

Programs of the Federal Motor Carrier Safety Administration (FMCSA) encompass a range of issues and disciplines, all related to motor carrier safety and security. FMCSA's Office of Analysis, Research and Technology defines a "research program" as any systematic study directed toward fuller scientific discovery, knowledge, or understanding that will improve safety, and reduce the number and severity of commercial motor vehicle crashes. Similarly, a "technology program" is a program that adopts, develops, tests, and/or deploys innovative driver and/or vehicle best safety practices and technologies that will improve safety and reduce the number and severity of commercial motor vehicle crashes. An "analysis program" is defined as economic and environmental analyses done for the agency's rulemakings, as well as program effectiveness studies, state-reported data quality initiatives, and special crash and other motor carrier safety performance-related analyses. A "large truck" is any truck with a Gross Vehicle Weight rating or Gross Combination Weight rating of 10,001 pounds or greater.

Currently, FMCSA's Office of Analysis, Research and Technology is conducting programs in order to produce safer drivers, improve safety of commercial motor vehicles, produce safer carriers, advance safety through information-based initiatives, and improve security through safety initiatives. The study described in this Tech Brief was designed and developed to support the strategic objective to produce safer drivers. The primary goals of this initiative are to ensure that commercial drivers are physically qualified, trained to perform safely, and mentally alert.



U.S. Department of Transportation
Federal Motor Carrier Safety Administration

Office of Analysis, Research and
Technology

1200 New Jersey Ave. SE
Washington, DC 20590

Safety Belt Technology Countermeasures Study

Background and Purpose

Safety belts are the single most effective injury prevention component of highway vehicles today. Although Section 392.16 of the Federal Motor Carrier Safety Regulations (FMCSR) requires commercial motor vehicle (CMV) drivers to wear safety belts, 45 percent of the 703 CMV drivers who died in 2006 in commercial motor vehicle crashes were not wearing a safety belt.

The Federal Motor Carrier Safety Administration (FMCSA) has established the CMV Safety Belt Program which includes the CMV Safety Belt Partnership – a coalition of government and industry entities formed to increase CMV drivers' safety belt use. A 2006 Department of Transportation (DOT) study showed that the average rate for safety belt use for CMV drivers of Class 7 and 8 CMVs was 59 percent. Although this is a significant improvement from the start of the program in 2003, when the rate was 48 percent, it is still far behind the greater than 80 percent usage rate for passenger vehicle drivers.

The CMV Driver Safety Belt Technology Countermeasures Study was initiated to assist in the continuing effort to increase safety belt use among CMV drivers. This study addresses identification of technologies that could potentially increase CMV driver safety belt use, and the analysis of CMV-involved crashes to better understand the dynamics of these crashes in relation to safety belt use.

Study Design

A literature review was conducted to identify technologies that are likely to increase safety belt usage by drivers of large trucks. Based on the results of the literature review and stakeholder input, the report focused on four promising technologies or approaches:

1. Enhanced Audible Reminder Systems
2. Brightly Colored Safety Belts
3. Safety Belt Tension Adjustors
4. Seat-Integrated Safety Restraint Systems

The study also conducted a benefit-cost analysis to determine the monetary impact of increased safety belt use by drivers of all large trucks and drivers of Class 7 and 8 trucks. The benefit-cost analysis first involved the

determination of injury costs for belted drivers and unbelted drivers. Since safety belts are not equally effective for all crash types (head-on, rollover, rear, etc.), it was necessary to calculate separate injury costs by safety belt use/non-use for each crash type. The difference between the actual annual cost of injury to belted and unbelted drivers of large trucks and the expected cost of injury if all drivers were now belted is the potential injury cost savings. The maximum injury benefit would be realized if a safety belt technology was 100 percent effective in increasing safety belt use (e.g., addressing the 41 percent of drivers not currently buckled). Since a 100 percent usage rate is not likely, the total potential cost savings is scaled based on the changes in usage rate anticipated for each device. Anticipated increases in safety belt use per device were estimated based on expert opinions provided by industry stakeholders. The “investment” would be the purchase of the safety device by an individual or fleet owner; the “return” would be a reduction in the cost of sustained injuries by drivers. This cost is usually paid for by fleet owners directly or through insurance for other means.

The study analyzed crash data from the Fatality Analysis Reporting System (FARS), National Accident Sampling System (NASS), General Estimates System (GES) and the Large Truck Crash Causation Study (LTCCS) databases to identify characteristics of belted and unbelted CMV drivers in fatal and serious injury crashes for all CMVs. A similar analysis was done specifically for Class 7 and 8 vehicles.

Crash Analysis

CMV drivers of Class 7 and 8 vehicles were significantly overrepresented in fatal crashes. In 2005, there were 702 fatalities of Class 7 and 8 truck occupants, representing 88 percent of all large truck occupants. For drivers whose safety belt use status was known, 58 percent of Class 7 and 8 drivers involved in fatal crashes were unbelted.

The analysis identified that for both belted and unbelted drivers, the majority of CMV driver fatalities occurred during rollover crashes, followed by impacts with other vehicles. A review of unbelted driver fatalities and serious injuries indicated that 39 percent of unbelted driver fatalities could be prevented with safety belt use and 47 to 81 percent of moderately to seriously injured drivers could have sustained injuries less severe if they were properly restrained.

Types of Crashes – For both belted and unbelted drivers, the majority of CMV driver fatalities occurred during rollover crashes followed by impacts with other vehicles. Of the 688 truck driver fatalities, 232 (37 percent) of driver deaths occurred during rollovers. Sixty-six percent of those deaths are unbelted drivers. There were 133 drivers fatality injured during vehicle-to-vehicle collisions, and 46 percent were unbelted. Of the 123 drivers fatally injured during collisions with fixed objects, 63 percent were unbelted.

Crash Vehicle Characteristics – The majority of driver fatalities involved tractor trailers with a cargo body type designated as “van/enclosed box.” The study suggests that even a slight increase in safety belt use by Class 8 truck drivers will have a greater impact on injury and fatality numbers for CMV drivers when compared to other vehicle segments. The study also found that a larger percentage of single unit truck driver fatalities are sustained by unbelted drivers (68 percent of single unit truck driver fatalities /55 percent of truck/tractor driver fatalities).

Technology Countermeasures

Enhanced Audible Reminders – The Code of Federal Regulations Part 571, Federal Motor Vehicle Safety Standard Number 208, requires that audible and visual reminder systems be installed at the driver’s seating position for passenger vehicles. These reminders have been shown to increase safety belt use. No federal regulations exist that require safety belt reminder systems of any kind for CMVs weighing 10,000 pounds or more. Enhanced audible reminders systems chime intermittently if a safety belt is not fastened. These devices were the most widely accepted and supported by stakeholders; it was stressed, however, that the technology must be tailored to a large truck application. The benefit-cost ratio (BCR) for original equipment for all trucks is well above the acceptable threshold.



Brightly colored safety belt for CMV operators

Brightly Colored Safety Belts – Brightly colored safety belts are a potential enforcement strategy to increase CMV safety belt use. Such safety belts are usually bright orange, yellow or green and are more visible to law enforcement. Colored safety belts are currently in use by fleets of all sizes. The anticipated BCR for all trucks is close to or above the acceptable threshold.

The incremental cost of this technology is estimated to be \$12 over the base (noncolored) safety belt. If the entire safety belt system is purchased and installed (including retractor, D-ring, buckle system, and safety belt webbing) the estimated cost is \$95-\$120.

Safety Belt Tension Adjustors – Safety belt tension adjustors allow truck drivers to introduce some slack into the safety belt to reduce abrasion and irritation against the upper body. The system is integrated with the safety belt system and as such is not available as an aftermarket device. Stakeholders generally agreed that adding too much slack for the sake of comfort was not ideal and could lead to reduced effectiveness of safety belts; however, the tradeoff between potentially reduced effectiveness and potentially increased rates in safety belt use by CMV drivers was acceptable. The anticipated BCR for original equipment for all trucks was below the acceptable threshold, and for Class 7 and 8 vehicles was above the acceptable benefit cost ratio threshold.



**Komfort Latch System
Safety Belt Tension Aduster**

Researcher: This study, "Safety Belt Technology Countermeasures Study" was conducted by Pacific Institute for Research and Evaluation, 11720 Beltsville Drive, Suite 900, Calverton, Maryland 20705

Authored by: George Bahouth, Elizabeth Langston, A. James McKnight, Eduard Zaloshjna, Jerry Robin, Janet Kumer

Key Words: Crash Causation, Driver Injury, Large Truck, Rollover, Safety Belt

Notice: This Tech Brief is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The Tech Brief provides a synopsis of the final publication for this study. The Tech Brief does not establish policies or regulations, nor does it imply USDOT endorsement of the conclusions or recommendations. The U.S. Government assumes no liability for its contents or their use.

Web Site: All FMCSA Tech and Analysis Briefs may be accessed at www.fmcsa.dot.gov.

Technical Writer:
Peter Vaka
C² Technologies, Inc.

Technical Editor:
Kirse Kelly
C² Technologies, Inc.

December 2007
Publication No. FMCSA-RRR-07-019

Seat Integrated Safety Restraint Systems

– Seat integrated safety restraint systems operate much like a traditional safety belts system, but the upper D-ring and lower anchorage points are attached to the seat structure itself, which reduces the relative motion between suspended seats and the fixed belt anchorage. Drivers and stakeholders expressed that seat integrated restraints could improve comfort but were not very familiar with such systems. The anticipated BCR for all trucks was below the acceptable threshold.



Seat integrated safety restraint

Conclusion

The study concluded that increased safety belt usage would reduce the number of serious and fatally injured CMV drivers. This was reinforced by the review of unbelted driver fatalities and serious injuries indicating that 39 percent of unbelted driver fatalities and 47 to 81 percent of moderate to serious driver injuries could be prevented with safety belt use. As many as 2500 drivers per year could have sustained less severe injuries by being properly restrained. The economic burden associated with these casualties due to non-use of safety belts for drivers of large trucks was estimated to be \$675 million annually. The cost of injuries and fatalities associated with unbelted drivers of class 7 and 8 trucks is \$490 million.

Based on estimates from the study, brightly colored safety belts and enhanced audible reminders are both assumed to be cost beneficial solutions. Alternatively, seat integrated safety restraints could offer an enhanced comfort solution, but device costs exceed the likely benefit of the proposed system. Safety belt tension adjusters, which are widely available today, are well suited to help CMV drivers configure safety belt systems for optimal comfort; however, significant driver education and training must occur in order to realize maximum effectiveness in increasing safety belt usage for these devices.

Some approaches must be adopted voluntarily by vehicle manufacturers or fleet owners when purchasing vehicles. Others could be addressed through improvements in existing regulations (i.e. potentially adding CMVs to the Code of Federal Regulations Part 571, Federal Motor Vehicle Safety Standard Number 208 which presently requires audible and visual reminder systems be installed at the driver's seating position for passenger vehicles). The required introduction of basic audible or visual reminder systems would have some positive effects; however, the implementation of an enhanced system would likely bring about a greater positive change in safety belt use.