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Evaluation of FMVSS 214 Side Impact Protection for Light Trucks: Crush Resistance Requirements for Side Doors

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16. Abstract

Beginning September 1, 1993, all light trucks (pickup trucks, vans, and sport utility vehicles) were required to meet a crush resistance standard for side doors. Data from calendar years 1989 through 2001 of the Fatality Analysis Reporting System (FARS) were used to determine the effectiveness of changes made by vehicle manufacturers to meet this standard. Effectiveness was determined by comparing changes in the number of fatalities in side impacts relative to those in frontal impacts.

Three analysis techniques were applied to the data. First, simple ratios of side-impact to frontal crash fatalities were computed, with comparisons made between vehicles with and without side door beams. Second, side impact fatality rates per one thousand vehicle registration years were determined, with vehicles separated according to whether they were manufactured before or after side door beam installation. Finally, a regression analysis of the ratio of side-impacts to frontal fatalities as a function of the presence of side door beams was done.

The effectiveness of side door beams for front outboard occupants was estimated to be 19 percent in all single vehicle side impacts, which would result in the saving of 151 lives in those type crashes if all light trucks were equipped with the side beams. Looking at single vehicle *nearside* impacts only, the effectiveness of the beams was estimated to be 25 percent. If all light trucks were equipped with side door beams, an estimated 124 lives would be saved annually in single vehicle nearside impacts. Little or no effectiveness was found in multi-vehicle crashes.

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Executive Summary

From January 1, 1973 until August 31, 1993, Federal Motor Vehicle Safety Standard (FMVSS) 214 had been applicable to passenger cars only. Beginning September 1, 1993, all light trucks (pickup trucks, vans, and sport utility vehicles) were also required to meet the crush resistance standard, which specified minimum crush resistance when a load is applied to the outer surface of a vehicle door. Manufacturers were permitted to meet the standard earlier, and in a few cases this was done, but the majority of light trucks were installed with side door beams beginning in model year 1994. Manufacturers met the static crush requirement of FMVSS 214 by installing longitudinal side door beams.

Data from calendar years 1989 through 2001 of the Fatality Analysis Reporting System (FARS) were used. Vehicle model years used in the analysis ranged from 1989 through 1997. These data included 1,376 cases of single vehicle side impact fatalities. This is the type of crash most likely to benefit from the presence of the side door beams.

An earlier evaluation on the effectiveness of side door beams in passenger cars had found the greatest benefit to be in single vehicle side impacts, and little or no effect on fatalities in multi-vehicle crashes. In the current evaluation, side impact data were first compared to frontal impacts, which served as a control group. Effectiveness of installing side door beams was determined by comparing changes in the number of fatalities in side impacts relative to those in frontal impacts. Data were examined for all front outboard occupants, as well as for drivers and right front passengers individually. Vehicles were limited to those without changes in the presence of air bags, or analytic techniques were used to control for air bags, since this would clearly have an impact on the number of fatalities in frontal impacts.

Three analysis techniques were applied to the data. First, simple ratios of side-impact to frontal crash fatalities were computed, with comparisons made between vehicles with and without side door beams. Second, side impact fatality rates per one thousand vehicle registration years were determined, with vehicles separated according to whether they were manufactured before or after side door beam installation. Finally, a regression analysis of the ratio of side-impacts to frontal fatalities as a function of the presence of side door beams was done. The regression analysis allowed control of additional influencing variables, such as the presence of air bags and vehicle age.

The regression analysis was considered the best technique, because it allowed several factors to be investigated at the same time, such as seat position, presence of air bag, and vehicle age, which could have affected the previous two analyses, as well as allowing a larger sample size, since data before and after beam installation did not have to be matched for such situations as presence of air bags or years of production.

Regression models were run for various combinations for side impacts. All side impacts were combined; single and multi-vehicle crashes were also examined separately, as were near and far side crashes. Presence of the side door beam was found to statistically significantly reduce fatalities in single vehicle side and single vehicle nearside impacts, relative to frontal crashes, for drivers alone as well as in combination with right front passengers. The regression analysis showed that side door beams are effective in preventing front outboard fatalities in single vehicle side impacts. There was a

19 percent reduction in fatalities attributed to the beams for both drivers alone as well as for all front outboard occupants. In single vehicle nearside impacts, drivers alone saw a 26 percent reduction, while the reduction for all front outboard occupants was 25 percent. All four of these reductions were statistically significant. Right front passengers also saw sizable 18 and 17 percent reductions, in single vehicle and single vehicle nearside impacts, respectively, although these were not statistically significant. Little or no effectiveness was found in multi-vehicle crashes.

The effectiveness of side door beams for front outboard occupants was estimated to be 19 percent in all single vehicle side impacts, and 25 percent in single vehicle nearside crashes. Based on these two different effectiveness estimates, the number of lives saved annually was estimated. Using the 19 percent fatality reduction for front outboard occupants in single vehicle side impacts, it is estimated that, if all light trucks were equipped with side door beams, 151 lives would be saved each year in single vehicle side impacts (both nearside and far side). The 95 percent confidence band for effectiveness for all front outboard occupant single vehicle side impact fatalities ranged from 4 to 32 percent. The 95 percent confidence bounds range from 29 to 285 lives saved if all light trucks were equipped with side door beams. These calculations are based on the average effect of side door beams over all single vehicle side impact fatalities, and applying the effectiveness estimate to the total of nearside and far side fatalities combined.

A slightly more conservative estimate can be obtained by assuming the beams are effective only in nearside single-vehicle crashes, and have little effect in the far side crashes. Using the 25 percent effectiveness estimate for all front outboard occupants in single vehicle nearside fatalities, the 95 percent confidence band for all front outboard occupant nearside fatalities ranged from 8 to 39 percent. If all light trucks were equipped with side door beams, an estimated 124 lives would be saved annually in single vehicle nearside impacts. The 95 percent confidence band is 35 to 222 lives saved.

Introduction and Background

The National Highway Traffic Safety Administration (NHTSA) issues Federal Motor Vehicle Safety Standards (FMVSS) that must be met by vehicles manufactured for sale in the United States. FMVSS 214 (“Side Impact Protection”) specifies performance requirements for the protection of occupants in side impact crashes, in order to reduce the risk of serious and fatal injury to occupants. A primary objective of FMVSS 214 is to minimize danger caused by intrusion into the passenger compartment. FMVSS 214 has both a crush resistance requirement for side doors as well as a side impact requirement based on dynamic testing. This report covers only the extension of the crush resistance requirement to light trucks.

The initial version of FMVSS 214 was limited to a crush resistance requirement for passenger cars, effective January 1, 1973. On December 22, 1989, NHTSA published a Notice of Proposed Rulemaking (NPRM) to extend FMVSS 214’s existing passenger cars quasi-static test requirement to light trucks. This would, in effect, require light trucks to be equipped with side door beams.

From January 1, 1973 until August 31, 1993, FMVSS 214 had been applicable only to passenger cars. In most cases, manufacturers met FMVSS 214 by equipping cars with a longitudinal beam in vehicle doors. NHTSA evaluated the benefits of the crush resistance regulation in passenger cars, and found single vehicle side impact occupant fatalities were reduced by 14 percent, saving 480 lives annually (Kahane, 1982).

FMVSS 214 was extended to light trucks in 1991 (for the final rule extending static test to light trucks, see *Federal Register* 56 (June 14, 1991): 27427), with an effective date of September 1, 1993. Beginning with model year 1994, all light trucks met the standard. Some vehicles were already being manufactured with side door beams prior to the effective date of the standard.

The 1982 evaluation of the crush resistance requirement found the greatest benefit was for passenger cars in single vehicle side impacts. The crush resistance requirement was found to have little or no effect on reducing fatalities in multi-vehicle side impacts. Thus, the focus of this report is on single vehicle crashes, although data from multi-vehicle crashes are presented for comparison. In addition, occupant seating position is noted, to distinguish between nearside and far side impacts.

The crush resistance test consists of gradually forcing a steel cylinder of 12 inch diameter into the door. With seats removed, the cylinder must encounter a resistance averaging at least 2,250 pounds during the first 6 inches of crush, averaging at least 3,500 pounds during the first 12 inches, and reaching a peak of at least 7,000 pounds or twice the vehicle’s curb weight (whichever is less) at some point during the first 18 inches of crush. With seats installed in the vehicle, the cylinder must encounter a resistance averaging at least 2,250 pounds during the first 6 inches of crush, averaging at least 4,375 pounds during the first 12 inches, and reaching a peak of at least 12,000 pounds or three and one half times the vehicle’s curb weight (whichever is less) at some point during the first 18 inches of crush.