

National Transportation Safety Board

Analysis of Diversion to Automobile in regard to the disposition of Safety Recommendation A-95-51

Office of Research and Engineering
Safety Studies and Statistical Analysis Division
August 3, 2004

Introduction

In response to discussion regarding the status of Safety Recommendation A-95-51, to “revise 14 Code of Federal Regulation (CFR) Parts 91, 135, and 121 to require that all occupants be restrained during takeoff, landing, and turbulent conditions, and that all infants and small children be restrained in a manner appropriate to their size,” staff has once again reviewed the relevant facts associated with the recommendation and prepared the following summary. The principle argument against requiring child restraints has used statistical and economic models to predict diversion from air to highway travel. Such diversions can result in the additional risk of highway crash injuries and/or fatalities. Rather than evaluating the assumptions and metrics of those arguments, staff chose to take an alternate approach of analyzing data associated with historic instances when diversion from air travel was known to have occurred. Also included is the resulting effect observed in highway travel and associated injuries/fatalities.

Background

The current exemption for children under 2 years of age from the requirements of 14 CFR Parts 91, 135, and 121 for aircraft occupants to be properly restrained during taxi, takeoff, landing, and turbulent conditions was first specified in the revised Federal Aviation Regulations that followed the 1958 establishment of the Federal Aviation Administration (FAA) out of the previous Civil Aeronautics Authority. However, the practice of allowing an “infant” to be held rather than restrained during flight dates to the mid 1920’s and the beginning of commercial air travel. The infant exemption from any restraint requirement was initially granted out of practicality, since infants could not be properly restrained in the existing aircraft seats.

Infant and child restraint systems became widely available for use in automobiles during the 1960s and 70s, and by the mid 1980s all U.S. states required young children to be properly restrained in an appropriate child safety seat when traveling in an automobile. In contrast, despite several Safety Board recommendations and ongoing lobbying efforts by concerned organizations including the Association of Flight Attendants and the American Academy of Pediatrics, and the 1998 Advanced Notice of Proposed Rulemaking by the FAA to require child restraints, there is still no requirement that children under 2 be protected by any form of restraint during flight.

Predicting future benefit

The historic successes of Safety Board recommendations, FAA initiatives, and industry improvements have made domestic air travel incredibly safe. For example, there were only two fatal accidents involving scheduled 14 CFR Part 121 airline operations during 2003¹, and zero fatal accidents during 2002. Although aviation accident risk is related to exposure (e.g. the number of departures or the number of passenger miles flown) the complexity of commercial accident causal influences and the small number of resulting accidents make attempts at prediction problematic. Because fatal accidents are now rare events in domestic airline operations, any statistical analysis of these events must recognize the problems associated with calculations based on small numbers. Rather than calculating the probability of an accident based on measures of a normal distribution such as the average number of events during a specified time frame, airline accidents must be treated more like randomly occurring events.

The Part 121 fatal accident data from 2002 and 2003 serve as an illustration of the problem with making predictions based on small numbers. With 0 fatal accidents during 2002 and 2 accidents during 2003, there was an average of 1 accident per year. The standard distribution, or variability associated with this average is approximately 1.4. Because the probability of future accidents is calculated in comparison to the variability of a distribution around the average, a prediction based on 2002 and 2003 accident totals would indicate an approximate 16% chance of having a negative number of fatal accidents in following years. The obvious absurdity of these results should be taken into account when evaluating cost-benefit analyses based on predictions of future accident events based on historically small numbers.

The infrequency of fatal and large-scale fatal air carrier accidents in the United States, combined with an ongoing public image of air carrier accidents as always catastrophic and unsurvivable events may lead travelers to minimize the importance of passenger restraints. Accident data clearly show this perception to be incorrect considering that between 1983 and 2000, more than 95% of occupants of aircraft involved in 14 CFR Part 121 air carrier accidents survived.²

Because of the low number of fatalities and injuries to airline passengers under age 2, the FAA has determined that the cost of a child restraint requirement is too great for the expected safety benefit. Basing the evaluation of relative worth of a requirement for appropriate child restraints solely on the number of historic injuries and deaths overlooks the fact that every lap-held child traveler lacks adequate protection. Both laboratory testing and real-world accidents have proven that under high load force events when restraint is most important, arm strength is not sufficient to protect even a small child. Unlike aircraft components that can be evaluated based on the mean time between failure and criticality to maintaining safe flight should they fail, passenger restraints are part of an invaluable last

¹ One of the scheduled Part 121 accidents during 2003 was a ground handling accident that resulted in the fatal injury of a tug driver, but no passenger injuries.

² See NTSB Safety Report SR-01/01, March 2001

line of defense because they help protect occupants in the event of *any* failure or unexpected hazard encountered.

It is also important to note that Safety Board recommendation A-95-51 refers not only to scheduled Part 121 airlines, but all segments of aviation. During 2003 alone, 622 aircraft occupants were killed in general aviation. Complete records are not available for the number of children under 2 who travel annually in general aviation, but the impact of a restraint requirement would no doubt extend beyond commercial airline operations.

Opposition

In the executive summary of its 1995 report to Congress entitled “Child Restraint Systems”, the FAA states that their analysis of the economic and safety effects of requiring infant restraints assumed five premises:

1. Mandatory use of child restraint systems (CRS) will require the use of passenger seats that will then be unavailable for other passengers.
2. There will be costs associated with a CRS requirement, and those costs will either be absorbed or shared by air carriers and/or passengers.
3. Increased air travel charges for families with infants will cause some families to divert to other modes of transportation or forego travel.
4. Increased costs and/or lost revenue affects the profits of air carriers.
5. Air travelers who divert to other modes of transportation will be exposed to the higher injury and mortality rates associated with those modes.

The argument against restraints has continued since the FAA report to Congress, but the basic assumptions of that argument have remained the same. The stated link between cost, revenue, and air carrier profits is an obvious economic fact and won't be questioned. However, staff wishes to address the remaining assumptions.

Opposition Response

Requiring CRS use will take seats from other passengers

The apparent implication that infants are somehow less worthy of occupying seat space because of age or size notwithstanding, this assumption is problematic because it suggests a zero-sum relationship between airline seats. Although recent economic pressures have led many airlines to reduce fleet sizes and flight schedules to maximize aircraft load factors, the Air Transport Association of America reports that the average passenger load factor for major and national airlines during 2003 was 73.4%. The chances of being denied boarding are low, with approximately only 20 passengers out of 10,000³ being bumped (of those

³ US Dept. of Transportation, Office of Aviation Enforcement and Proceedings, Aviation Consumer Protection Division, *Air Travel Consumer Report, June, 2004*. Washington, D. C. Available for download at: <http://airconsumer.ost.dot.gov/reports/2004/0406atcr.pdf>.

bumped 95% volunteered their seats). Although the non-revenue status of lap-held infants makes their numbers difficult to accurately quantify, estimates suggest that children under 2 account for approximately 1% of domestic airline passengers.⁴ The complex ticket pricing structures used by airlines already routinely adjust pricing and restrict discount fare availability for the busiest flights and there is no reason to suggest that a significant number of adult seat fares would be “lost” even if discounted or free travel were granted to children under 2.

Costs associated with a CRS requirement

At one time, there was also the possibility that aircraft-specific restraints would have to be purchased either by passengers or the airline and that cost would therefore add to the total cost of travel. However, the standard used to approve child restraint systems, Federal Motor Vehicle Safety Standard No. 213, has since been amended to include child restraint certification criteria for use in both aircraft and automobiles, and any infant transported by car must already have an approved restraint. The resulting reality is that many of the approved safety restraints now used to transport infants to and from airports end up flying as checked baggage while those infants ride in the cabin unprotected.

Any increase in airline costs will lead families to divert to more dangerous modes, resulting in more deaths and injuries

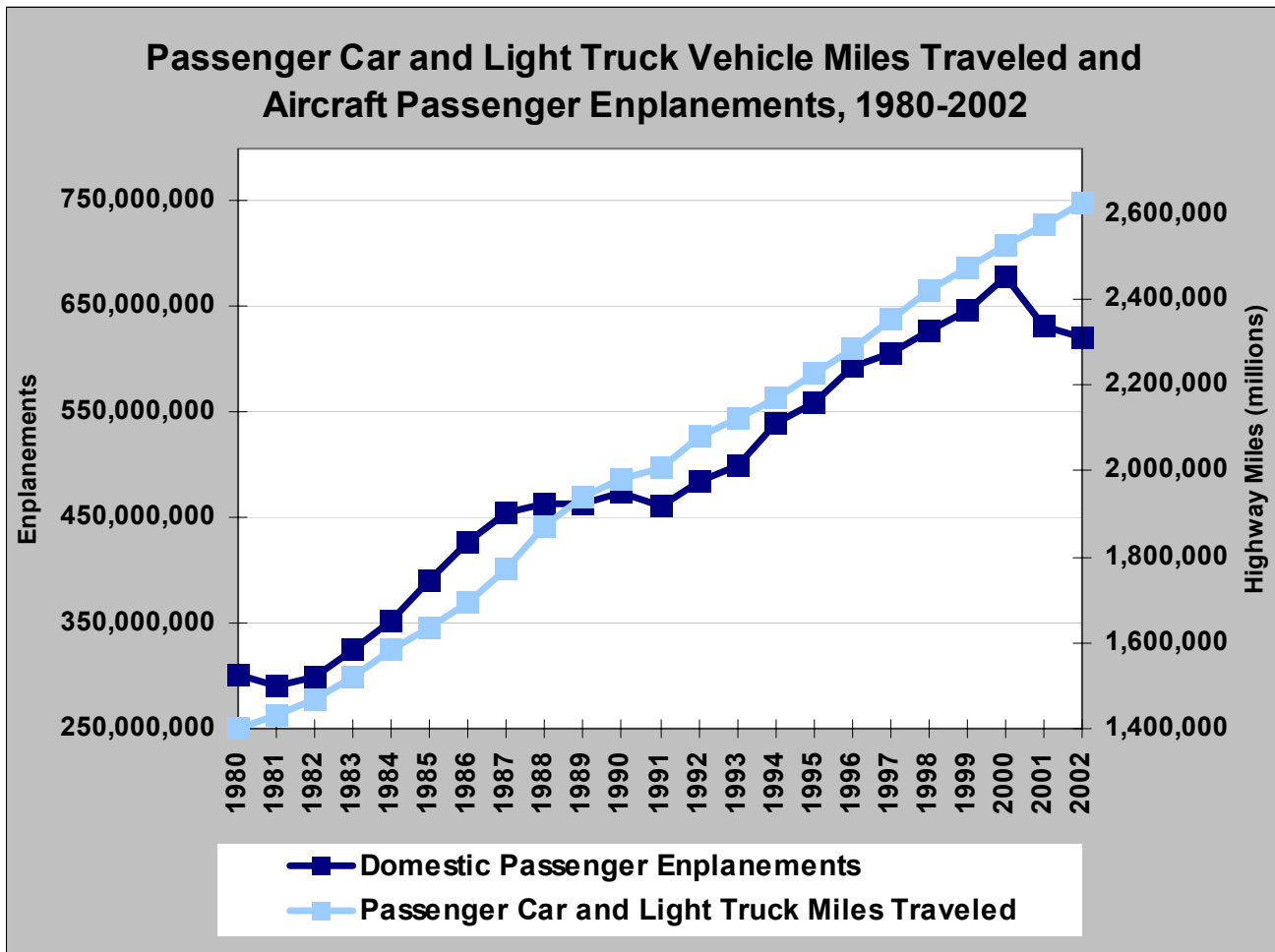
The combination of these assumptions represent the most compelling, and most enduring, argument offered against an infant restraint requirement – that the law of unintended consequences would result in more children being killed in highway accidents than would be saved in airplanes. Because it is the mission of the Safety Board to aggressively pursue safety in all modes of transportation, staff does not take this possibility lightly, and the remainder of this analysis is dedicated to the issue of diversion.

Diversion encompasses several complex issues – economic theory of price elasticity that involves assumptions and unqualified values, assumptions about traveler attitudes, and calculated risk models for specific trip and driver profiles. For example, what is the relationship between travel distance, trip cost, family size, and the decision to divert to driving? These relationships have no doubt changed and become even harder to evaluate with the rapid growth of the discount/budget air carriers and the rise of gasoline prices in recent years. For families that choose to divert, what is their increase in risk (if any) considering that they are likely to be exemplars of several of the safest driver categories (i.e., between 25 and 45, not driving after 9:00 at night, not using alcohol or drugs while driving, traveling via inter/intra-state highways, etc.). Since the FAA first raised the diversion issue in 1985, those arguing for and against an infant restraint requirement have repeatedly disagreed over the various assumptions used in the prediction model. Staff has stated on several occasions that because of the lack of empirical data to characterize passenger diversion behavior and thresholds, and the statistical problems of predictions

⁴ Federal Aviation Administration. *Report to Congress: Child Restraint Systems: Report of the Secretary of Transportation to the United States Congress Pursuant to Section 522 of the Federal Aviation Administration Authorization Act of 1994, Pub L No. 103-305*. Washington, D. C.: US Dept. of Transportation 1995.

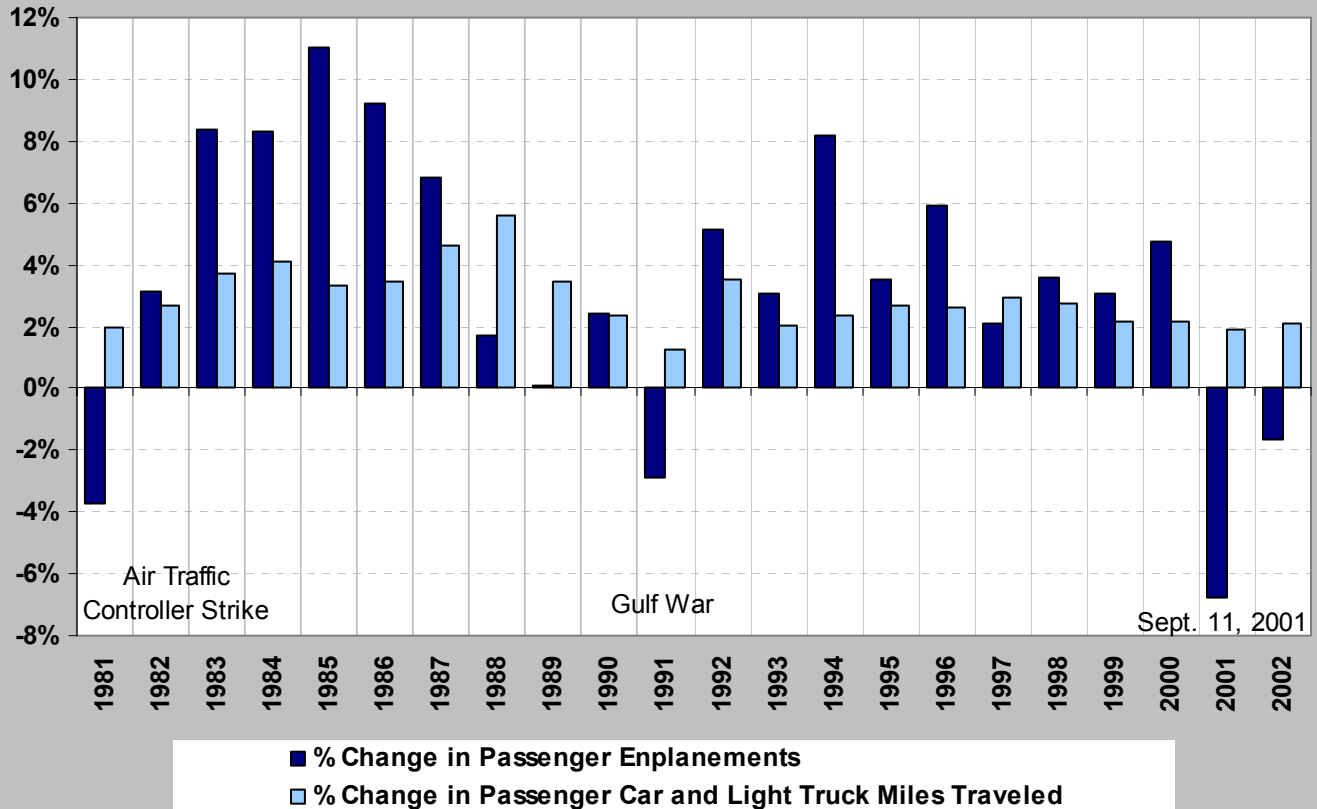
based on small numbers, it believes the diversion argument to be flawed. Rather than persist in this statistical analysis stalemate, staff has chosen to examine the historic record for large-scale diversions from air travel and the resulting effects on road travel, injuries, and fatalities.

The first step of this analysis was to examine historic records of annual airline passenger enplanements and passenger car and light truck miles traveled to identify possible periods of diversion from air to road travel. The following chart illustrates the total number of vehicle miles traveled and total domestic airline passenger enplanements that took place annually from 1980 to 2002.



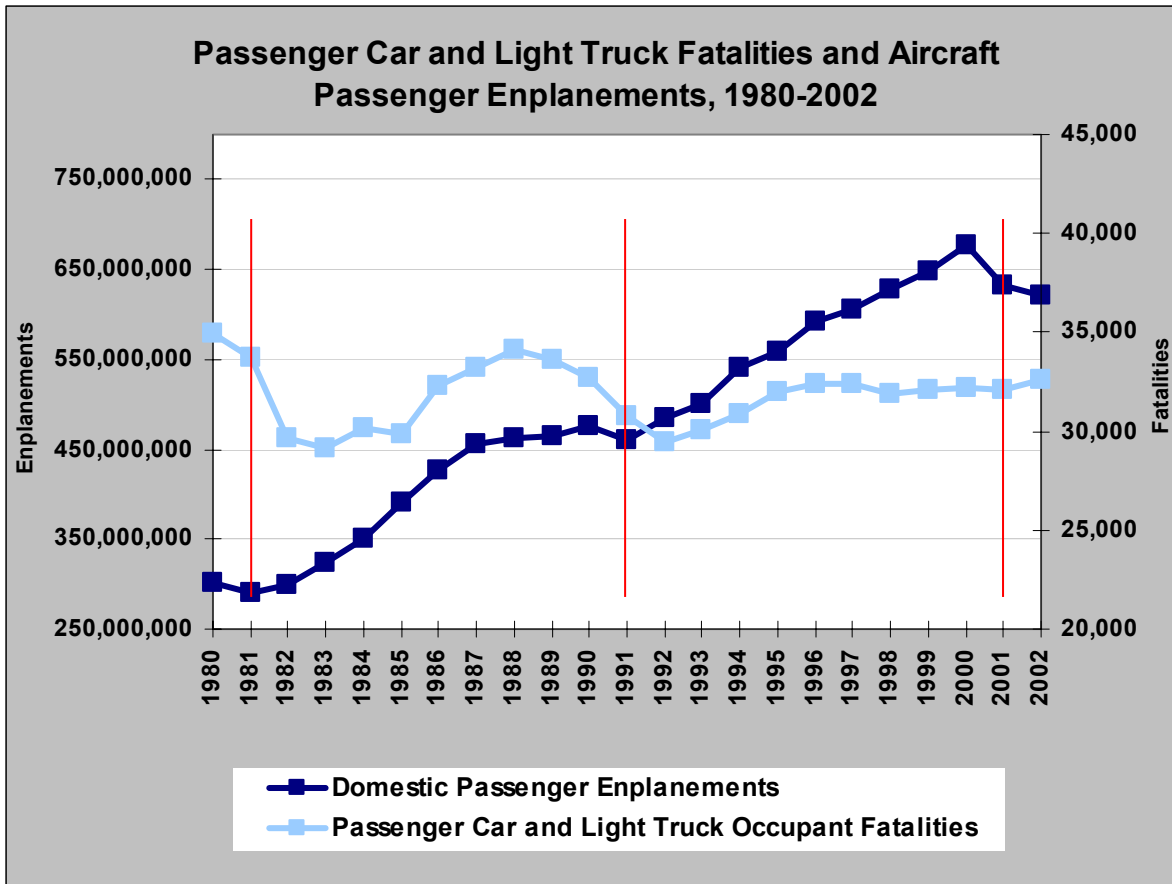
As this chart illustrates, there has been a steady increase in the number of vehicle miles traveled annually in passenger cars and light trucks during the 1980 to 2002 time period. Airline passenger enplanements have also generally increased, but there are three time periods when annual passenger enplanements appear to have decreased, first in 1981, again in 1991, and most noticeably during 2001 and 2002. These changes are even more obvious when the percent change in vehicle miles and enplanements are compared year-over-year as in the following chart.

Year-over-year Changes in Passenger Enplanements and Passenger Car and Light Truck Miles Traveled, 1981-2002



Although there are many factors that influence air travel, the timing of the declines in airline passenger enplanements appear to have coincided with specific events. The 1981 drop appears to coincide with the air traffic disruptions that resulted for the air traffic controller strike that year, the 1991 drop coincides with the first Persian Gulf War, and the largest disruption in air traffic on record coincides with the September 11, 2001 terrorist attacks.

When these changes in total annual airline passenger enplanements are then compared with annual totals for passenger car and light truck fatalities, it does not appear as though declines in air travel have correlated closely with large scale increases in road fatalities.

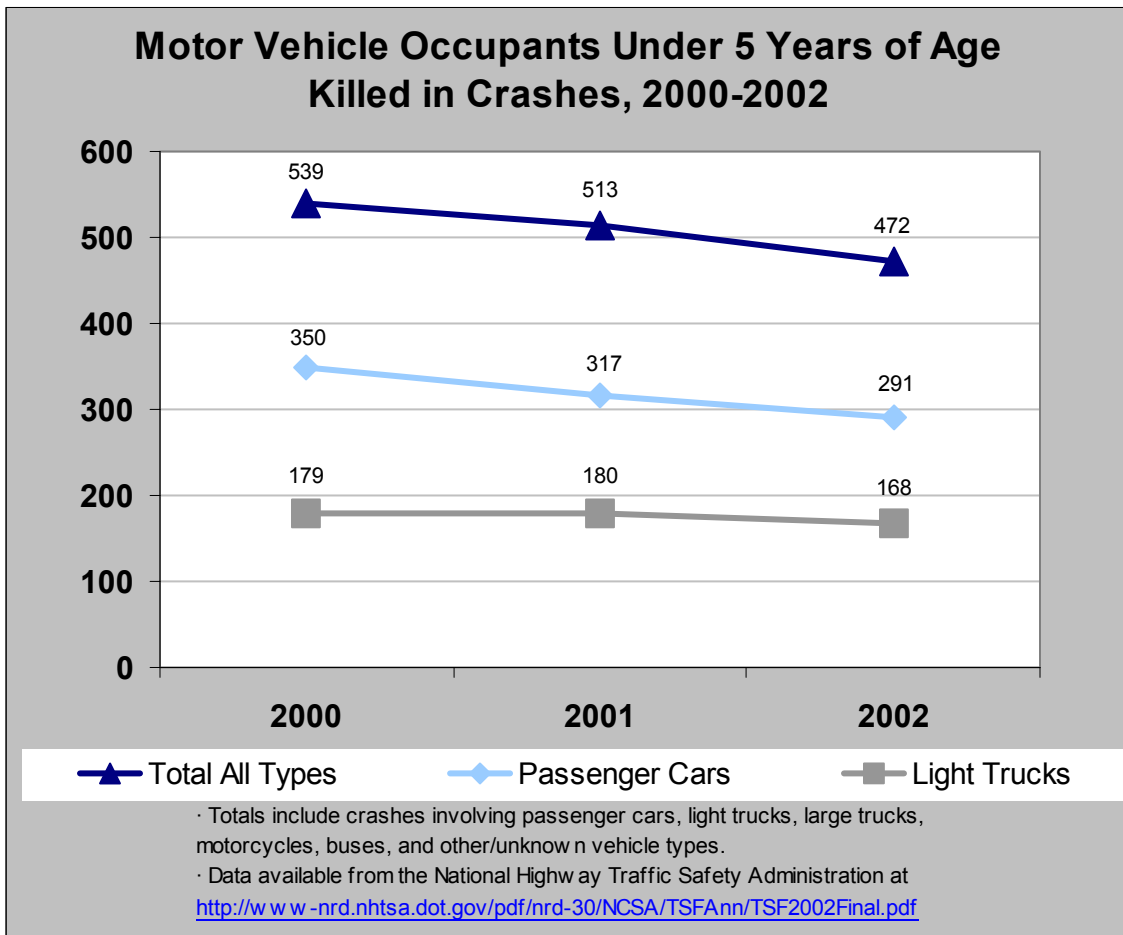


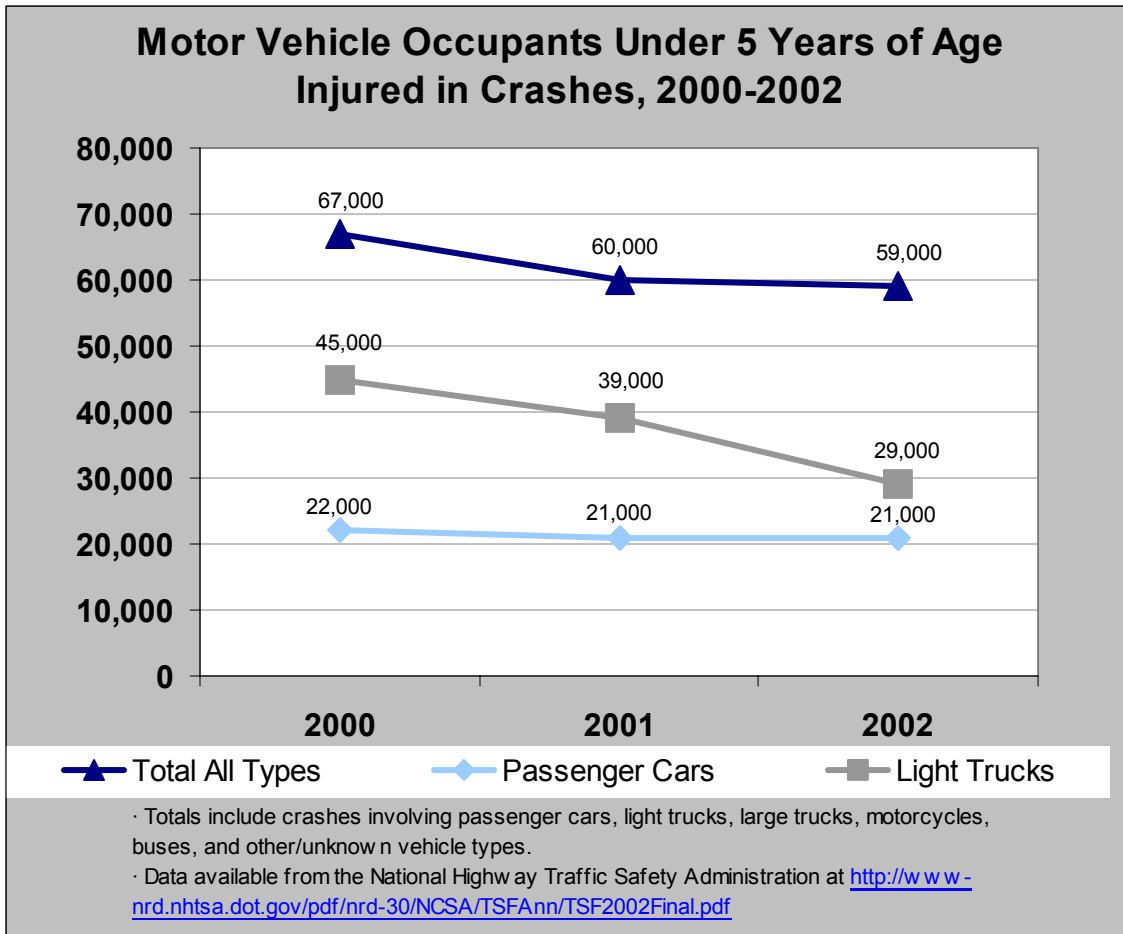
During the 1981 drop in air travel, there was a 3.5% decrease in passenger car and light truck fatalities from the previous year; during 1991, there was a 5.9% decrease in fatalities from the previous year; and during 2001, there was a 0.6% decrease in fatalities from the previous year. However, because of the lingering psychological and economic effects of the terrorist attacks, changes in domestic travel continue to be obvious into 2002 (the most recent years with available data). In total, domestic passenger enplanements decreased 8.3% from 2000 to 2002 (approx. 56.4 million passengers) while passenger car and light truck miles increased 4% (approx. 100 billion miles). Although passenger car fatalities continued an historic decline during these years, the decrease in passenger car fatalities was offset by an increase in light truck fatalities (predominantly due to the increase in SUV sales during this period) and there was a net increase in fatalities of slightly greater than 1% between 2000 and 2002. Passenger car and light truck occupant injuries decreased 8.7% (approx. 255,000 injuries) between 2000 and 2002.

It should be noted that the increase in fatalities from 2000 to 2002 included all drivers of all age groups, under all road and travel conditions, and was not specific to the population of interest, young children and their families. When examined more closely, we find that the combined total of fatal injuries to all vehicle occupants who were under 5 years of age⁵

⁵ Although the specific recommendation refers to children under 2 years, the road accident injury and fatality rates published by NHTSA refer to children under 5 years.

decreased 12.4%, from 539 to 472, between 2000 and 2002, and injuries decreased 11.9%, from 67,000 to 59,000.





Not only did total numbers of fatalities and injuries to children under 5 years old decrease despite increases in road travel during these years, but there was also a corresponding increase in this segment of the United States population⁶ from 19.2 million children in 2000 to 19.6 million children in 2002. As a result, the rate of fatalities for children under 5 years old decreased from 2.82 deaths per 100,000 children in 2000 to 2.41 deaths per 100,000 in 2002. The injury rate also decreased from 349 injuries per 100,000 in 2000 to 301 injuries per 100,000 in 2002. No doubt the use of appropriate child restraints played a large part in the observed reductions in the risk of death and injury.

Summary

Contrary to the arguments that have been raised in opposition to a CRS requirement, staff does not believe that such a requirement would result in an unreasonable burden on passengers or air carriers. Previous problems of child restraint availability have now been solved with dual certification standards for both road vehicles and aircraft, and dually certified CRSs are now widely available.

⁶ Population size based on U.S. Census estimates.

The FAA has further argued that the cost for implementing such a requirement ultimately does not justify the potential benefits. Not only does staff disagree with this argument based on the statistical problems associated with making predictions based on small numbers, but also because it is contrary to all reasonable safety practices. Because laboratory and real-world accident data have shown that lap-held children cannot be adequately protected, the age of the passenger becomes arbitrary. Choosing to continue to exempt children under 2 from an adequate restraint requirement is then no different from granting a similar exemption for any other segment of the passenger population. Although ludicrous, exempting children under 2 is not functionally different from exempting passengers over 80 from a restraint requirement. Further, passengers are now required to securely stow all carry-on baggage during takeoff and landing because of the potential risk of injury to other passengers in the event of an unexpected hazard encounter. However, the same passengers are permitted to hold a child of equal size and weight in their lap. When children under 2 are not required to be restrained for their own safety, the safety of their fellow passengers also becomes an issue.

After considerable analysis of real-world air and road vehicle data, staff has found that in extreme cases, diversion from air travel may result in increased risk of fatality or injury for some specific vehicle, trip, and driver types, but this accident risk is not evenly distributed and no evidence was found to suggest an increased risk for children under 5 years old. In total, there does not appear to be a clearly defined relationship between diversion from air travel and highway accidents or injury. In fact, despite the acknowledged difference in relative risk between road and commercial airline travel in the United States, and the largest diversion from air travel in U.S. history during recent years, road fatalities and injuries for children under 5 years old have continued to decrease.