

CHILD PASSENGER SAFETY:
Standards and Regulations

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INTRODUCTION

“Motor Vehicle Crashes are the Number One Killer of Children Over Age 1.”

— Children’s Hospital of Philadelphia Report, May 2005¹

I chose to conduct my research on the topic of Child Passenger Safety (CPS) for a number of reasons:

1. **Timing.** I am soon to be a first-time father. As the dad and the highly-trained engineering expert in the family, I have taken on the duty and responsibility of bravely muddling through the Babies’R’Us hoopla and Consumer Reports pomp to select the exact car seat that is most optimally suited for our specific tykes needs. My wife is a pediatric nurse, so she knows things, but I am best suited to understand the complex vagaries of crash test results and mean head deflections.
2. **Applicability.** Car seat and vehicle safety standards exist in an interesting and complicated world that well suits the confines of the current course material.
3. **Importance.** As the Children’s Hospital of Philadelphia quote above highlights, CPS is a very serious business and deserves continued attention.

In this report I intend to look at the history and effectiveness of CPS. I will also look at the complex combination of organizations that standardize and regulate the industry.

Finally, I intend to take a somewhat cynical look at how corporate greed could drive the certification process.

CHILD PASSENGER SAFETY HISTORY

The history CPS systems actually only extends back a few decades. It was not very long ago that cars did not have seatbelts much less the five-point harnesses for 70 pound 7 year olds that are now welded to the vehicle's frame. I remember, as most people my age probably do, arguing with my parents about being relegated to the back seat when the first studies started coming out in the 1970's saying that the back seat was a safer "kid-zone". I also have vivid memories of having a "booster seat" similar to figure 1 whose only real function was to get me higher up in the seat so I could better look out the window and enjoy the passing scenery and moo-cows. Largely driven by government regulation and popular demand, car seat technology has certainly come a long way as can be seen by the polyvinyl and plastic high-speed engineering marvel shown in figure 2.



Fig 1²



Fig 2³

In 1933 the first production children's car seat was manufactured and sold by the Bunny Bear Company. These chairs, however, were not designed to protect the child in the event of an accident. Their purpose was to confine the child in place and to raise them up to make them more visible and controllable for the adults in the front seat. The first true safety seats did not appear until 1962. Jean Ames of the United Kingdom

created a design that featured a foam padded seat strapped to the rear passenger seat of the vehicle and held the child in place with a Y-shaped harness.⁴ Steady improvements to this basic design have followed ever since.

Paralleling and closely associated with the evolution of CPS is the development of vehicle safety in general. In the early years of vehicle production, safety considerations were strictly at the discretion of the buyer. Most buyers were not highly discerning of safety considerations and the manufacturers only built cars as safe as needed in order to maximize sales. The different manufacturer's approaches to safety widely varied and the laws and regulations posed by the local and federal governments did little to standardize these approaches.

In 1958, in response primarily to issues with widely varying world-wide standards for vehicle headlamps, the United Nations Economic Commission for Europe (UNECE) held a World Forum for the Harmonization of Vehicle Regulations. The product of this forum was an agreement officially titled "*Agreement concerning the adoption of uniform technical prescriptions for wheeled vehicles, equipment and parts which can be fitted and/or be used on wheeled vehicles and the conditions for reciprocal recognition of approvals granted on the basis of these prescriptions*". This was an important step in furthering the international standardization of vehicle safety design including CPS. The UNECE CPS standard is ECE R44 and is noted by a circle around an E and a number.⁵

Among the 56 current signatory nations of UNECE, the most notable decliner is the United States. We elected to maintain separate standards. In the late 1960's however, public pressure began growing within the United States to improve vehicle safety. Ralph Nader's 1966 book "Unsafe at Any Speed" helped push twin Highway

Safety Acts in 1966 and 1970 that empowered the United States Department of Transportation to set and regulate federal vehicle safety standards. The Department of Transportation in turn created the National Highway Traffic Safety Administration (NHTSA) to perform these duties. In 1972 the first Federal CPS standard was issued: Federal Motor Vehicle Safety Standard 213 (FMVSS 213).⁶

In 1979 Tennessee became the first state to pass a CPS law. It required parents to put their infants in child restraint systems that met the Federal Standard. By 1985 all 50 States, the District of Columbia and Puerto Rico all had enacted legislation requiring the use of approved CPS systems.⁷

More recently, two important events occurred in 2002 that had significant affects on CPS in this country. First, the United States adopted an internationally accepted standard method for attaching child restraints to a vehicles rear seat. This system, known as LATCH in the United States (Lower Anchors and Tethers for Children) is also known as UAS in Canada (Universal Anchorage System) and internationally as “ISOFIX”. LATCH is derived from the International Organization for Standardization standard ISO 13216.⁸

The second important event that occurred in 2002 was the passage of “Anton’s Law” in the United States congress. This law, named after a four year old child that died in a car crash, requires the Department of Transportation to track and improve CPS for toddlers and other non-infant children. This law has sparked an increase in booster seat use, higher age limits in several state laws and new procedures for certification to federal standards.⁹

CHILD PASSENGER SAFETY EFFECTIVENESS

The National Highway Traffic Safety Administration (NHTSA) also has the task of tracking vehicle safety statistics within the United States for consumer use and safety process improvement. According to their records, 8,325 lives were saved between 1976 and 2006 by CPS systems. 425 children under the age of five were saved in 2006 alone.¹⁰ Unfortunately however, motor-vehicle accidents remain the number one killer of children over age one.

Although the numbers certainly validate the effectiveness of CPS systems, efforts continue to try to make them do more. Figure 3 is a graph derived from data available on NHTSA's FARS tool (Fatality Analysis Reporting System).¹¹ It shows a slight decline in deaths over the years which is impressive given the fact that Our Nation's highways and roads become more crowded and dangerous with every additional driver. Note also the recent decline in deaths of children aged 5-9 years. This could be attributed to the recent efforts of the Anton's Law legislation.

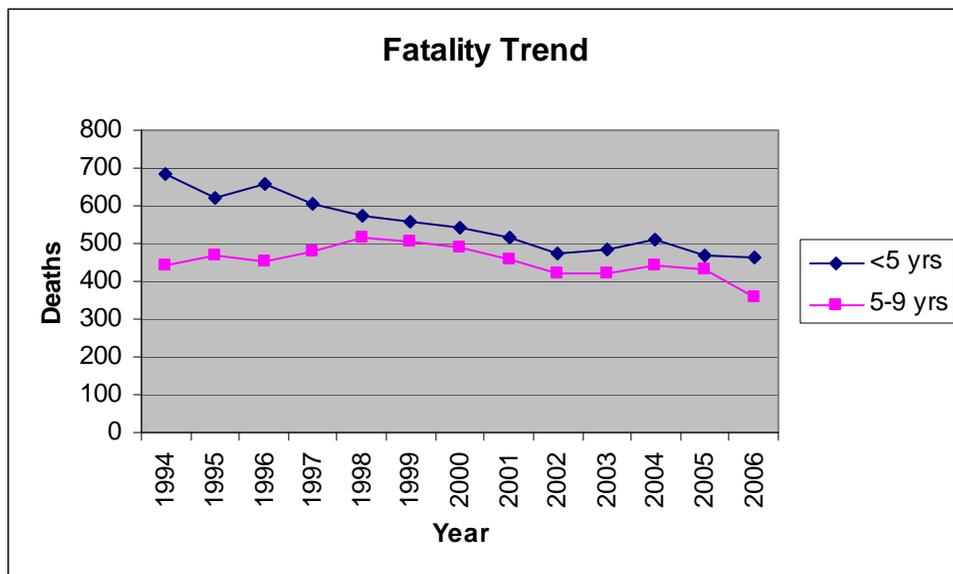


Fig 3

The proper use of CPS systems is certainly effective at saving lives. The Department of Transportations best estimate is that these systems reduce the likelihood of an infant (under one year old) being killed in a vehicle crash by 71 percent and the likelihood of a toddler (one through four years old) being killed by 54 percent. According to studies by the Children’s Hospital of Philadelphia, proper use of booster seats for young children (four through seven years old) also reduces the likelihood of injury in a car crash by 59 percent when compared to seat belts alone.¹²

ORGANIZATIONS INVOLVED

There are MANY organizations involved with vehicle safety standards and regulations within this country and internationally. CPS standards and regulations are mostly produced by the same organizations. I have chosen to divide the organizations into “Domestic” and “International” for ease of discussion. It is important to recognize however that the “Domestic” organizations, although based in the United States, certainly exhibit an international influence. Likewise, the “International” organizations have a great deal of influence on the standardization processes within our country.

Domestic

The Government of the United States places responsibility for the safety of our motor-vehicles, roads and highways on the Department of Transportation. The arm of the Department of Transportation that executes this responsibility is the National Highway Traffic Safety Administration (NHTSA). Their stated mission is:

“Save lives, prevent injuries and reduce economic costs due to road traffic crashes, through education, research, safety standards and enforcement activity.”¹³

The NHTSA's programs include some that are familiar to most people. The New Car Assessment Program (NCAP) provides consumers with "5 Star Safety Ratings" of new vehicles. NCAP uses its test results and evaluations to provide new car shoppers with comparative safety assessments they can use in selecting a vehicle. This in turn provides incentives for manufacturers to improve their safety performance.

Of note, NCAP does not provide a similar assessment for CPS systems. Although they have received some public and governmental encouragement to do so, NHTSA currently only verifies that systems meet federal standards and provide a pass or fail assessment. They do rate the systems "Ease of Use" with a 5-Star grade for consumer comparison. Products that do not "pass" or meet the Federal Safety Standard cannot be sold in the United States. In 2005, after conducting a pilot test program, NHTSA released the following statement to explain why they do not provide ratings for the safety of child restraints:

"... A rating program based on simulated crashes would not provide practicable, readily understandable, or meaningful information to consumers."¹⁴

The standards federalized by the NHTSA are known as Federal Motor Vehicle Safety Standards (FMVSS). FMVSS 213 is the standard that regulates CPS systems. It is closely tied in with FMVSS 208 which is the standard covering occupant crash protection features in motor vehicle such as seat belts. It also specifies the performance requirements for the anthropomorphic crash test dummies that are used in the testing of child restraint systems.¹⁵

Another significant function of the NHTSA is to collect, analyze and provide safety data and statistics for the use of consumers. Insurance companies in particular are

frequent customers of these products. The National Center for Statistics and Analysis (NCSA) is the office of the NHTSA that is responsible for this function. They maintain an extensive database of crash information including the Fatality Analysis Reporting System (FARS) that is used worldwide.¹⁶ It is interesting to note that despite the variances in standards throughout the world, crash-statistics from this domestic database are occasionally referenced in the discussion of standards development elsewhere in the world.

The final Domestic organization I would like to talk about on the playing field of CPS standards and regulations is the International Society of Automotive Engineers (SAE). Although, as their name implies, they are an international organization, they exercise the most influence on standards within the United States. FMVSS regulations, including FMVSS 213, are based almost entirely on SAE standards, which in turn, are heavily influenced by the “Big Three” United States auto manufacturers. This practice equates to standards within this country that are not fully compatible with most of the rest of the world. Child restraint manufacturers that sell products in the United States must meet different standards and therefore create different designs if they wish to sell their wares in most other countries.¹⁷

International

Although the big player for CPS standards internationally is undoubtedly the United Nations Economic Commission for Europe (UNECE), the first country that I wish to talk about is Canada. It is the one country that is most similar to our own in this regard. Canada Transport is the arm of the Canadian Government that has jurisdiction over traffic safety. They adopt most of our standards and turn them into Canadian Motor

Vehicle Safety Standards (CMVSS). Therefore child restraint systems manufactured for sale in the United States can usually also be sold in Canada and vice versa. One interesting additional requirement for Canadian car seats is that they must have an “expiry” date.¹⁸ Canada requires manufactures to affix a sticker that states the expiration date of the seat and does not allow any restraints on the road that are over 10 years old. Most seats that are sold in the United States now also have an expiration date, although not required, partly because it is easier to maintain a single manufacturing line for both countries. Another interesting feature of the Canadian system is that they also allow products that meet UNECE standards on their roads. This creates the opportunity for argument and competition as to which “standard” is safer.

As stated, the biggest player on the international standards forum for CPS is UNECE. 56 countries have adopted UNECE standards as regulations within their borders. The UNECE standard for CPS is UNECE R44.¹⁹ The internet is filled with debate as to which standards, UNECE R44 or FMVSS 213, provide the most protection. I think this is unfortunate. Both have the same objectives of providing protection for children. Both also conduct very similar testing including simulated frontal and side impact crashes using a sled. Unfortunately the differences in test criteria (such as sled dimensions and crash dynamic profiles) are dissimilar enough to require different designs to pass each standard. This has the consequence of establishing separate industrial bases for each market. Subsequent political pressure to maintain these individual industrial bases will probably serve to maintain the divergent criteria in the future. Fortunately for the consumer however, the products of these multiple bases continue to merge towards a technologically similar and safer CPS system.

EURO NCAP is an organization similar to NCAP in the United States that provides testing, certification and safety rating information for consumers in Europe. It was founded in 1997 by the Department for Transport in the United Kingdom and has since been adopted by the European Coalition. They conduct similar, but again slightly different testing that cannot be directly translated to United States markets.

The independent organization that provides the majority of the standards language for UNECE R44 is the International Organization for Standardization (ISO). They were also responsible for the LATCH system that has eased compatibility between vehicles and restraint systems. ISO was started in 1946, when delegates from 25 countries met in London to create a new international organization, of whose objective would be "to facilitate the international coordination and unification of industrial standards".²⁰ They are one of the primary organizations one thinks of when discussing "standards".

Two other nations worth discussion on this topic are Australia and China. Australia is interesting because it operates under yet another standard (AUS/NZ1754) which is just technically dissimilar enough from the other standards to maintain another separate industrial base. China is interesting because of its extremely large consumer base. It is currently without a current strong standards or regulations program for its many vehicles. They have not focused much effort on vehicle safety despite their dangerous roads because they estimate only about 8 percent of motor vehicle fatalities are due to the vehicles themselves.²¹ The majority of the deaths are attributed to poor road conditions and poor driving. China has, however, started looking towards the future of their vehicle safety standards both for the benefit of Chinese drivers and for their own potential automotive export market. They have signed a Memorandum of Cooperation

with NHTSA and initiated annual talks where they exchange technology and information for the improving China's vehicle safety among other things.²²

FMVSS 213

FMVSS 213 is the standard for CPS in the United States. It specifies the requirements for child restraint systems used in all motor vehicles and aircraft sold in this country. It has gone through several revisions since its initial creation in 1980 and its latest version was published in 2006. The most recent changes to the standard included the addition of the LATCH system and the addition of toddler and small child anthropomorphic crash dummies. The stated purpose of FMVSS 213 is:

“...to reduce the number of children killed or injured in motor vehicle crashes and in aircraft.”²³

FMVSS 213 specifies requirements for quality and testing criteria of the restraints. It also gives requirements for design and performance in multiple simulated crash tests. It also provides requirements for labeling and system instructions. It requires tests for durability and flame resistance as well as dynamic excursion criteria for the crash tests.

The current version of the FMVSS 213 uses at least three different dummies to conduct the acceptance simulated crash tests: infant, toddler and child. Figure 4 shows the “family” of dummies used in federal testing. Figure 5 shows a restraint system with a toddler dummy mounted to the sled that simulates the forces experienced during a “typical” crash. Note that restraint in the sled is attached to a “bench” type seat. This is an example of the diversion between FMVSS 213 and UNECE R44 which uses “bucket” type seats on its testing sleds.



Fig 4

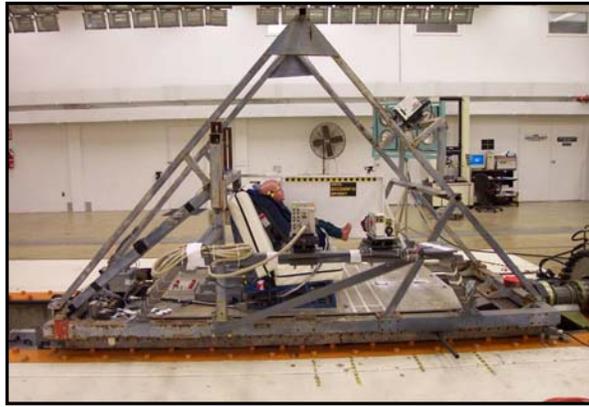


Fig 5

REGULATIONS

Federal Guidelines

Although the Federal Government leaves the actual regulation and enforcement of vehicle safety laws to the individual states, the NHTSA has an active program to influence state and local governments to conform to their prescribed guidance. This guidance is developed as a result of all the studies and testing previously discussed.

The “4 STEPS FOR KIDS” guideline is published by NHTSA through educational and advertising campaigns such as the annual “CPS Week” in September. They also field and fund certified inspection stations, mostly at police and firefighting stations, to help educate the public on how best to protect their children. The “4 STEPS FOR KIDS” is summarized in Figure 6 and the descriptions below:



Fig 6

Step 1: Rear-Facing child safety seats provide the best possible protection for newborns and infants and should be used as long as possible up to the height and weight limit of the particular seat. At a minimum use these seats until the infant is at least 1 year old and 20 pounds.

Step 2: When the child outgrows their rear-facing seats they should transition to a forward-facing child safety seat mounted in the rear seat of the vehicle until they reach the upper weight or height limit of the particular seat which usually occurs around age 4 and 40 pounds.

Step 3: When the child outgrows the child safety seat, they should ride in a booster seat in the back seat of the car until the vehicle's installed seat belts fit properly. This usually occurs about age 8 or when the child reaches 4'9" tall.

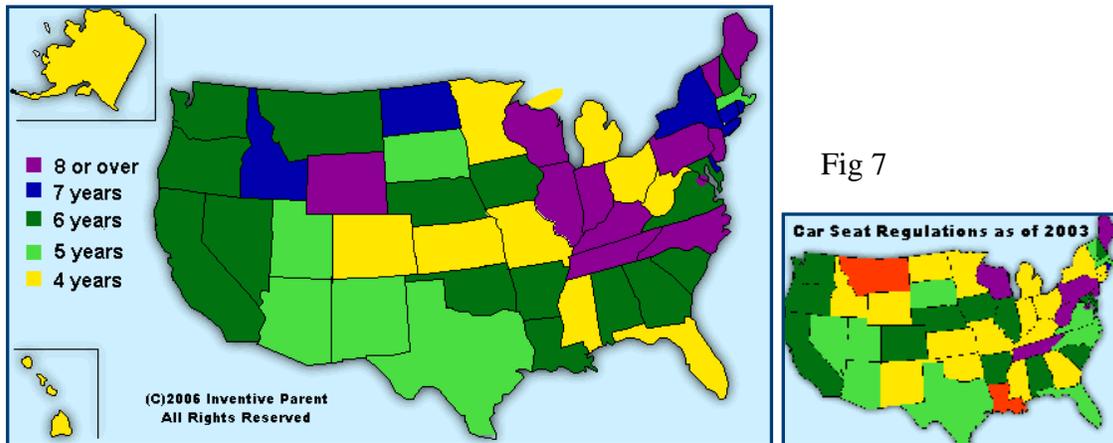
Step 4: After they outgrow the booster seat, the children should use adult seat belts for the rest of their lives. The back is the safest place for children under 12.²⁴

The next step will be to look at how these recommendations are translated into local and state laws.

State Laws

One of the challenges facing a new parent is to determine what exactly the CPS laws are in the state they are currently driving in. For example, we are having our baby at a hospital in Bethesda, Maryland; we live in Alexandria, Virginia and we will likely have to make the return trip from the hospital through the District of Columbia. Therefore, do I need to be prepared to reconfigure my car seat 3 times on the way back? The answer is fortunately no, but the point is, this can be very complicated, especially for parents that travel.

Figure 7 below is provided by a website called “The Inventive Parent”.²⁵ It shows the patchwork quilt of State CPS Laws as they existed as of 2006. Also shown for reference is a similar chart from 2003. Note the growing number of states that are following the NHTSA recommendation for requiring children up to age 8 to be in approved restraints. Not only do drivers need to know the rules in each state they drive through, they need to keep abreast of frequent changes.



As part of this research project, I also took a more detailed look at the specific rules for 5 states. I chose Maryland, Virginia and the District of Columbia because, as stated, I will be driving through all three on my child’s first trip. I also looked at Nevada and California because Nevada is my home state and my vehicles are licensed there and California has a reputation for being a more “liberal” state.

Two of the five states that I chose to look at have enacted new laws since the above graphic was made. As of July 1, 2007 in Virginia²⁶ and June 30, 2008 in Maryland²⁷, all children under age 8 in both states must be restrained in a child safety seat or booster seat unless they are over 4’ 9” tall. Maryland also adds a weight limit of 65 pounds. An interesting difference between the two laws is the way in which they reference the federal standard. The Maryland Law states that the restraints must be

“federally approved” while the Virginia Law states that the restraints “must meet standards adopted by the Department of Transportation”.

The District of Columbia, on the other hand, was actually one of the first states to enact a law requiring children up to age 8 to be in an approved CPS system.²⁸ The District is frequently used as a test bed for new federal policies and educational campaigns. This was the case for NHTSA’s “4 STEPS FOR KIDS” campaign. The effects of this law in the District have been used in the NHTSA congressional reports required by Anton’s Law.

California²⁹ and Nevada³⁰ each both still only require CPS systems for children up to 6 years old and under 60 pounds. Although California is perceived as a fairly liberal state, it has rejected proposals in each of the last two years to add laws requiring children under 8 to be restrained. In his veto, Governor Schwarzenegger stated his belief that “...the way to protect children was through efforts focused on education and enforcement of existing laws, not the addition of new ones”³¹. Nevada has similarly acknowledged the NHTSA’s recommendations by listing “Best Practices” alongside its laws. These practices directly mirror NHTSA’s “4 Steps for Kids” federal guidelines.

Another area where CPS regulations are enforced is in our hospitals. At our hospital in Bethesda, I am required to show my approved and inspected car seat in order to take my child home. The hospital my wife works at, Fairfax INOVA, similarly requires a satisfactory car seat present at the time of check out. If the family cannot afford a seat, the hospital provides contact information for several charities that will provide one. Some of these families do not even have a car.

EFFECTS OF GREED

I intended to make one of the primary points of exploration for this research paper to be the hypothetical effects of greed on the CPS system certification process. One of our class speakers stated that all successful certification processes are “essentially greed driven” (non-attributable). In other words, companies develop and modify standards for baby seats not so that they can save babies, but so that they can sell more seats and therefore increase profits. Some questions a hypothetical baby seat tycoon might consider during a planning meeting include:

- How many engineers should the company employ focusing on making the baby seat safer rather than focusing on making them easier to use or cooler looking.
- How much money should we spend annually on research and development to build safer baby seats?
- What is the ideal rate of change for the roll out improvements and new standards? We want every new baby to need at least one new seat.

Not surprisingly, although I am sure these conversations take place, there is very little public information available on this topic.

CONCLUSION

In the end, I can not tell a lie, my wife picked out our car seat. It is the Chicco KeyFit 30 and it is very pretty. She saw that Consumer Reports ranked it as its number one seat in their latest review. She also checked all the appropriate blogs, talked to her friends, and that was good enough for her. I used my newfound knowledge to look up all the pertinent engineering facts on the unit and decided not to use my Veto Authority. It is a good seat, fits well in the car, passed muster with the fireman at Bethesda, and meets all current federal standards.

As for the standards processes that produced this seat, one key takeaway that I have is that I cannot see the continued isolation of the different standards processes continuing much longer. Each different organization is essentially working towards the same goal (making babies and children safer) while trying to maintain face in the political environment of their local industrial bases. The arguments that the average cars and car crashes in the United States are different than those in Europe probably has some level of truth, however, I want my child to be safe in crashes between cars of multiple foreign origins. Rather than try to devise a model crash for each continent, we should work together to develop worst-case scenarios that provide adequate certification criteria for all continents.

ENDNOTES

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