reasons why children were prematurely moving into safety belts or riding unrestrained; but also on assessing the performance of restraint systems and identifying injury patterns associated with young children involved in motor vehicle crashes (Kelleher-Walsh, Walsh, and Duffy, 1995; National Transportation Safety Board, 1996; Winston, Durbin, Kallan, and Moll, 2000; Winston, Arbogast, Lee, and Menon, 2000).

Kelleher-Walsh, et al. (1995) focused on injuries observed in young children (ages 5 and younger) who had been involved in automobile crashes while restrained in CRSs. They created a child injury database containing information on 371 children who sustained a total of 601 injuries. The study was a retrospective case review of medical and police records on child injuries caused in motor vehicle crashes from 1986 through 1990 in western counties of New York. The database provided an increased understanding of child impact injury mechanisms and an increased knowledge of the characteristics of injuries (i.e., body regions, type of injury,

severity levels) that have been suffered by children improperly restrained in CRSs. The study revealed that head and facial injuries were predominant, regardless of impact direction and seating position. A comparison of toddler abdominal injury and CRS design (forward-facing harness or booster/shield) indicated that abdominal injury might be associated to a higher degree with booster/shield type restraints than to harness-type restraints. Comparisons of toddler shoulder injuries and CRS design showed that shoulder injuries may be associated to a higher degree with toddler harness type restraints than to booster/shield-type restraints. Injuries to children restrained by rear-facing infant seats included a high percentage of facial injuries in frontal impacts, even though the infant's back is toward the principal direction of force in this crash mode. No injuries to the neck, abdomen, or thorax of infants in rear-facing infant restraints were found regardless of impact direction.

In the mid-1990s, the National Transportation Safety Board (NTSB) conducted a study to examine the performance and use of occupant protection systems (i.e., CRSs, vehicle SBs, and air bags) for children. They investigated 133 crash incidents in which the vehicle was transporting a child passenger younger than age 11 and in which at least one occupant was admitted to the hospital. The study examined the severity of injuries to children restrained in CRSs and vehicle SBs, including the effects of CRS misuse, crash severity and seating position. Analysis was performed on 207 child passengers, of whom 52 were restrained in CRSs, 80 were restrained in SBs, and 75 were unrestrained. Thirty percent of the children sustained moderate-to-severe injuries, or were fatally injured. Many children sustained injuries to the head and face. NTSB found a higher likelihood of severe injury for those children in the front seat, regardless of the presence of a passenger frontal air bag. The analysis also examined the injury severity level by type of CRS misuse error, and there was a greater likelihood of more severe injuries and fatalities when young children were not in the appropriate type of CRS for their age and weight (NTSB, 1996).

In the late 1990s, Partners for Child Passenger Safety (PCPS) developed a child-focused crash surveillance system based on a representative sample of children from birth to 15 years of age who were involved in crashes that were reported to State Farm Insurance Companies in 15 States and the District of Columbia. Analyses of the PCPS data showed that many young children were inappropriately graduating from their CRS to a safety belt, putting these children at higher risk for intestinal, liver, spleen and spinal cord injury. In addition, a large number of infants were incorrectly turned to face forward before one year of age, increasing the risk of spinal injury. It was also reported that many children less than age 12 still continue to ride in the vehicle front seat, increasing their risk of injury caused by air bag deployment (Winston, Durbin, Kallan, and Moll, 2000).

Other PCPS results showed that there is still a high level of CRS misuse (82 percent). The common mistakes include failing to attach the seat tightly to the vehicle, failing to fasten the harness tightly around the child, and using the chest clip incorrectly. The PCPS team also reported that unrestrained children were three times more likely to sustain severe injury in a crash when compared with children who were restrained; and reported that sixty-four percent of severe injuries sustained by children in a crash were to the head (Winston, 2000).

Field Observation Techniques

The *Patterns of Misuse of Child Safety Seats* study conducted for NHTSA provided recommendations for performing efficient and successful field observations (Decina and Knoebel, 1996). In brief, the following attributes are critical to a successful field observation effort: (1) knowledge and community support at test sites; (2) a high volume of target group vehicles traveling in test sites; (3) permission from shopping center proprietors and local police departments; (4) optimal test site characteristics (i.e., limited entrance lanes, ample openness of parking areas, safe designated areas to pull over target vehicles, etc.); (5) a data collection team comprised of personable, well-trained individuals who are knowledgeable about CRS misuse issues and who are familiar with community and test site locations; (6) a comprehensive training program, which includes a training manual and supplemental material, classroom workshops and hands-on CRS demonstration sessions, in-field training exercises, and closely supervised "live" data collection; (7) a state-of-the-art training manual, incorporating child development, CRS characteristics, CRS misuse errors, instructions for interviewing and following data collection protocols and methodology, and copies of all necessary field activity forms; (8) customized data-collection forms for observations and interview questions; and (9) proper safety attire (i.e., orange vests, photo identification) and maintenance of a professional appearance.

1.2 PROJECT OBJECTIVES AND SCOPE OF WORK

The main objective of this project was to obtain a measure of the current level of misuse of child restraint systems (CRS) among the general public. The project focused specifically on forms of misuse that can be expected to raise the risk of injury.

To reach the objectives of this project, the following task activities were performed:

1. Held an initial meeting with the Contracting Officer's Technical Representative (COTR) and other NHTSA staff to discuss study objectives and activities.

2. Finalized a work plan based on discussions from the initial meeting.

3. Conducted a workshop with National experts on injury and CRS misuse issues to develop appropriate measurement criteria.

4. Selected observation sites and State site coordinators in six States.

5. Prepared data collection instruments.

6. Held "train-the-trainer" session with State site coordinators and their field managers (finalized CRS misuse measures and data collection methodology).

7. Convened an institutional review board (IRB) panel to review and approve the study plan and methodology.

8. Coordinated staff and site logistics (e.g., gaining permission at sites to collect data).

9. Conducted data collection of CRS misuse among the public, with a goal of 4,000 target vehicles, in six States across the country.

10. Prepared data summary and analysis.

11. Submitted draft and final reports to NHTSA.

2.0 RESEARCH METHODOLOGY

This section of the report identifies the research methodology used in meeting the project objectives. The methodology included: (1) conducting a workshop to identify the most important CRS misuse measures for study; (2) establishing criteria for site selection; (3) selecting States and State site coordinators (SSCs) to oversee the data collection; (4) conducting a train-the-trainer workshop with SSCs and their field site managers (FSMs); (5) developing data collection instruments; (6) having project methods reviewed and approved by an institutional review board (IRB); (7) recruiting qualified field personnel; (8) conducting training for field observers and greeters; (9) collecting field data over a 2 to 3 month period; (10) identifying socio-economic and demographic characteristics of field sites; (11) performing data analysis activities; and (12) providing documentation that summarizes results and makes recommendations for future research and programs.

2.1 WORKSHOP TO IDENTIFY CRS MISUSE MEASURES (BASED ON INJURY SEVERITY)

The first key task was to conduct a workshop with child passenger safety experts from the fields of biomechanics, injury prevention, public health, CRS manufacturing, and program implementation to prioritize CRS misuse characteristics according to their potential for resulting in injury to the child during a crash.

The workshop was held in Washington D.C. on March 12, 2002; and was attended by the contractor (TransAnalytics) and subcontractor (Children's Hospital of Philadelphia), expert panelists, and NHTSA staff. Expert panelists in attendance were: Paul Butler (Ford Automobile Safety Office), David Campbell (David Campbell and Associates), Karen DiCapua (National Safe Kids Campaign), Dr. Susan Ferguson (Insurance Institute for Highway Safety), William Hall (Highway Safety Research Center, University of North Carolina), Lorrie Walker (Florida Traffic Safety Resource Center, Florida Atlantic University), Kathleen Weber (University of Michigan Medical School, retired), and Dr. Narayan Yoganandan (Medical College of Wisconsin). Kelly Orzechowski (Crash Injury Research and Engineering Network Project, Children's National Medical Center) was also in attendance as a visitor. The Principal Investigator (L. Decina) was the moderator and the session was recorded and transcribed.

The workshop agenda included: opening remarks; discussions on types of child injury in crashes and their severity; identification of types of CRS misuse and their relationship to serious injury; identification of most important CRS measures to include in data collection; CRS misuse definitions; and summary and concluding remarks.

Not surprisingly, opinion was strong on any misuse that results in excursion of the child from the CRS. (Excursion defined as the distance traveled by an occupant or test dummy in the direction of impact during a crash.) Loose CRS installations in the vehicle and loose CRS harness straps on the child cause the greatest injuries, as does installing a seat in the wrong direction for infants, or placing infants in front of an air bag.

The workshop attendees recommended the following critical CRS misuse measures as important to study in the field observations:

- Age and weight appropriateness of CRS.
- Direction of CRS.
- Placement of CRS in relation to air bags.
- Installation and secureness of CRS to the vehicle seat (tight SB).
- Secureness/tightness of harness straps and crotch strap of the CRS.
- Use of locking clip for certain vehicle safety belts.
- Fit of vehicle SBs across child in belt-positioning booster seat.
- Defective or broken CRS elements.

Results of the workshop were used in the development of the first draft of the data collection instrument, and guided procedures presented to State site coordinators and their field managers at the train-the-trainer session. (See Appendix A for definitions of correct use.)

2.2 CRITERIA FOR SITE SELECTION

The next key task was to select six States to conduct the observations of CRS misuse among the public. The selection criteria included the following:

- Diverse geographic regions across the country.

- Coverage of urban, suburban, and rural areas.

- Diverse socio-demographic and economic characteristics of communities across geographic regions.

- State site coordinators (SSCs) with extensive child passenger safety knowledge and experience.

- SSCs with experience in managing similar studies.

- SSCs who represent child injury prevention organizations.

- SSCs with AAA CPS certification as instructors/technicians.

- SSCs with established contacts in their communities to secure observation sites

- SSCs experienced in training, recruiting, and managing field observers.

2.3 STATE AND GEOGRAPHIC REGION SITE SELECTION

A candidate list of States and study site areas which met the above criteria was developed and submitted to NHTSA. Upon NHTSA approval of the SSCs and their State sites, contractual agreements were made with the SSCs and their organizations. The SSCs, their affiliations, and the site regions for study are listed below.

Arizona - Nancy R. Avery, Inspector/Public Education Officer/Firefighter, City of Tucson Fire Department, Tucson SAFE KIDS, Children Always Ride Restrained (CARR) Program. The study area selected for Arizona was the city of Tucson.

Florida – Lorrie Walker, Program Coordinator/Administrator, Florida Atlantic University, Christine E. Lynn College of Nursing, Florida CPS Program and Resource Center. The study areas selected for Florida were Boca Raton, Fort Myers, Fort Pierce, and Miami.

Mississippi – Kay Brodbeck, Project Director for Mississippi Safety Services, and Cynthia Huff, Mississippi SAFE KIDS. The study area selected for Mississippi was the city and surrounding area of Jackson.

Missouri – Catherine Metzger, Co-coordinator SAFE KIDS St. Louis, Cardinal Glennon Children's Hospital. The study area selected for Missouri was the city of St. Louis and the surrounding area.

Pennsylvania – Juli McGreevy, Consultant and Robert Mott, Coordinator, South Central PA Highway Safety. The study areas selected for Pennsylvania were the areas including and surrounding Carlisle and Harrisburg.

Washington – Kathy P Kruger, Executive Director, Washington State Safety Restraint Coalition. The study areas selected for Washington were Seattle, Tacoma, and their surrounding areas.

The SSCs and their staff were from three SAFE KIDS organizations, two Statewide CPS programs, one regional comprehensive highway safety program, and one private consulting firm. Six different regions of the United States were represented in the study.

Child restraint and safety belt laws for the six States at the time of data collection (September 2002) are shown in Tables 1 and 2, respectively.

Table 1. Child restraint laws of States in the study (as of September 2002).

State	Must be in child restraint	Adult safety belt permissible	Maximum fine 1st offense
Arizona	4 yrs. and younger	Not permissible	$50
Florida	3 yrs. and younger	4 through 5 yrs.	$60
Mississippi	3 yrs. and younger	Not permissible	$25
Missouri	3 yrs. and younger	Not permissible	$25
Pennsylvania	3 yrs. and younger	Not permissible	$25
Washington	5 yrs. and younger and 60 lbs or less (CRS type specified in law)	6 through 15 yrs. or 60 lb and more	$35

Source: (IIHS, 2002 and Safety Restraint Coalition, 2002)

Table 2. Safety belt laws of States in the study (as of September 2002).

State	Standard enforcement?	Who is covered? In what seats?	Maximum fine 1st offense
Arizona	No	5+ yrs. in front seat-	$10
Florida	No	6+ yrs. in front seat; 6 through 17 yrs. in all seats	$30
Mississippi	No (yes for children less than 8 yrs.)	4 through 7 yrs. in all seats/8+ yrs. in front seat	$25
Missouri	No (yes for children less than 16)	4+ yrs. in front seat; 4 through 15 yrs. in all seats	$10
Pennsylvania	No	4+ yrs. in front seat	$10
Washington	Yes	All in all seats	$35

Source: (IIHS, 2002 and Safety Restraint Coalition, 2002)

2.4 TRAIN-THE-TRAINER WORKSHOP

The purpose of the workshop was to provide a forum with the SSCs and their field site managers (FSMs) to discuss the field operations. All participants in attendance were AAA CPS-certified instructors and technicians. A workshop notebook was given to each participant. This notebook included: an agenda; a summary report on previous CRS misuse observation studies; examples of data collection forms; guidelines for locating and recruiting sites; a training manual

for data collection; the most recent information on CRS use and proper use guidelines; and a list of participants.

The workshop was conducted in August 2002 at the Philadelphia Airport Marriott Hotel in Philadelphia, PA. The first day of the workshop focused on establishing the CRS correct use definitions. Topics covered were proper age and weight requirements for each CRS type; proper CRS installation; and proper placement of child in the CRS. Guidelines were also established in the areas of harness strap tightness, harness connection, and harness retainer clip positioning. Appendix A, "CRS Correct Use Definitions" identifies the guidelines used in the study during field operations.

The second day of the workshop focused on creating the final version of the data collection forms. The Principal Investigator (PI) presented a draft of the greeter and observer forms to the participants. The drafts were based on previous CRS misuse observation forms used in the field by the PI, as well as forms used at CRS inspection station clinics and by other researchers. Input from newly established guidelines for correct CRS use was used to refine the data collection instruments.

The remainder of the workshop focused on the following: instructions for conducting the field observations and managing field crews, training techniques, recruitment of field observers (AAA CPS-certified instructors/technicians only) and greeters, suggested techniques in gaining site permission and community cooperation, and administrative issues (i.e., contractual agreements, time sheets, staff reimbursement, scheduling for data collection).

2.5 DATA COLLECTION INSTRUMENTS

One greeter (contact) form was completed for each target vehicle. The form included category boxes for recording the following data: form identification number; greeter and observer initials; date of contact/observation; State and site identification; vehicle make, model, and year; location of passive protection devices in the vehicle; driver safety belt use; and vehicle seating position and age and weight of target children.

One observation form was completed for each sampled child. The form included category boxes for recording the following data: form identification number; observer initials; date of contact/observation; State and site identification; restraint type (i.e., CRS, SB, or unrestrained); child seating position in vehicle and vehicle restraint type (including LATCH system); CRS misuse categories for each type of CRS and seat direction; and SB misuse categories for lap only, shoulder only, or lap/shoulder SB systems.

CRS types for which misuse data were collected were categorized as follows:

- Rear-facing seats (infant, convertible, other).
- Forward-facing seats (convertible, forward-facing only, integrated, other).
- Booster seats (belt-positioning, integrated, other).

- Other (shield booster, Laptop car seat, other).

Appendices B and C provide a copy of the greeter (contact) and observation forms, respectively.

2.6 INSTITUTIONAL REVIEW BOARD

An institutional review board (IRB) panel was used to review and formally approve the data collection plan of the project. Chesapeake Research Review Inc. (CRRI) from Columbia, MD was contracted to manage the IRB. They have in place a U.S. Department of Health and Human Services-approved and registered IRB panel to review selected types of research. In August of 2002, the IRB panel reviewed the data collection plan and field observation protocols. The panel approved the protocol for the site plan and determined that the research study met the criteria found in the pediatric risk category described in 45 CFR 46.404: "Research/clinical investigations not involving greater than minimal risk." CRRI sent the confirmation letter describing the IRB acceptance of the data collection plan to NHTSA. Based on this letter, NHTSA then approved the plan to proceed with the fieldwork.

2.7 FIELD PERSONNEL

Each State site coordinator (SSC) had overall responsibility for recruiting field site managers (FSMs), field observers and greeters. The FSMs were selected during the initial negotiation activities with the SSCs and the selection of their States. SSCs recruited FSMs who were AAA certified CPS instructors/technicians and were already working with their organization on current CPS projects and programs, including local inspection station events.

Field observers were selected and recruited from the National and State lists of AAA certified CPS instructors and technicians who lived in the geographic areas near the SSCs and their FSMs. The SSCs and FSMs contacted people from these lists to inquire about their interest to participate in the study as paid field observers/data collectors.

SSCs recruited greeters by placing ads in local newspapers. In many cases, the candidates for field observers and greeters were active in the CPS field and were already participating in local CPS events. Efforts were also made to hire multi-lingual greeters to accommodate Spanish speaking drivers and to assist in gaining permission to make observations in their vehicles.

2.8 TRAINING

Training for field observers and greeters was conducted at each State site. SSCs followed guidelines established at the train-the-trainer workshop. All data collectors were given a training manual and were given classroom and field instruction. Classroom sessions covered the following topics: CRS misuse measures; observation and recording techniques; and protocols for greeters and observers when interacting with target drivers.

Classroom sessions were followed up with practice trials in parking lots using drivers and young children in mock situations. Various restraint system configurations were included in the practice. After a day of field practice, data collectors were taken to shopping centers to conduct real fieldwork. They were closely supervised by the training staff for at least two days or until staff was comfortable with their data collection activity.

2.9 DATA COLLECTION

Data were collected by teams of two consisting of a greeter and an observer. The greeter's responsibilities included identifying the target vehicle entering the designated area; stopping the target driver; requesting permission to conduct the "child safety" observations; and assisting with data collection. The observer's responsibilities included entering the vehicle and conducting the observational tasks necessary to record the type of restraint use and CRS misuse.

Field procedures used to collect CRS misuse data were:

- Select a target vehicle entering the site and approach the driver.
- Identify oneself, briefly explain the purpose of the study (including informing the driver that the children would not be removed from their CRSs), and request permission to conduct observation.
- Upon receipt of permission, direct driver to designated safety zone.
- Ask driver about ages and weights of target children; make CRS misuse observations; and record findings on form.
- Upon completion of observation, thank driver.
- Review what was observed and recorded.
- Move back into position to wait for next vehicle.

Each site had a field site manager (FSM) responsible for overseeing the field operation. Duties included: observing techniques used by greeters and observers; supplying pre-numbered forms; collecting the data forms; managing staff scheduling; collecting and checking timesheets; and reporting to the SSCs. In many cases, FSMs also participated as observers collecting data. SSCs and FSMs also checked for consistency, missing data, incorrect coding patterns, and other miscellaneous items. Questions about data were brought to the attention of the data collectors. Data were sent to the Principal Investigator on a regular basis.

Data were collected from September to November 2002 in four of the States (AZ, MO, PA, and WA). Data were collected in October to December 2002 in Mississippi; and data were collected in November 2002 to January 2003 in Florida. Data collectors thanked the parents for their participation and provided information on child passenger safety.

2.10 SITE CHARACTERISTICS

Each SSC used knowledge of the local area and personal contact with community and business representatives to identify potential sites for the study. Sites were selected based on the following criteria:

- Large volume of target vehicles (drivers with young children) visiting the site.
- Limited number of entrances and exits (if possible) to the site.
- Adequate visibility and space for safely conducting the initial interaction with the driver and subsequent observations and data collection in the parked vehicle.
- Permission from site proprietors to use site.

Urban, suburban, and rural sites spanning diverse socio-economic and demographic characteristics were used. A variety of community, health, retail and other commercial locations were included, such as: child care centers; discount stores (e.g., Sam's Club, Super Kmart, and WalMart); fast-food restaurants (e.g., McDonalds); hospital and pediatric centers; shopping centers and malls; stores specializing in infant and children's merchandise (e.g., Babies R Us, Toys R Us); libraries and churches; entertainment complexes; and commuter parking lots (e.g., ferry docks). Special events, safety festivals, and holiday gatherings for young children were also used in the study.

Each State used a broad selection of sites, generally located in one geographical area of the State (i.e., Southcentral Arizona; Southcentral Florida; Central Mississippi; Eastcentral Missouri; Central Pennsylvania; and Westcentral Washington.)

In Arizona, 11 sites were used in the study. These sites were all located in Pima County and within the city limits of Tucson. The sites were located across several areas of the city. A diverse group of socio-economic and ethnic communities was included in the field observations. Many sites were set up with multilingual (English/Spanish) greeters. Sites with a large Mexican population were included.

In Florida, seven sites were used in the data collection effort. These sites were all located in the southern part of the State in four cities (Boca Raton, Fort Myers, Fort Pierce, and Miami). These cities are located in four counties (Lee, Miami, Palm Beach, and Saint Lucie). A wide range of socio-economic and ethnic communities was included in the field observations. Many sites were set up with multilingual (English/Spanish) greeters. Sites with large Caribbean and African-American populations were included.

In Mississippi, four sites were used in field observations. These sites were all located in central Mississippi in four municipalities located in two counties (Hinds and Rankin). Jackson was the largest city among the sites. Diverse socio-economic and ethnic communities were included in field observations. Sites with a large African-American population were included.

In Missouri, 15 sites were used in data collection. These sites were located in the east central section of the State. Sites were in nine cities/municipalities, located in three counties (Jefferson, Saint Charles, and Saint Louis). Saint Louis was the largest of the cities. Similar to the other States, a wide range of socio-economic and ethnic communities was included in the field observations. Sites with large Latino and African-American populations were included.

In Pennsylvania, eight sites were used in data collection. These sites were located in central Pennsylvania, across several cities (Carlisle, Harrisburg, and Mechanicsburg), municipalities, and townships. All of the sites were in Cumberland and Dauphin counties. A diverse range of socio-economic communities was included in the data collection effort. Sites with a large African-American population were included.

In Washington, 27 sites were used in data collection. Most of the data were collected at 8 sites. These sites were located in the central western part of the State, across several cities (Bellevue, Seattle, Tacoma) and municipalities. The sites were in four counties (King, Kitsap, Pierce, and Snohomish). A diverse range of socio-economic and ethnic communities was included in the field observations. Sites with large Asian and Pacific-Island populations were included.

2.11 DATA ANALYSIS

Data were checked in the field by the field observers, as well as by the project management team at the site. Inconsistencies and errors in recording information were resolved with data collectors. Data were then keyed into a Microsoft Access 2002 database by the data entry staff and provided to the research analyst.

Descriptive summaries of the data were prepared. Summary tables were developed for project briefing purposes and inclusion in the final report.

Data from the U.S. Bureau of Labor Statistics and the U.S. Census Bureau were used to identify county-level socio-economic and demographic characteristics of sites. Characteristics of interest included population, race (percent white), age (percent children less than age 5), household size (persons per household), household median income, and unemployment rate of each State's study areas at the county level. The data were used to show characteristics of study sites across the country.

Appendix D identifies socio-economic and demographic characteristics of State sites at the county levels.

3.0 RESULTS AND ANALYSIS

This chapter presents sample characteristics; observed restraint use and misuse; and other findings from the observation study.

3.1 SAMPLE SIZE CHARACTERISTICS

A total of 4,126 vehicles and 5,527 children less than the driver-estimated weight of 80 lb were included in the study. Table 3 identifies the sample size by State and the total.[1]

Table 3. Number of sampled vehicles and children (State and total).

	State						
	Arizona	**Florida**	**Mississippi**	**Missouri**	**Pennsylvania**	**Washington**	**Total**
Number of Vehicles (% of Total)	697 (16.9%)	682 (16.5%)	566 (13.7%)	637 (15.4%)	677 (16.4%)	867 (21%)	4,126 (100%)
Number of Children Less than 80 lb (% of Total)	965 (17.5%)	891 (16.1%)	699 (12.6%)	834 (15.1%)	919 (16.6%)	1,219 (22.1%)	5,527 (100%)

The 5,527 children in the sample included 511 children less than 20 lb (9.2 percent); 2,483 children from 20 to 39 lb (44.9 percent); and 2,533 children from 40 to 79 lb (45.8 percent). Table 4 presents the number of sampled children by weight from each State and the total.

Table 4. Number of sampled children, by weight (State and total).

Weight Categories	State						
	Arizona	**Florida**	**Mississippi**	**Missouri**	**Pennsylvania**	**Washington**	**Total**
Less than 20 lb (% of Total)	73 (7.6%)	94 (10.5%)	59 (8.4%)	148 (17.7%)	47 (5.1%)	90 (7.4%)	511 (9.2%)
20 to 39 lb (% of Total)	419 (43.4%)	436 (48.9%)	322 (46.1%)	391 (46.9%)	345 (37.5%)	570 (46.8%)	2,483 (44.9%)
40 to 79 lb (% of Total)	473 (49%)	361 (40.5%)	318 (45.5%)	295 (35.4%)	527 (57.3%)	559 (45.9%)	2,533 (45.8%)
Total	965 (100%)	891 (100%)	699 (100%)	834 (100%)	919 (100%)	1,219 (100%)	5,527 (100%)

The age categories of the children weighing less than 80 lb are presented in Table 5, by State. There were 676 children less than 1 year of age; 2,021 children 1 through 3 years of age; 2,571 children 4 through 8 years of age, and 259 children age 9 and older.

[1] It should be noted that percentages in Tables may not add up to 100 percent as a result of rounding.

Table 5. Number of sampled children, by age (State and total). (Children weighing less than 80 lb)

Target Child Age	State						
	Arizona	Florida	Mississippi	Missouri	Pennsylvania	Washington	Total
Less than 1 Year Old (% of Total)	100 (10.4%)	131 (14.7%)	82 (11.7%)	175 (21%)	69 (7.5%)	119 (9.8%)	676 (12.2%)
1 through 3 Years Old (% of Total)	337 (34.9%)	345 (38.7%)	270 (38.6%)	318 (38.1%)	290 (31.6%)	461 (37.8%)	2,021 (36.6%)
4 through 8 Years Old (% of Total)	453 (46.9%)	382 (42.9%)	323 (46.2%)	335 (40.2%)	466 (50.7%)	612 (50.2%)	2,571 (46.5%)
Age 9 and Older (% of Total)	75 (7.8%)	33 (3.7%)	24 (3.4%)	6 (0.7%)	94 (10.2%)	27 (2.2%)	259 (4.7%)
Total	965 (100%)	891 (100%)	699 (100%)	834 (100%)	919 (100%)	1,219 (100%)	5,527 (100%)

3.2 VEHICLE SEATING POSITION OF CHILDREN

The vehicle seating position of the 5,527 sampled children less than 80 lb was observed and recorded. Only 9.4 percent of the children were in the front seat and most of these were seated on the outboard passenger side (7.8 percent) as opposed to the front center position (1.6 percent). Most children were in second row seats (84.8 percent). This included 30.4 percent on the left side (behind the driver); 21.2 percent in the second row middle position; and 33.2 percent in the second row right side position (passenger side). In addition, 5.5 percent of the children were in the third row seats of minivans or sport utility vehicles; and 0.4 percent of the children were in the area behind the third row seats of a minivan or in the cargo area of a pickup truck.

3.3 CHILD RESTRAINT SYSTEM (CRS) USE

Of the 5,527 children less than 80 lb, 62.3 percent were in a CRS, 25.9 percent were in a vehicle SB, and 11.8 percent were unrestrained. Table 6 presents the restraint type by each State and the total sample.

Table 6. Number of sampled children by type of restraint used (State and total). (Children weighing less than 80 lb)

Restraint Type	STATE						
	Arizona	Florida	Mississippi	Missouri	Pennsylvania	Washington	Total
Child Restraint System (% of Total)	495 (51.3%)	591 (66.3%)	382 (54.6%)	568 (68.1%)	498 (54.2%)	908 (74.5%)	3,442 (62.3%)
Safety Belt (% of Total)	265 (27.5%)	235 (26.4%)	184 (26.3%)	127 (15.2%)	365 (39.7%)	255 (20.9%)	1,431 (25.9%)
Unrestrained (% of Total)	205 (21.2%)	65 (7.3%)	133 (19%)	139 (16.7%)	56 (6.1%)	56 (4.6%)	654 (11.8%)
Total	965 (100%)	891 (100%)	699 (100%)	834 (100%)	919 (100%)	1,219 (100%)	5,527 (100%)

The number of children in a CRS, SB, or unrestrained across the six States is shown in Table 7 for each of four weight categories. For the 511 children less than 20 lb, 97.1 percent were in a CRS. For the 2,483 children 20 to 39 lb, 86.4 percent were in a CRS, 6.3 percent were in a SB, and 7.2 percent were unrestrained. For the 1,704 children 40 to 59 lb, 41.7 percent were in a CRS, 43.1 percent were in a SB, and 15.2 percent were unrestrained. For the 829 children 60 to 79 lb, only 10.9 percent were in a CRS, 64.9 percent were in a SB, and 24.2 percent were unrestrained.

Table 7. Type of restraint used by weight.

Weight Category	Restraint Type			Total
	CRS	Safety Belt	Unrestrained	
Less than 20 lb	496 (97.1%)	1 (0.2)	14 (2.7%)	511 (100%)
20 to 39 lb	2,146 (86.4%)	157 (6.3%)	180 (7.2%)	2,483 (100%)
40 to 59 lb	710 (41.7%)	735 (43.1%)	259 (15.2%)	1,704 (100%)
60 to 79 lb	90 (10.9%)	538 (64.9%)	201 (24.2%)	829 (100%)
Total	3,442 (62.3%)	1,431 (25.9%)	654 (11.8%)	5,527 (100%)

A comparison of all children less than 60 lb with the previous NHTSA CRS observation study by Decina and Knoebel (1996) is shown in Table 8. The comparison shows that overall restraint use improved by only 3.3 percentage points since the previous study. However, CRS use greatly improved by 20.9 percentage points. There were also fewer unrestrained children (by 3.2 percentage points). (Data were collected in the Spring of 1995 for the previous study, compared with the Fall of 2002 for data collected in this study.)

Table 8. Comparison of current and past NHTSA CRS misuse observation studies. (Children less than 60 lb only data)

NHTSA CRS Study	Overall restraint use	CRS Use	SB Use	Unrestrained
Decina and Knoebel (1996) 5,865 children less than 60 lb	87.2 %	50.6 %	36.6%	12.8%
Decina and Lococo (2003) 4,698 children less than 60 lb (percentage point difference)	90.5 % (+3.3)	71.5 % (+20.9)	19 % (-17.6)	9.6 % (-3.2)

The number of children in a CRS, SB, or unrestrained is shown in Table 9 for each of the 4 age categories. For the 676 children less than 1 year of age, 97.3 percent were in a CRS. For the 2,021 children 1 through 3 years of age, 90 percent were in a CRS, 3.6 percent were in a SB, and 6.4 percent were unrestrained. For the 2,571 children 4 through 8 years of age, 37.2 percent were in a CRS, 45.5 percent were in a SB, and 17.3 percent were unrestrained. For the children age 9 and older who weighed less than 80 lb, 3.1 percent were in a CRS, 72.6 percent were in a SB, and 24.3 percent were unrestrained.

Table 9. Type of restraint used by age.
(Children weighing less than 80 lb)

Age Category	Restraint Type			Total
	CRS	Safety belt	Unrestrained	
Less than 1 Year of Age (% of Total)	658 (97.3%)	1 (0.15%)	17 (2.5%)	676 (100%)
1 through 3 Years of Age (% of Total)	1,819 (90%)	72 (3.6%)	130 (6.4%)	2,021 (100%)
4 through 8 Years of Age (% of Total)	957 (37.2%)	1,170 (45.5%)	444 (17.3%)	2,571 (100%)
Age 9 and Older (% of Total)	8 (3.1%)	188 (72.6%)	63 (24.3%)	259 (100%)
Total	3,442 (62.3%)	1,431 (25.9%)	654 (11.8%)	5,527 (100%)

Comparison with the NHTSA National Occupant Protection Use Survey (NOPUS[2]), which provides the only National probability based observation data on the use of child restraints (CRS or SB) on the Nation's roads, revealed results similar to this study. (NOPUS data were collected in June 2002. Observation data for this misuse study were primarily collected in October and November 2002.) NOPUS found 99 percent of infants (children less than 1 year of age) restrained (CRS or SB), compared to this study's 97.5 percent restrained (CRS or SB). NOPUS found 94 percent of children ages 1 through 3 restrained (CRS or SB), compared to this study's 93.6 percent restrained (CRS or SB). NOPUS found 83 percent of children ages 4 through 7 restrained (CRS or SB), compared to this study's 82.7 percent of children ages 4 through 8 restrained (CRS or SB).

[2] NOPUS observers estimated ages of children at their sites (Glassbrenner, 2003). In this study, greeters and observers asked drivers the age and weight of their children.

The number of children less than 80 lb riding restrained in various types of CRSs (i.e., infant, convertible, forward-facing only, belt-positioning booster, shield booster, other types) as well as in a SB, and riding unrestrained is shown in Table 10 for each weight category. Almost 90 percent of the children less than 20 lb were either in an infant seat or riding in a rear-facing position in a convertible child safety seat. About 70 percent of children 20 to 39 lb were either in a forward-facing only child safety seat or riding forward-facing in a convertible seat. However, fewer than half of children 40 to 59 lb (about 40 percent) were in a convertible seat, forward-facing only seat, or booster seat. Barely 10 percent of children 60 to 79 lb were in a child restraint of any type.

Table 11 shows, by age category, the number of children less than 80 lb who were restrained in various types of CRSs, as well as those restrained in a SB and those unrestrained. The results are similar to those for the weight data. More children were either in SBs or unrestrained as their age increased. Only about 22 percent of booster-age children (4 through 8) were in a booster seat.

Table 10. Type of child restraint used by weight.

Weight	Restraint Type										
	Infant	Convrt R-F*	Convrt F-F*	Convertible (Total)	Forward Facing Only	Belt-Positioning Booster	Shield Booster	Other**	Safety Belt	Unre-strained	Total
Less than 20 lb	395 (77.3%)	59 (11.5%)	37 (7.3%)	96 (18.8%)	5 (1.0%)	0 (0%)	0 (0%)	0 (0%)	1 (0.2%)	14 (2.7%)	511 (100%)
20 to 39 lb	102 (4.1%)	81 (3.3%)	1,131 (45.5%)	1,212 (48.8%)	603 (24.3%)	154 (6.2%)	50 (2%)	25 (1%)	157 (6.3%)	180 (7.2%)	2,483 (100%)
40 to 59 lb	0 (0%)	0 (0%)	75 (4.4%)	75 (4.4%)	150 (8.8%)	437 (25.6%)	33 (1.9%)	15 (0.9%)	735 (43.1%)	259 (15.2%)	1,704 (100%)
60 to 79 lb	0 (0%)	0 (0%)	4 (0.5%)	4 (0.5%)	8 (1.0%)	73 (8.8%)	3 (0.4%)	2 (0.2%)	538 (64.9%)	201 (24.2%)	829 (100%)
Total	497 (9%)	140 (2.5%)	1,247 (22.6%)	1387 (25.1%)	766 (13.9%)	664 (12%)	86 (1.6%)	42 (0.8%)	1,431 (25.9%)	654 (11.8%)	5,527 (100%)

*__Convrt R-F__ (Convertible Seat rearward facing), **Convrt F-F** (Convertible Seat forward facing), **Convertible (Total)** includes total number of CRSs for both categories
** Integrated Seats, Laptops

Table 11. Type of child restraint used by age. (Children weighing less than 80 lb).

Age	Restraint Type										
	Infant	Convrt. R-F*	Convrt. F-F*	Convertible	Forward Facing Only	Belt-Positioning Booster	Shield Booster	Other**	Safety belt	Unre-strained	Total
Less than 1 Year Old	463 (68.5%)	106 (15.7%)	74 (10.9%)	180 (26.6%)	15 (2.2%)	0 (0%)	0 (0%)	0 (0%)	1 (0.1%)	17 (2.5%)	676 (100%)
1 through 3 Years Old	34 (1.7%)	34 (1.7%)	1,047 (51.8%)	1,081 (53.5%)	513 (25.4%)	129 (6.4%)	40 (2.0%)	22 (1.0%)	72 (3.6%)	130 (6.4%)	2,021 (100%)
4 through 8 Years Old	0 (0%)	0 (0%)	126 (4.9%)	126 (4.9%)	237 (9.2%)	529 (20.6%)	46 (1.8%)	19 (0.7%)	1,170 (45.5%)	444 (17.3%)	2,571 (100%)
Age 9 and Older	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (0.4%)	6 (2.3%)	0 (0%)	1 (0.4%)	188 (72.6%)	63 (24.3%)	259 (100%)
Total	497 (9%)	140 (2.5%)	1,247 (22.6%)	1,387 (25.1%)	766 (13.9%)	664 (12%)	86 (1.6%)	42 (0.8%)	1,431 (25.9%)	654 (11.8%)	5,527 (100%)

*__Convrt R-F__ (Convertible Seat rearward facing), **Convrt F-F** (Convertible Seat forward facing), **Convertible (Total)** includes total number of CRSs for both categories
** Integrated Seats, Laptops

3.4 CHILD RESTRAINT SYSTEM (CRS) MISUSE

CRS misuse measures based on potential for causing injury were identified at the workshop with child passenger safety experts. These critical CRS misuse measures were used to develop the data collection instruments and observation guidelines that were then finalized at the train-the-trainer workshop. The critical areas identified for observation were appropriateness of CRS type by age, weight, and height characteristics; CRS installation in the vehicle (i.e., proximity to air bag, direction of seat, vehicle SB tightness, use of LATCH); and placement of the child in the CRS (i.e., harness strap tightness and connection).

One of the most important findings from the study is the percentage of CRSs with a critical misuse. Of the 3,442 CRSs observed in this study, 72.6 percent displayed one or more types of critical misuse.

For the total sample of CRSs observed in the study, the percentage of CRSs exhibiting critical misuses, by CRS type is shown in Table 12.

Table 12. Percentage of CRSs exhibiting critical misuses, by CRS type.

CRS Type	Number of Seats Observed	Percentage with Critical Misuses
Total	**3,442**	**72.6%**
Infant	497	83.9%
Rear-Facing Convertible	140	83.5%
Forward-Facing Convertible	1,247	81.9%
Forward-Facing Only	766	79.3%
Integrated Forward-Facing	22	63.6%
Belt-Positioning Booster	664	39.5%
Shield Booster	86	60.5%
Integrated Booster	7	42.9%
Other Booster	5	20%
Laptop Car Seat	6	0%
Other Restraints	2	100%

The most common CRS misuses were loose vehicle SB attachment to the CRS and loose harness straps securing the child to the CRS. Misuse by CRS type and each critical misuse element is presented in Tables 13 through 19. The critical misuses are not mutually exclusive. In many cases, more than one critical misuse was observed on a CRS. Definitions of the critical misuse measures used in the study are provided below.

CRITICAL MISUSE DEFINITIONS

Age/fit inappropriateness: *The child's weight or age does not meet the criteria for the CRS being used.*

Harness strap not used: *Self-explanatory*

Head restraint needed: *The child's head is above the back of the vehicle seat. (A high-back booster seat is needed.)*

Improper fit of vehicle shoulder belt in booster seats: *The vehicle shoulder belt is loose, or does not cross the center of the shoulder, or cuts into or crosses the neck, throat, or face. Also includes belt placed under the arm, behind the back, or not touching the torso.*

Improper fit of vehicle lap belt in booster seats: *The vehicle lap belt is loose and/or the lap belt is positioned across the child's stomach (instead of across the upper thighs/lower hips)*

Improper harness belt paths/slots: *Based on the child's size, the harness straps are not in the correct CRS harness slots.*

Improper position of harness strap: *Harness strap is tucked under the arm of the child.*

Improper use of locking clip to SB: *On vehicles with a sliding latchplate on the SBs, the locking clip is more than 1 inch away from the SB's latchplate.*

Improper vehicle SB path/slots: *Vehicle SB is not correctly routed through the CRS slots for the SB.*

Incorrect seat direction: *Self-explanatory*

Location of CRS: *A rear-facing CRS is installed in front of an active airbag.*

Loose harness straps: *The harness strap has more than 1 finger's slack.*

Loose vehicle SB: *The CRS can move more than 1 inch when checked at the belt path.*

Unbuckled harness strap: *Self-explanatory*

Unbuckled vehicle SB: *Self-explanatory*

Visible damage to CRS: *Crack in the shell, broken harness parts, frayed harness straps, torn padding.*

(Appendix A provides the "CRS Correct Use Definitions Guidesheet.")

Table 13. Critical misuses of infant seats.*

Critical Misuse Measures	Percent of Seats Exhibiting Misuse
Loose Vehicle SBs	58.1%
Loose Harness Straps	57.3 %
Improper Position of Harness Strap	10.9 %
Age/Fit Inappropriateness	7.4 % (n=487)
Incorrect Seat Direction	6.3% (n=492)
Improper Harness Belt Path/Slots	3.6%
Improper Vehicle SB Path/Slots	3.2%
Unbuckled Vehicle SB	2.8 %
Harness Strap Not Used	2.2 %
Unbuckled Harness Strap	1.8 %

* The sample size was 497, unless otherwise noted due to missing data.

There were 137 children greater than 20 pounds but less than 1 year of age in a CRS. Of this sample, 27.7 percent were facing the wrong direction (forward).

Table 14. Critical misuses of rear-facing convertible seats.*

Critical Misuse Measures	Percent of Seats Exhibiting Misuse
Loose Harness Straps	54.3%
Loose Vehicle SBs	50.7%
Improper Position of Harness Strap	10.7%
Incorrect Seat Direction	5.0 % (n=139)
Improper Harness Belt Path/Slots	5.7%
Improper Vehicle SB Path/Slots	2.1%
Improper Use of Locking Clip to SB	7.1%

* The sample size was 140, unless otherwise noted due to missing data.

Table 15. Critical misuses of forward-facing convertible seats.*

Critical Misuse Measures	Percent of Seats Exhibiting Misuse
Loose Harness Straps	58.9%
Loose Vehicle SBs	54.4%
Improper Position of Harness Strap	18.4%
Age/fit Inappropriateness	7.1% (n=1,224)
Incorrect Seat Direction	5.6% (n=1,223)
Improper Use of Locking Clip to SB	4.9%
Unbuckled Vehicle SB	2.3%
Improper Vehicle SB Path/Slots	2.1%
Unbuckled Harness Strap	1.9%
Harness Strap Not Used	1.1%

* The sample size was 1,247, unless otherwise noted due to missing data.

Table 16. Critical misuses of forward-facing only seats.*

Critical Misuse Measures	Percent of Seats Exhibiting Misuse
Loose Harness Straps	55.2%
Loose Vehicle SBs	49.6%
Improper Position of Harness Strap	15.9%
Age/Fit Inappropriateness	9.5% (n=747)
Improper Belt Path/Slots of Harness Straps	6.4%
Improper Use of Locking Clip to SB	3.7%
Improper Vehicle SB Paths/Slots	2.9%
Harness Strap Not Used	2.3%
Unbuckled Vehicle SB	2.1%
Incorrect Seat Direction	1.3%

* The sample size was 766, unless otherwise noted due to missing data.

Table 17. Critical misuses of belt-positioning booster seats.*

Critical Misuse Measures	Percent of Seats Exhibiting Misuse
Improper Fit of Vehicle Shoulder Belt	20.9%
Loose Vehicle SBs	15.8%
Improper Fit of Vehicle Lap Belt	10.2%
Age/Fit Inappropriateness	9.2% (n=661)
Unbuckled Vehicle SB	2.9%
Head Restraint Needed	2.4%

* The sample size was 664, unless otherwise noted due to missing data.

Table 18. Critical misuses of shield boosters.*

Critical Misuse Measures	Percent of Seats Exhibiting Misuse
Age/Fit Inappropriateness	38.4%
Loose Vehicle SBs	25.6%
Improper Fit of Vehicle Shoulder Belt	15.1%
Improper Fit of Vehicle Lap Belt	9.3%
Head Restraint Needed	9.3 %
Unbuckled Vehicle SB	3.5%

* The sample size was 86, unless otherwise noted due to missing data.

Table 19. Critical misuses of forward-facing integrated seats.*

Critical Misuse Measures	Percent of Seats Exhibiting Misuse
Loose Harness Straps	63.6%
Improper Position of Harness Strap	13.6%

* The sample size was 22, unless otherwise noted due to missing data.

3.5 HARNESS RETAINER CLIP MISUSE

Even though harness retainer clip misuse was not identified as a critical misuse at the expert workshop, the State site coordinators and their field site managers felt it was important to include the misuses relating to the harness retainer clip as an observation measure in the study. Harness retainer clips are found on many (but not all) infant, convertible, forward-facing, and integrated seats for children less than 40 lb. If the harness retainer clip was not connecting the harness straps together at armpit level, correctly threaded and free from damage or alteration, it was coded as a misuse. This misuse was checked on the 2,672 CRSs that could have a harness retainer clip.

Overall misuse (with harness retainer clip misuse included) for each type of CRS which uses a harness retainer clip is shown in Table 20. Because other harness misuse measures were usually associated with harness retainer clip misuse, the inclusion of harness retainer clip misuse made little difference in the overall misuse measure.

Table 20. Harness retainer clip misuse by CRS type.

CRS Type	Number of CRSs (n=2,672)	Misuse Including Harness Retainer Clip Measure	Misuse Not Including Harness Retainer Clip Measure (Critical Misuses)
Infant	497	85.9%	83.9%
Convertible (Rear-Facing)	140	83.6%	83.5%
Convertible (Forward-Facing)	1,247	85.3%	81.9%
Forward-Facing Only	766	82.4%	79.3%
Integrated Forward-Facing	22	77.3%	63.6%

3.6 OTHER CHILD RESTRAINT SYSTEM (CRS) MISUSE TYPES AND LATCH USE

The data collection teams also recorded whether the CRSs were visibly damaged, whether the CRS base extended too far beyond the vehicle seat, and whether there were aftermarket devices or extraneous items on the CRS or SB.

There were 114 visibly damaged CRSs observed in the study (crack in the shell, broken harness parts, frayed harness straps, torn padding). Of these, 68 were forward-facing convertible seats, 19 were forward-facing only seats, 12 were belt-positioning booster seats, 10 were infant seats, 3 were shield boosters, and 2 were rear-facing convertible seats. The study considered visible damage to be a critical misuse. There were 80 CRSs with the base of the CRS extending beyond the vehicle seat more than 20 percent. This type of misuse was not considered critical misuse in the study. In addition, there were 102 CRSs with aftermarket devices or extraneous items either on the CRS or in the vehicle. These included toys on harness straps, blankets behind the child's back, and plastic mat under the CRS.

Observations were also made on the use of the LATCH System (Lower Anchors and Tethers for CHildren) for CRS installation to the vehicle seat. LATCH installations were identified in 42 vehicles (of a total of 4,126 vehicles). Field observers found three cases of improperly used lower anchors; three cases of improperly used tethers, and six cases of the vehicle SB and the lower anchor being used together.

3.7 SAFETY BELT (SB) ONLY USE BY CHILDREN

Of the 5,527 children less than 80 lb, 25.9 percent (1,431) were in a SB. The majority of these SB users (80.9 percent) were in a lap/shoulder belt combination; 17.5 percent were in a lap-belt-only system; and 1.1 percent were in a shoulder-belt-only system. Field observers recorded inappropriate fit of the SB on children according to the proper use definitions (see Appendix A). For 1,158 lap/shoulder belt combinations observed, the SB did not fit the child in 68.5 percent of the cases. For the 250 lap-belt-only systems observed, the lap belt did not fit the child in 70.4 percent of the cases. For the 16 shoulder-belt-only systems observed, the shoulder belt did not fit the child in 87.5 percent of the cases. There were 7 children in SBs in which type of SB was unrecorded.

3.8 UNRESTRAINED CHILDREN

Of the 5,527 children less than 80 lb, 11.8 percent were unrestrained. The percentage of unrestrained children increased with each heavier weight category of children. For the 511 children less than 20 lb, 2.7 percent were unrestrained. For the 2,483 children 20 to 39 lb, 7.2 percent were unrestrained. For the 1,704 children 40 to 59 lb, 15.2 percent were unrestrained. And for the 829 children 60 to 79 lb, 24.2 percent were unrestrained.

3.9 DRIVER CHARACTERISTICS

Of the 3,752 drivers observed for SB use, 77.4 percent were restrained. When the driver was wearing a SB, 91.7 of the children less than 80 lb were restrained in either a CRS (44.2 percent) or a SB (47.5 percent). Only 8.3 percent of children less than 80 lb were unrestrained when the driver was restrained. When the driver was not wearing a SB, 62.3 percent of the children less than 80 lb were restrained in either a CRS (43.2 percent) or a SB (19.1 percent). Another 37.7 percent of the children were unrestrained when the driver of the vehicle in which they were riding was unrestrained.

The relationship in NOPUS of driver restraint use to child restraint use was very similar to the findings of this study (see description of NOPUS study on page 28). NOPUS found that when the driver was belted, 92 percent of observed children under age 8 were restrained (CRS or SB), compared to 91.7 percent of children less than 80 lb restrained (CRS or SB) in this study. NOPUS found that when the driver was unbelted, 72 percent of the observed children under age 8 were restrained, compared to 62.3 percent of children less than 80 lb restrained in this study (Glassbrenner, 2003).

Drivers were questioned regarding CRS acquisition (new or used). For 90 percent of the CRSs observed, drivers indicated that the CRS was obtained new. Only 10 percent of the seats observed were obtained used. Drivers were not asked if the CRS had been involved in a crash.

3.10 AIR BAG SYSTEM CHARACTERISTICS

Air bag systems were also observed and recorded. Field observers were able to identify the vehicle occupant protection system for most of the total vehicle sample. Among the vehicles where the air bag system could be determined:

- 83.1 percent of 4,004 vehicles were equipped with driver frontal air bags.
- 71.8 percent of 3,898 vehicles were equipped with passenger frontal air bags.
- 4.6 percent of 3,602 vehicles were equipped with front side air bags.
- 1.3 percent of 3,602 vehicles were equipped with front side and rear side air bags.
- 4.9 percent of 3,134 vehicles were equipped with an air bag switch.

The status of air bag switches was also observed and recorded. For 88 vehicles checked for the position of the on/off switch, 51 vehicles had the switch “on” and 37 vehicles had the switch “off.” Sixteen children less than 80 lb were in the front seat of vehicles with the air bag switch in the “on” position. Of the 16 children, 2 were in rear-facing CRSs, 4 were in forward-facing seats, 3 were in SBs, and 7 were unrestrained.

4.0 SUMMARY AND RECOMMENDATIONS

This chapter summarizes findings from the data analyses; and provides recommendations for future research.

4.1 SUMMARY

The study began with a workshop with child passenger safety experts from the fields of biomechanics, injury prevention, public health, occupant protection systems, and highway safety education to discuss and prioritize the most critical CRS misuse characteristics associated with serious injury. A list of critical misuses was developed and used to formulate data collection procedures and instruments.

CRS use and misuse observations were conducted across a wide range of geographic regions in the country by teams of AAA-certified child passenger safety (CPS) instructors and technicians. These teams attended a train-the-trainer workshop hosted by the contractor in Philadelphia, PA to finalize data collection instruments and critical CRS misuse definitions, as well as to discuss data collection procedures. Prior to collecting data, the teams recruited greeters and additional certified CPS technicians. These local teams were given two-day training programs and observed closely in the field for the approximate two-month data collection period.

The regional data collection sites were Tucson (Arizona), Boca Raton/Fort Myers/Fort Pierce/Miami (Florida), Jackson (Mississippi), St. Louis (Missouri), Carlisle/Harrisburg (Pennsylvania), and Bellevue/Seattle/Tacoma (Washington). Site locations were predominantly parking areas of community shopping centers. However, many sites consisted of parking areas at fast-food restaurants, health and medical centers, and stores specializing in infant and children's merchandise. Community events were also used to collect data.

A convenience sampling approach was used. Sites needed to have a high volume of young children. Permission from shopping center owners or managers was required for a site to be considered acceptable for study. Additional site selection criteria were size of parking lot, number of exits and entrances, and traffic patterns. Malls and large shopping centers were avoided. Local and community shopping centers were primary choices for sites. Demographics of the communities were also considered. A wide range of ethnic and socio-economic variables was used in identifying appropriate sites. (See Appendix D.)

The data collection procedure involved intercepting potential target vehicles (driver with young children less than 80 lb), explaining the purpose of the stop, asking permission to make observations, and directing the driver to a safe parking area. If permission was received from the driver, the observer entered the vehicle and made observations of restraint use and misuse by the children, and recorded the information. At the same time, the greeter recorded information about age and weight of the children, seating position of the children, and type of restraints used by the driver and children. Once all the information was collected, the data collection team thanked the driver and then moved back into position to find the next vehicle meeting the sampling criteria.

Observation data were collected on 5,527 children less than the weight of 80 lb. Overall restraint use was 88.2 percent, as 62.3 percent used a CRS and 25.9 percent used a safety belt (SB).

A comparison of data for all children less than 60 lb with the previous NHTSA CRS misuse study by Decina and Knoebel (1996) showed that overall restraint use improved by only 3.3 percentage points. However, CRS use increased by 20.9 percentage points, while SB use decreased by 17.6 percentage points. Thus more children in the less than 60 lb category are remaining in CRSs than was evident in the earlier study of over 7 years ago.

The study found overall critical CRS misuse continues to be a problem in the country. CRS misuse— based on the critical CRS misuse measures identified by experts as having significant injury potential—was 72.6 percent. The most common critical misuses were loose harness straps securing the child to the CRS and loose vehicle SB attachment to the CRS.

Critical misuse remains fairly high for CRSs used by infants and young children less than 40 lb. Infant seats showed the highest misuse (83.9 percent) followed by rear-facing convertible seats (83.5 percent), forward-facing convertible seats (81.9 percent), and forward-facing only seats (79.3 percent). The most common types of critical misuses for these CRSs were loose harness straps and loose vehicle safety belts.

Critical misuse was much lower for CRSs used by young children from 40 to 79 lb. Belt-positioning booster seat misuse was 39.5 percent. Shield booster seats showed misuse of 60.5 percent. The most common form of critical misuse for these CRSs was that the child did not fit appropriately in the seat.

Premature movement of the child from CRS to SB remains a serious problem. While children less than 20 lb and 20 to 39 lb are predominantly in CRSs (97.1 and 86.4 percent, respectively); only 41.7 percent of children 40 to 59 lb were in a CRS, compared to 43.1 percent in SBs. Even worse, only 10.9 percent of children 60 to 79 lb were in a CRS, compared to 64.9 percent who were in a SB.

The study found that 11.8 percent of children less than 80 lb were not using any type of restraint system. For children less than 60 lb, 9.6 percent were unrestrained. The previous NHTSA CRS observation study (Decina and Knoebel, 1996) reported 12.8 percent of children less than 60 lb unrestrained.

Driver SB use continues to be related to restraint use by children. When drivers were belted, 91.7 percent of children less than 80 lb were restrained in either a CRS or SB. When drivers were unbelted, only 62.3 percent of children less than 80 lb were restrained. For belted and unbelted drivers, 44.2 percent and 43.2 percent of children less than 80 lb were in a CRS, respectively.

Comparison with the NHTSA National Occupant Protection Use Survey (NOPUS), which provides the only National probability based observation data on the use of child restraints (CRS or SB) on the Nation's roads, revealed results similar to this study, in terms of overall

restraint use (CRS or SB) for infants, children ages 1 through 3, and children ages 4 through 7. In addition, the relationship in NOPUS of driver restraint use to child restraint use was very similar to the findings of this study. Both NOPUS and this study found that when the driver was belted, over 90 percent of observed children were restrained (CRS or SB).

A large proportion of the vehicles that were stopped in this study had driver frontal air bags (83.1 percent) and passenger frontal air bags (71.8 percent). Only 4.6 percent of the vehicles had front side air bags; and only 1.3 percent had front side and rear side air bags. Only a small percentage of the vehicles (less than 5 percent) had on/off air bag switches. Of the 88 switches checked for the on/off position, 16 children were in the front seat with an air bag switch in the "on" position. Of the 16 children, 2 were in rear-facing CRSs, 4 were in forward-facing seats, 3 were in SBs, and 7 were unrestrained.

4.2 RECOMMENDATIONS

Recommendations are given for future research and enforcement and education programs.

Research – Periodic Monitoring of CRS Misuse

Periodic monitoring of CRS misuse among the general public is recommended. Biennial or triennial monitoring would be reasonable. There are several reasons for this recommendation. Vehicle manufacturers are constantly upgrading and changing designs of their occupant protection systems. While all new vehicles include driver and passenger frontal air bags, many also include newer side air bags. In addition, as of Fall 2002, all vehicles are required to have the LATCH system in place (Stewart and Kern, 2003). These changes can directly affect the ability of the public to provide the safest occupant protection for young children. As more people acquire newer vehicle models, the issues (and misuses) associated with CRS compatibility with air bag position and CRS use with LATCH will need to be identified and addressed. While proper use of a LATCH system is designed to eliminate the need for a vehicle SB and any associated misuses in CRS installation in the vehicle, CPS technicians are finding LATCH system misuses at inspection stations. Parents/caregivers are sometimes not using the top tether, not hooking the lower attachment to the lower anchor, or hooking the lower attachment incorrectly (upside down) (Osterhuber, 2003).

Another reason for periodic monitoring of CRS misuse involves the current status of occupant protection laws in the fifty States. Many States have either recently passed booster seat laws or have bills under consideration. These laws vary from State to State in terms of age and weight restrictions. As these laws take effect, it will be important to monitor public compliance and CRS misuse.

CRS misuse observations with the general public should be made by qualified and experienced personnel who are trained to gather CRS misuse data. Despite the public's general willingness to participate in these studies, drivers are willing to volunteer only a limited amount

of time to an observation survey. Thus, there is a need to be efficient, accurate, and quick in methods used to observe and record restraint system use and misuse. State and regional highway safety organizations offer NHTSA standardized child passenger safety training courses. It is recommended that field observers be course-certified technicians or instructors. In order to gain field observer experience, it is also recommended that individuals participate in local community CRS safety checks.

For researchers involved in CRS misuse observation studies, NHTSA provides (on their Web site – www.nhtsa.dot.gov) a list of certified instructors and technicians in each State. This list can be quite helpful as a starting point in recruitment.

Field observation studies of this nature should employ train-the-trainer workshops for supervisors, field managers and senior field observers; and training sessions for greeters and field observers at the local site level. The train-the-trainer workshops should focus on identifying the critical CRS misuse measures and how to observe, identify and record these measures. Data collection forms should include categories in line with defined CRS misuse measures. Forms should be structured to allow for expeditious recording of information. Check off boxes or codes to circle are recommended. Single-sided forms are also suggested.

At least two days of time should be spent training field observers. Classroom time should be spent covering the following:

- Review of CRS types and misuse measures.
- Procedures for recruiting the public.
- Techniques to interact with drivers.
- Methods to make CRS misuse observations and record data.

Role-playing should be conducted in a parking lot before going out into a real field observation environment. Field staff should be observed in action for at least two full days.

Other Research Needs

Engineering approaches have been developed (e.g., LATCH) to reduce the problems of a loose CRS to the vehicle. Loose harnesses are more of a challenge. This misuse can stem from drivers not properly following harness strap procedures (e.g., position of straps in slots, threading of harness through slots, retainer clip placement, buckling of crotchplate, and tightness of straps on child). Research needs to identify the most effective educational approaches that will help drivers understand and focus on this critical CRS misuse issue. Efforts to reduce critical CRS misuses should extend beyond relying on parents/caregivers to read and correctly follow manufacturer instructions. Findings from a NHTSA telephone survey found 74 percent of parents/caregivers learned how to install the CRS that their child used by reading the instructions (Block, 2002). With such a high rate of critical CRS misuse evident, reading instructions is clearly not enough. Maybe, more hands-on approaches are necessary. Research should focus on the effectiveness of hands-on demonstrations available at CRS inspection clinics or events, and the programs and media necessary to get parents/caregivers to go to these places. The NHTSA

telephone survey found that only 13 percent of parents/caregivers of children who used a CRS reported visiting an inspection station (Block, 2002).

This study found a large percentage of children (nearly 12 percent) unrestrained. Are the media not reaching this group? Are loaner programs ineffective? Are socioeconomic and demographic factors the reason? What do we need to do to increase CRS use, not just CRS correct use, by the public?

Enforcement

Enforcement of traffic safety laws has been effective in influencing the behavior of the public in a number of traffic safety areas, including restraint use. NHTSA surveys show the public generally agreeing that it is important to enforce the child passenger safety (CPS) laws (Block, 2002). The current study found that non-use of any restraint occurred with some frequency among the child population, particularly among children 60 to 79 lb. Enforcement of CPS laws in such situations is rather straightforward, and needed. But this study also found instances where parents were using the wrong restraint for the child. For example, many children less than 9 years of age were in vehicle safety belts instead of child restraint systems. A number of these children were in clear violation of the CPS laws in their States. The only way that enforcement of correct restraint use will occur is to have effective programs that make law enforcement agencies aware of the importance of correct CRS use, as well as keeping children in CRSs as long as possible. Recognizing the benefits of booster seat use for children ages 4 through 8 may lead to the development of enforcement strategies on how to identify this problem on the highways and cite violators of booster seat laws.

Law enforcement agencies across the country should actively take a role in community-based CRS education programs. Many law enforcement officers are CPS-certified and provide CRS installation checks at their stations. They regularly participate at “car seat safety check” events; and they conduct “education checkpoints” to facilitate CRS use and misuse surveys. Their involvement with these programs and other CPS education activities encourages public compliance with the occupant restraint laws, promotes driver and passenger restraint use, likely improves proper CRS use, and presents a positive public image of law enforcement and strengthens community relationships.

Education

As evident from the results of this study (i.e., high levels of CRS misuse, inappropriateness of restraint types, and unrestrained young children), education programs should continue to promote proper use of CRSs, occupant restraint laws, enforcement of these laws, availability of CRS inspection stations, loaner programs, and local and National CRS hotline information assistance. Programs should also provide information about new technology relating to vehicle occupant protection systems (e.g., side air bags) and CRSs (e.g., LATCH system).

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Appendix A. CRS Correct Use Definitions Guidesheet (for Observers).

(1) CRS Selection:

(a) An infant seat faces the rear and must only be used by children under 20 pounds.

(b) A convertible seat is used by children 5 to 40 pounds. It may be used rear-facing for infants and converts to forward-facing for children up to 40 pounds.

(c) A forward-facing only CRS is used by children at least 1 year of age **AND** over 20 pounds.

(d) A belt-positioning booster properly positions the vehicle lap/shoulder belt for children who have outgrown the forward-facing seat.

(e) A shield booster may be used for children weighing 30-40 pounds.

(f) A vehicle lap/shoulder belt is used when a child is tall enough to sit with his/her back against the vehicle seat back, while the knees are bent at the edge of the seat cushion. The shoulder belt crosses the center of the shoulder and chest, and the lap belt crosses the upper thighs/lower hips.

(2) CRS Installation:

(a) CRS Location: A rear-facing CRS should never be installed in front of an active air bag. A CRS must be installed on a forward-facing vehicle seat with at least 80 percent of the CRS base contacting the vehicle seat.

(b) CRS Direction: A child may be forward facing at a minimum weight of 20 pounds **AND** at least 1 year of age. Children who do not meet these criteria must be rear facing.

(c) Vehicle Restraint System: The vehicle safety belt must be correctly routed through the CRS and attached to the buckle. The CRS should move no more than 1 inch when checked at the belt path.

(d) Locking Clip: A locking clip is used to create a fixed length of webbing on a lap/shoulder belt when there is no other way to lock the belt. It must be positioned within 1 inch from the latchplate.

(e) Lower Anchors and Tethers for Children (LATCH): Rear-facing seats require 2 lower anchor points. Forward-facing seats require 2 lower anchors and the tether anchor point.

(f) Pool noodles and rolled towels or newspapers are considered appropriate for positioning of rear-facing CRSs. Thin rubberized mats, such as shelf liners, are acceptable for positioning both rear- and forward-facing CRSs.

(3) Placement of Child in CRS:

(a) Harness Strap: The harness straps must be in the correct seat slots, properly positioned on the child, snug (no more than 1 finger's slack), flat, and free from damage or alteration.
(b) Harness Connection: The harness is buckled.
(c) Harness Retainer Clip: The clip holds the shoulder straps close together over the child's chest at armpit level. It must be threaded correctly and free from damage or alteration.

Notes:

- Data collectors are not allowed to remove, touch, weigh or measure children, or remove a CRS from the vehicle to determine CRS misuse.
- Defective/broken CRS elements are included under each specific misuse characteristic.
- Other types of CRSs observed must meet FMVSS 213.
- CRS recalls are not being checked in this study.
- Some infant seats accommodate children weighing more than 20 pounds.

Appendix B. Greeter Form.

CRS CONTACT FORM (Rev 8-28-02)

FORM NUMBER	GREETER INITIALS	OBSERVER INITIALS	DATE (MO/DAY/YEAR)
			/ /

STATE: SITE:

****

Vehicle Make:_____ **Vehicle Model:**_____ **Vehicle Year:**_____

Record driver belt use. Record the presence of air bags for all positions, and passenger air bag on/off switch presence and mode. For children under age 9 in positions 2 through 9, enter age & weight. If entering age in years, specify "yrs" after the number. If entering age in months, specify "mo" after the number. Circle type of CRS. If the vehicle has other positions occupied by children, edit form to match vehicle design.

Driver	Vehicle Seating Position 2	Vehicle Seating Position 3
Belt Used: (1) YES (2) NO (3) UNKNOWN **AIR BAG** DRIVER: (1) YES (2) NO (3) UNKNOWN PASSENGER: (1) YES (2) NO (3) UNKNOWN PASSENGER AIRBAG ON/OFF SWITCH? (1) YES (2) NO (3) UNKNOWN IF YES, SWITCH MODE: (1) ON (2) OFF SIDE: (1) YES (2) NO (3) UNKNOWN ***if yes, circle location:*** D 3 4 6 7 9	**Age:** **Weight:** **CRS Type** ***(circle)***: (1) New (2) Used Infant Convertible Forward Facing Belt Positioning Seat Belt Unrestrained Other ***(describe)***:	**Age:** **Weight:** **CRS Type** ***(circle)***: (1) New (2) Used Infant Convertible Forward Facing Belt Positioning Seat Belt Unrestrained Other ***(describe)***:

Vehicle Seating Position 4	Vehicle Seating Position 5	Vehicle Seating Position 6
Age **Weight** **CRS Type** ***(circle)***: (1) New (2) Used Infant Convertible Forward Facing Belt Positioning Seat Belt Unrestrained Other ***(describe)***:	**Age** **Weight** **CRS Type** ***(circle)***: (1) New (2) Used Infant Convertible Forward Facing Belt Positioning Seat Belt Unrestrained Other ***(describe)***:	**Age** **Weight** **CRS Type** ***(circle)***: (1) New (2) Used Infant Convertible Forward Facing Belt Positioning Seat Belt Unrestrained Other ***(describe)***:

Vehicle Seating Position 7	Vehicle Seating Position 8	Vehicle Seating Position 9
Age **Weight** **CRS Type** ***(circle)***: (1) New (2) Used Infant Convertible Forward Facing Belt Positioning Seat Belt Unrestrained Other ***(describe)***:	**Age** **Weight** **CRS Type** ***(circle)***: (1) New (2) Used Infant Convertible Forward Facing Belt Positioning Seat Belt Unrestrained Other ***(describe)***:	**Age** **Weight** **CRS Type** ***(circle)***: (1) New (2) Used Infant Convertible Forward Facing Belt Positioning Seat Belt Unrestrained Other ***(describe)***:

"Hello, we are with the (Community) Child Safety Program. We are conducting a child passenger safety field study. The study involves confirming a few issues about child passenger safety, and entering your vehicle to take a look at the child safety seats or other restraint systems being used by your child passengers. There will be no need for you or your children to leave your vehicle; and you will park your vehicle. The confirmations will only take about a minute, and the observations will take just a few minutes. You are more than welcome to watch us make the observations. At the end, we can provide information to help you feel comfortable that you are properly securing your children in the vehicle. Do we have your permission to conduct these activities?

Appendix C. Observation Form.

Revised 9-10-02

NHTSA CRS MISUSE OBSERVATION FORM

FORM NUMBER: ☐☐☐☐ OBSERVER INITIALS: ☐☐ DATE: ☐☐ / ☐☐ / ☐☐ (Month / Day / Year) STATE: ☐☐ SITE: ☐

Record data for each child on a separate form. Use blue or black ink. Circle the most appropriate choice. Use a second sheet if additional comments are needed.

CHILD RESTRAINT TYPE	CHILD POSITION IN VEHICLE & VEHICLE RESTRAINT TYPE	REAR-FACING SEAT (1) *Circle one:*	FORWARD-FACING SEAT (2) *Circle one:*	BOOSTER (3) *Circle one:*	OTHER CRS TYPES (4) *Circle one:*	SEAT BELT (5) *Circle one:*
		INFANT (1) CONVERTIBLE (2) OTHER *(describe)*: (3)	CONVERTIBLE (1) FORWARD-FACING ONLY (2) INTEGRATED (3) OTHER *(describe)*: (4)	BELT-POSITIONING (1) INTEGRATED (2) OTHER *(describe)*: (3)	SHIELD BOOSTER (1) LAP TOP (2) OTHER *(describe)*: (3)	LAP ONLY (1) SHOULDER ONLY (2) LAP/SHOULDER (3)
CRS (1) SB (2) UNRESTRAINED (3) IS SEAT VISIBLY DAMAGED? (1) YES (2) NO DOES AT LEAST 80% OF CRS BASE CONTACT VEHICLE SEAT? (1) YES (2) NO Other Notes:	*circle one:* D 2 3 4 5 6 7 8 9 *circle belt type for this position:* Lap Only (1) Shoulder Only (2) Lap/Shoulder (3) None (4) Other : _____ (5) LATCH Lower Anchors in Use? (1) YES (2) NO Lower Anchors Used Properly? (1) YES (2) NO Tether in Use? (1) YES (2) NO (3) N/A Tether Used Properly? (1) YES (2) NO (3) N/A Seat Belts Used with LATCH? (1) YES (2) NO	LATCH? (1) YES (2) NO PROPER DIRECTION? (1) YES (2) NO AGE/FIT APPROPRIATE? (1) YES (2) NO APPROPRIATE ANGLE? (1) YES (2) NO SEAT BELT/LATCH HARNESS STRAP (1) CORRECT (1) (2) INCORRECT (2) *IF INCORRECT* (3) UNBUCKLED (3) (4) IMPROPER BELT PATH/SLOTS (4) (5) LOOSE (5) --- NOT USED (6) --- HARNESS STRAP IMPROPER POSITION (7) (8) LOCKING CLIP IMPROPER USE -- --- HARNESS RETAINER CLIP NEEDED BUT NOT USED/MISSING (9) --- HARNESS RETAINER CLIP IMPROPER POSITION (10) --- HARNESS RETAINER CLIP IMPROPER THREADING (11) (17) AFTERMARKET DEVICE (17)	LATCH? (1) YES (2) NO PROPER DIRECTION? (1) YES (2) NO AGE/FIT APPROPRIATE? (1) YES (2) NO SEAT BELT/LATCH HARNESS STRAP (1) CORRECT (1) (2) INCORRECT (2) *IF INCORRECT* (3) UNBUCKLED (3) (4) IMPROPER BELT PATH/SLOTS (4) (5) LOOSE (5) --- NOT USED (6) --- HARNESS STRAP IMPROPER POSITION (7) (8) LOCKING CLIP IMPROPER USE -- --- HARNESS RETAINER CLIP NEEDED BUT NOT USED/MISSING (9) --- HARNESS RETAINER CLIP IMPROPER POSITION (10) --- HARNESS RETAINER CLIP IMPROPER THREADING (11) (17) AFTERMARKET DEVICE (17)	AGE/FIT APPROPRIATE? (1) YES (2) NO (1) CORRECT (2) INCORRECT *IF INCORRECT* (3) UNBUCKLED (5) BELTS LOOSE (8) LOCKING CLIP IMPROPER USE (13) SHOULDER BELT IMPROPER FIT (14) LAP BELT IMPROPER FIT (15) HEAD RESTRAINT NEEDED (16) LAP ONLY BELT (17) AFTERMARKET DEVICE	AGE/FIT APPROPRIATE? (1) YES (2) NO (1) CORRECT (2) INCORRECT *IF INCORRECT* (3) UNBUCKLED (5) BELTS LOOSE (8) LOCKING CLIP IMPROPER USE (13) SHOULDER BELT IMPROPER FIT (14) LAP BELT IMPROPER FIT (15) HEAD RESTRAINT NEEDED (17) AFTERMARKET DEVICE	AGE/FIT APPROPRIATE? (1) YES (2) NO (1) CORRECT (2) INCORRECT *IF INCORRECT* (5) BELTS LOOSE (8) LOCKING CLIP IMPROPER USE (13) SHOULDER BELT IMPROPER FIT (14) LAP BELT IMPROPER FIT (15) HEAD RESTRAINT NEEDED (17) AFTERMARKET DEVICE

Appendix D. Socio-Economic Characteristics of State Sites (County-Level).

Location (STATE) (County)	Sites	Population	Race (%) White	Age (%) (0-5)	Household Size (persons)	House hold Median Income ($)	Unempl. Rate (%)
ARIZONA							
Pima	11	843,746	75.1	6.6	2.47	36,758	2.8
FLORIDA							
Lee	1	440,888	87.7	5.2	2.31	40,319	4.0
Miami/Dade	1	2,253,362	69.7	6.5	2.84	35,966	7.0
Palm Beach	4	1,131,184	79.1	5.6	2.34	45,062	5.4
St. Lucie	1	192,695	79.1	5.6	2.47	36,363	6.6
MISSISSIPPI							
Hinds	2	250,800	37.3	7.4	2.64	33,991	4.7
Rankin	4	114,638	81.5	7.0	2.62	44,946	2.5
MISSOURI							
Jefferson	1	198,099	97.5	7.2	2.74	46,338	3.3
St. Charles	2	283,883	94.7	8.2	2.76	57,258	4.0
St. Louis	12	1,016,315	76.8	6.3	2.47	50,532	3.9
PENNSYLVANIA							
Cumberland	4	213,674	94.4	5.5	2.41	46,707	2.0
Dauphin	4	251,798	77.1	6.2	2.39	41,507	2.9
WASHINGTON							
King	16	1,737,034	75.7	6.1	2.39	53,157	3.6
Kitsap	1	231,969	84.3	6.7	2.60	46,840	5.6
Pierce	8	700,820	78.4	7.1	2.60	45,204	5.3
Snohomish	2	606,024	85.6	7.2	2.65	53,060	4.1

U.S. Census Bureau, *County and City Data Book*: 2000
www.quickfacts.census.gov/qfd/states/

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