TTMA Exhibit A

Potential Costs, Safety Benefits, and Cost-Effectiveness of Side Impact Guards for Truck Trailers

(amended version – April 2006)

Prepared for

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Correction – In April 2006, a review by the author of some of the calculations in the original July 2005 version of this report revealed an error in the methodology used to calculate potential payload displacement safety disbenefits for side impact guards. To correct this error, revised calculations for this effect have been made, starting on page 38. Corresponding changes also have been made in the Executive Summary and in other sections, as needed. This revised April 2006 version of the report should be substituted in its entirety for the original July 2005 version of the report.

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Executive Summary

On January 24, 1996, NHTSA published in the *Federal Register* a final rule establishing two Federal Motor Vehicle Safety Standards (FMVSS) which operate together to reduce the number of injuries and fatalities resulting from the collision of passenger vehicles into the rear ends of heavy trailers and semitrailers. One of these standards, FMVSS 223, Rear Impact Guards, specifies particular performance standards that rear impact guards must meet before they can be installed on new trailers and semitrailers. The second standard, FMVSS 224, Rear Impact Protection, requires that most new trailers and semitrailers with a Gross Vehicle Weight Rating (GVWR) of 10,000 pounds or more be equipped with a guard meeting the requirements of FMVSS 223. FMVSS 224 also includes requirements for the mounting location of the guard relative to the rear end of the vehicle.

The two standards, FMVSS 223 and 224, relate solely to rear impact guards. In 1991, as part of the rulemaking that led to establishing these standards, the agency rejected extending requirements to guards that might address injuries and fatalities due to passenger vehicles colliding with the sides of heavy trailers and semitrailers. On page 15 of its September 1991 "Preliminary Regulatory Evaluation, Combination Truck Rear Underride Guards, New FMVSS," the agency stated, "Combination truck side underride countermeasures have been determined not to be cost-effective."

At the request of the Truck Trailer Manufacturers Association, this author undertook an assessment to quantify the potential costs and benefits of side impact underride guards for trailers and semitrailers with GVWRs of 10,000 pounds or higher. The approach used to estimate these potential costs and benefits is the same basic approach NHTSA used in its December 1995 "Final Regulatory Evaluation, Rear Impact Guards, FMVSS No. 223 and Rear Impact Protection, FMVSS No. 224," which accompanied the January 1996 final rule on rear impact guards. This new study is not based on an engineering design or engineering analysis of any particular potential side impact guard. It does not purport to demonstrate that side impact guards are technically feasible. Instead, this study is based on the assumption that the general design and costs of rear impact guards can be extrapolated to hypothetical side impact guards.

By using an analytical approach comparable to NHTSA's, this side impact guard analysis can be directly compared to NHTSA's December 1995 rear guard analysis. In addition, this side impact guard analysis can be directly compared to other NHTSA regulatory decisions or proposals in recent years. This new analysis updates data elements, such as fuel price projections and crash, injury, and fatality data, used in the 1995 NHTSA analysis. It also uses current rear impact guards' weight, cost, and dimensional data from eight trailer manufacturers. The results of this side impact guard analysis are compared to NHTSA's 1995 rear impact guard analysis, as well as other NHTSA regulatory decisions or proposals between the early 1990s and 2004.

In summary, this new analysis supports NHTSA's 1991 conclusion that combination truck side underride countermeasures are not cost-effective. Side impact guards designed similarly to current rear impact guards would add at least $1,560 (2004 dollars) to the cost of each trailer. In addition, because side impact guards would add substantial weight (at least 750 pounds) to each trailer, lifetime fuel consumption would increase by $411 per trailer. Furthermore, to the extent that some tractor-trailer combinations are operated at, or close to, the maximum weight allowed by state laws, weight added for side impact guards would lead to a reduction in the maximum payload that could be carried. This means that part of a full-load payload would have to be diverted into additional shipments, resulting in increased costs for shippers. This payload-displacement effect is estimated at $323 over a trailer's operating life.

Total costs for potential side impact guards are estimated at $573.5 million annually, assuming yearly trailer sales of 250,000 units. The analysis discounts costs and benefits that accrue over a trailer's operating life back to its initial purchase year, using a 7 percent annual discount rate, as NHTSA typically does.

The potential gross safety benefits for side impact guards, if all trailers of 10,000 pounds GVWR and over were equipped with them, are estimated to be 11 lives saved, 104 moderate-to-critical injuries prevented, and 1,132 minor injuries prevented annually. However, payload displacement associated with the potential weight of side impact guards would lead to safety losses because of required increases in tractor-trailer travel to move the same amount of total cargo each year. With such payload displacement necessitating over 240 million more miles of combination-truck travel each year, this effect potentially translates into 6 more fatalities and 108 more injuries involving combination trucks annually. Thus, the net potential safety benefits for side impact guards are reduced to 5 lives, 85 moderate-to-critical injuries, and 1,043 minor injuries annually.

The "cost per equivalent fatality prevented," which considers both potential lives saved and injuries prevented, is estimated to be $47 million for side impact guards. This is substantially higher than the $1.1-3.4 million per equivalent fatality prevented estimated for NHTSA's 1996 rear impact guard final rule. It also greatly exceeds the average cost-per-equivalent-fatality-prevented of $3.2 million for all NHTSA safety rulemakings for which the agency prepared a formal regulatory analysis or evaluation during September 1992 to September 2004. Finally, it greatly exceeds the $3.7 million value per "statistical life" NHTSA has used in recent regulatory evaluations and assessments (all dollar figures are in 2004 economics).

Introduction

This report analyzes the potential costs, safety benefits, and cost-effectiveness of side impact guards for truck trailers and semitrailers with a Gross Vehicle Weight Rating (GVWR) of 10,000 pounds or more (hereafter usually referred to simply as "trailers"). Such devices are currently not required by Federal or state safety regulations. The results of this study are not based on an engineering design of any particular potential side guard. Instead, they are based on an extrapolation of work done by the National Highway Traffic Safety Administration[1] (NHTSA) in the early 1990s when that agency mandated performance standards and installation requirements for rear impact guards installed on most new trailers with GVWRs of 10,000 pounds or higher.[2] The results of this report also are based on information supplied by eight existing trailer manufacturers (1) to update NHTSA's earlier cost and design estimates to current industry practice and (2) to understand some of the unique issues that need to be addressed in developing side impact guards. The cost-effectiveness results of this analysis also are compared to NHTSA's estimates of the cost-effectiveness of other safety regulations the agency has either proposed or finalized in recent years.

NHTSA's rear impact guard standard

On January 24, 1996, NHTSA published in the *Federal Register* a final rule establishing two Federal Motor Vehicle Safety Standards (FMVSS) "...which will operate together to reduce the number of injuries and fatalities resulting from the collision of passenger vehicles with the rear end of heavy trailers and semitrailers."[3] One of these standards, FMVSS 223, Rear Impact Guards, specifies particular performance standards that rear impact guards must meet before they can be installed on new trailers and semitrailers. FMVSS 223 includes rear impact guard strength requirements and energy absorption requirements, as well as the test procedures NHTSA will use to determine compliance with the standard.

The second standard, FMVSS 224, Rear Impact Protection, requires that most new trailers and semitrailers with a Gross Vehicle Weight Rating of 10,000 pounds or more be equipped with a guard meeting the requirements of FMVSS 223. FMVSS 224 also includes requirements for the mounting location of the guard relative to the rear end of the trailer.

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[1] The National Highway Traffic Safety Administration was established as a separate organization within the United States Department of Transportation in 1970 to administer the Department's motor vehicle and highway safety programs. NHTSA's responsibilities include the establishment, amendment, and enforcement of Federal Motor Vehicle Safety Standards (FMVSS) and regulations for the manufacture of new motor vehicles and motor vehicle equipment.

[2] This analysis uses the terms "rear impact guards" and "rear underride guards" interchangeably. Although the Federal Motor Vehicle Safety Standards governing these guards use the term "rear impact guards," NHTSA's final rule on this subject stated, "This rule addresses the problem of rear underride crashes..." and focused its discussion of expected safety benefits on reducing instances of a passenger vehicle underriding a trailer "...so far that the rear end of the trailer strikes and enters its passenger compartment."

[3] 61 FR 2004.

In essence, these two standards work together. FMVSS 223 specifies the performance of the guard as a piece of equipment, while FMVSS 224 governs the installation of that piece of equipment on a trailer or semitrailer. The two standards became effective on January 26, 1998.

In the final rule, NHTSA provided the following safety justification for establishing FMVSS 223 and 224:

> This rule addresses the problem of rear underride crashes, in which a passenger car, light truck, or multipurpose vehicle... collides with the rear end of a trailer or semitrailer... and the front end of the passenger vehicle slides under (i.e., underrides) the rear end of the trailer. Underride occurs to some extent in most [such] collisions... because most trailer beds are higher than the hoods of passenger vehicles. In the worst cases, referred to as passenger compartment intrusion (PCI) or "excessive underride" crashes, the passenger vehicle underrides so far that the rear end of the trailer strikes and enters its passenger compartment. PCI collisions generally result in passenger vehicle occupant injuries and fatalities caused by occupant contact with the rear end of the trailer.
>
> The solution to PCI is upgrading underride guards to make them stronger, but this introduces another concern. Even if guards succeed in preventing PCI, overly rigid guards may stop the passenger vehicle too suddenly, resulting in excessive occupant compartment deceleration forces and killing or injuring passenger vehicle occupants.
>
> The agency estimates that about 11,551 rear-end crashes with trucks, trailers, and semitrailers occur annually. These crashes result in approximately 423 passenger vehicle occupant fatalities and about 5,030 non-fatal injuries.[4]

Federal standards governing rear underride have existed since 1953. That regulation, issued by the Bureau of Motor Carriers of the Interstate Commerce Commission (ICC) (currently the Federal Motor Carrier Safety Administration, U.S. Department of Transportation), required heavy trucks, trailers, and semitrailers to be equipped with a rear-end device to prevent underride. The rule required that the ground clearance of the underride guard not exceed 30 inches when the vehicle is empty, that the guard be located not more than 24 inches forward of the rear of the vehicle, that it extend laterally to within 18 inches of each side of the vehicle, and that the guard "...shall be substantially constructed and firmly attached."[5] Guards designed to this 1953 standard are often referred to as "ICC guards."

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[4] 61 FR 2004.
[5] Ibid.

NHTSA (and its predecessor National Highway Safety Bureau) had considered several times on previous occasions whether to establish FMVSS on underride guards. For example, the agency issued an Advance Notice of Proposed Rulemaking (ANPRM) in 1967, in which the agency said it was "...considering the issuance of a Federal Motor Vehicle Safety Standard specifying performance requirement for rear underride guards..."[6] In 1969, the agency issued a Notice of Proposed Rulemaking (NPRM) with specific proposed performance requirements for rear underride guards.[7] In 1970, the agency issued a revised proposal.[8] In 1971, the agency decided that "...at the present time, the safety benefits achievable in terms of lives and injuries saved would not be commensurate with the cost of implementing the proposed requirements"[9] and terminated the rulemaking. In 1977, NHTSA re-opened the rulemaking issue on rear underride guards, by issuing another ANPRM, stating:

> The condition of traffic and the mix of large and small motor vehicles in highway transportation has changed and will continue to change. The question now is whether the present rear end protective requirements are adequate. Second, Congressional interest is high as evidenced by the Subcommittee for Consumer of the Senate Committee on Commerce, Science, and Transportation, which held oversight hearings on auto-truck crash safety on March 16, 1977. Third, the Insurance Institute for Highway Safety (IIHS) of Washington, D.C., recently petitioned for more stringent rear end protection than currently required by the Department of Transportation.[10]

NHTSA subsequently issued another NPRM in 1981,[11] with revised performance requirements for underride guards. In 1992,[12] the agency issued a Supplemental Notice of Proposed Rulemaking, which first introduced the concept of having of having two FMVSS governing underride guards: one for the guard itself and another standard governing its installation. Previous proposals would have required testing the underride guard as installed on the trailer. NHTSA stated the advantage of this new approach:

> Testing guards under these conditions would relieve trailer manufacturers, many of whom are small businesses, of the responsibility of conducting a static or dynamic test of a vehicle equipped with a guard. No vehicle need be certified as to its actual performance with the guard installed. Instead, the vehicle manufacturer need only certify under the vehicle standard that the

[6] 32 FR 14279; October 14, 1967.
[7] 34 FR 5383; March 19, 1969.
[8] 35 FR 12956; August 14, 1970.
[9] 36 FR 11750; June 18, 1971.
[10] 42 FR 43414; August 29, 1977.
[11] 46 FR 2136; January 8, 1981.
[12] 57 FR 252; January 3, 1992.

trailer has an underride guard (separately certified to the equipment standard) at a specified location.[13]

The final rule published on January 24, 1996, maintained this "dual standards" approach. In none of these notices did the agency propose to establish requirement for side underride guards. NHTSA's focus was solely on rear underride guards. On page 15 of its September 1991 "Preliminary Regulatory Evaluation, Combination Truck Rear Underride Guards, New FMVSS," the agency stated, "Combination truck side underride countermeasures have been determined not to be cost-effective."

Costs of NHTSA's rear impact guard rule

NHTSA's most current estimates of the costs of upgraded rear impact guards were presented in its regulatory evaluation[14] accompanying the January 1996 final rule. It needs to be made clear that, as essentially all trailers were already equipped with rear underride guards meeting Federal Motor Carrier Safety Standards, these estimates were for the incremental costs of a stronger guard. These NHTSA cost estimates are summarized below:

Table 1

Summary of NHTSA 1995 Estimates of Incremental Rear Impact Guard Costs per Trailer Including Operational Costs (1993 economics) (future costs, such as added lifetime fuel consumption, discounted to initial trailer purchase year using 7 percent annual discount rate)

Rear Underride Guard and Installation Hardware	$77.00 to 96.00
Installation Labor	0.00 (no change over baseline guard)
Frame Modifications	7.00
Increased Fuel Consumption	23.05
Payload Displacement	0.33
Field Replacement of Damaged Guards	16.44
Amortization of Static Test Fixture Cost	1.16 to 1.46
Compliance Test Cost	3.03 to 3.79
Total Incremental Consumer Cost per Trailer	$128.01 to 148.07

[13] 57 FR 253 and 254.

[14] "Final Regulatory Evaluation, Rear Impact Guards, FMVSS No. 223 and Rear Impact Protection, FMVSS No. 224," Office of Regulatory Analysis, Plans and Policy, National Highway Traffic Safety Administration, December 1995, page VI-21, Table VI-8.

A brief description of how NHTSA derived each of these cost estimates is provided below:

Rear Impact Guard and Installation Hardware

Based on work done on testing rear impact guard designs at NHTSA's Vehicle Research and Test Center, the agency estimated material costs of $85 per guard, plus an average of 4.5 hours labor for cutting, assembly, and welding. At an assumed labor rate of $17 per hour (based on a Bureau of Labor Statistics estimate for steel mill workers), the total guard cost was estimated to be $162. This figure is derived by the following formula: $85 material cost plus 4.5 times labor cost of $17/hour equals $161.50, which NHTSA rounded to $162 per unit. As NHTSA was estimating the cost of the new regulation above that of the existing Federal Motor Carrier Safety Regulation (FMCSR), the cost of a typical existing underride guard had to be subtracted. NHTSA estimated the average cost of an existing ICC underride guard to be $66. Subtracting that figure from $162 yielded NHTSA's "upper end" incremental cost estimate for the upgraded underride guard to be $96 per unit. To derive its "lower end" incremental cost estimate of $77 per unit, NHTSA took its cost estimate for an upgraded guard that the agency had developed in 1980, and updated it for inflation.[15]

Installation Labor

As trailer manufacturers were assumed by NHTSA to be simply installing a guard that met the agency's new standard FMVSS 223 instead of a guard meeting the older FMCSR, NHTSA assumed there would be no difference in installation costs.[16]

Frame Modifications

In testing NHTSA performed on upgraded rear underride guards in the early 1980s and early 1990s, reinforcements were added to the rear structure of the trailers tested to address the added weight of the upgraded rear underride guard. The agency estimated that upgraded guard would weigh about 96 pounds, compared to about 45 pounds for the baseline guard.[17] NHTSA concluded that about four pounds of reinforcement structure (doubler plates or brackets), at an estimated average cost (including labor) of $1.68 per pound. This yielded an estimate of $6.72, which NHTSA rounded to $7 per unit.[18]

Increased Fuel Consumption

As noted above, NHTSA estimated the incremental weight increase of the upgraded rear underride guard to be approximately 55 pounds (96 pounds for the upgraded guard plus four pounds of reinforcement structure minus 45 pounds for the baseline guard). NHTSA assumed that the average weight of a Class 8 tractor-trailer combination in its typically-

[15] Ibid. Pages VI-4 through VI-6.
[16] Ibid. Page VI-7.
[17] Ibid. Page VI-5.
[18] Ibid. Pages VI-6 trough VI-7.

loaded state is 65,000 pounds.[19] Based on a Society of Automotive Engineers' paper[20] and discussions with engineers at Cummins Engine Company, NHTSA concluded that adding 1,000 pounds of weight to a 65,000 pound truck would raise fuel consumption by 0.5 percent.[21] Using this relationship, NHTSA estimated that a 55-pound increase in weight would raise fuel consumption by 0.0275 percent. Using Federal Highway Administration data, NHTSA used a baseline fuel economy level of 5.60 mpg for combination trucks.[22] Assuming a 25-year operating life for trailers, and an average lifetime operating mileage of approximately 690,000 miles,[23] this weight increase resulted in an average increase in fuel consumption of about 34 gallons over a trailer's operating life. Using diesel fuel price projections, NHTSA translated this fuel consumption increase into a lifetime cost increase of $23.05 per unit, discounting[24] out-years' fuel consumption back to the initial trailer purchase year by using a 7 percent annual discount rate.[25]

Payload Displacement

To the extent that some tractor-trailer combinations are operated at, or close to, the maximum weight allowed by state laws (typically 80,000 pounds), if weight has to be added for an upgraded rear impact guard, the maximum payload would be reduced to compensate for this weight increase. This means that part of a full-load payload would have to be diverted into additional shipments, resulting in increased costs for shippers. NHTSA estimated that this effect added $0.33 per unit to the cost of the rear impact guard regulation.

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[19] Ibid. Page VI-7.
[20] "Tire Parameter Effects on Truck Fuel Economy," R.E. Knight, Goodyear Tire and Rubber Company, Society of Automotive Engineers Paper No. 791043, November 1979.
[21] "Final Regulatory Evaluation, Rear Impact Guards, FMVSS No. 223 and Rear Impact Protection, FMVSS No. 224," Office of Regulatory Analysis, Plans and Policy, National Highway Traffic Safety Administration, December 1995, page VI-7.
[22] Ibid. Page VI-9.
[23] Ibid.
[24] Discounting is performed because "Benefits and costs do not always take place in the same time period. When they do not, it is incorrect simply to add all of the expected net benefits or costs without taking account of when they actually occur... As a default position, OMB [Office of Management and Budget] Circular A-94 states that a real discount rate of 7 percent should be used as a base-case for regulatory analysis." (Office of Management and Budget (OMB) Circular A-4, September 17, 2003) In addition, OMB now recommends that calculations also be performed using a real annual discount rate of 3 percent. Since the early 1990s, NHTSA has consistently used a 7 percent real discount rate in its regulatory analyses. In recent years, NHTSA also has performed supplementary calculations using a 3 percent real discount rate. This paper uses 7 percent for comparison purposes with NHTSA's historical analyses. An analysis using a 3 percent discount rate is provided at the end of this report as a sensitivity analysis.
[25] Ibid. Page VI-11.

Field Replacement of Damaged Guards

Over the operating life of a trailer, some rear impact guards would have to be repaired or replaced due to rear-end collisions with other vehicles or other rear impacts (such as backing into a low loading dock). Based on "...information obtained from a major trailer manufacturer and affiliated service center,"[26] NHTSA concluded that the overwhelming majority of rear impact guards were repaired, rather than replaced, and that the typical repair was replacement of a crossbar. The agency estimated the incremental cost of a stronger crossbar, compared to the baseline guard's crossbar, would be $23.00. The agency also assumed that one replacement would typically be required over a trailer's operating lifetime. Discounting out-years' replacements back to the initial trailer purchase year, using the same 7 percent discount rate used above for fuel consumption, resulted in NHTSA's per-unit cost estimate of $16.44 for field replacement of damaged guards.[27]

Amortization of Static Test Fixture Cost

NHTSA concluded in its analysis that upgraded rear impact guards would "...be certified in the laboratory on a rigid test fixture."[28] The agency estimated the cost of each of these test fixtures to be $27,000, in 1993 economics. NHTSA estimated the industry would need to construct 80-100 of these fixtures to test rear impact guards. NHTSA assumed each fixture would have a 20-year life before it would have to be replaced. Amortizing these costs over the 20-year life, and assuming 92,747 rear impact guards would have to be tested annually, resulted in a per-unit cost estimate of $1.16 to $1.46, with the range determined by the assumptions of 80 to 100 test fixtures, respectively, assumed to be needed by the industry.[29]

Compliance Test Cost

NHTSA recognized that rear impact "...guards do not change from year-to year, hence certification costs are not incurred each year."[30] The agency assumed that 80-100 rear impact guard designs would need to be certified to the performance requirements of FMVSS 223, on average, each year. The agency estimated the cost to run each guard's compliance test would be $3,514, in 1993 economics. Assuming 80-100 guards tested annually, this would result in a total industry cost of about $280,000 to $350,000. Allocating this cost over the assumed annual trailer volume of 92,747 units yielded a per-unit cost estimate of $3.03 to $3.79.

[26] Ibid. Page VI-14.
[27] Ibid. Pages VI-14 and VI-15.
[28] Ibid. Page VI-15.
[29] Ibid. Pages VI-17 to VI-19.
[30] Ibid. Page VI-19.

[31] "MAIS" is Maximum injury severity per occupant on the Abbreviated Injury Scale, a widely-accepted scaling system developed by the Association for the Advancement of Automotive Medicine for ranking the severity of injury.

[32] "Equivalent fatalities saved" are defined as (1) lives saved plus (2) nonfatal injuries prevented, after these injuries are converted into "fatality equivalents." This concept is further explained later in this report.

Potential Costs and Benefits for Side Impact Guards

This section of the report provides the estimates, and the foundations for these estimates, of potential costs and benefits of installing side impact guards on trailers used in conjunction with track tractors. The goal is to estimate these potential costs and benefits using the same basic approach NHTSA used in its December 1995 "Final Regulatory Evaluation, Rear Impact Guards, FMVSS No. 223 and Rear Impact Protection, FMVSS No. 224," which accompanied the January 1996 final rule on rear impact guards. This document is hereafter referred to as "NHTSA's 1995 analysis" or NHTSA's "1995 FRE" [Final Regulatory Evaluation]. As noted previously in this report, this side impact guards study is not based on an engineering design or engineering analysis of any particular potential side impact guard. Instead, it is based on the assumption that the general design and costs of rear impact guards can be extrapolated to hypothetical side impact guards. This may or may not be accurate. For example, a typical van-type trailer has a substantial rear structure to which a rear impact guard can be attached. In contrast, a van-type trailer generally does not have a comparable structure running along its side to which a side impact guard could be attached. In addition, there may be features such as storage containers with openings along the lower sides of trailers; these features may have to be relocated or strengthened, if feasible, if side impact guards were installed. Nevertheless, in the absence of a specific, generally-applicable, engineered design for side impact guards, an extrapolation of rear impact guard characteristics to potential side impact guards is a reasonable approach for estimating potential costs and benefits of side impact guards.

The overall approach used in this analysis is comparable to the approach used by NHTSA in its 1995 analysis of rear impact guards. This is a deliberate decision: it allows this side impact guard analysis to be directly compared to NHTSA's 1995 rear impact guard analysis and also allows this side impact guard analysis to be directly compared to other NHTSA regulatory decisions or proposals in recent years. This new analysis updates data elements, such as fuel price projections and crash, injury, and fatality data, used in the 1995 NHTSA analysis. It also uses current rear impact guards' weight, cost, and dimensional data from eight trailer manufacturers. The results of this side impact guard analysis are compared to NHTSA's 1995 rear impact guard analysis, as well as other NHTSA regulatory decisions or proposals between the early 1990s and 2004.[33]

This analysis will first estimate the potential costs for side impact guards. Then, it will estimate potential safety benefits for side impact guards. Thirdly, it will then combine these figures to estimate the potential "cost per equivalent fatality saved" for side impact guards. Finally, some sensitivity analyses will be conducted to assess the robustness of the analysis's primary conclusions.

[33] Analyses done by NHTSA during this time period were performed using a similar methodology, particularly with regard to consistently discounting costs and benefits to the initial purchase year of new safety features or technologies. Once adjusted for price inflation, they can be directly compared to each other. Earlier NHTSA analyses are not comparable to these because the agency used differing analytical approaches.

Costs of side impact guards

To estimate the potential costs of side impact guards, this analysis will develop the equivalent of Table 1 (see page 4), which provided NHTSA's estimates of the costs of rear impact guards, for side impact guards.

Dimensions, Weights, and Hardware Costs for Side Impact Guards

The primary source of dimensions, cost, and weight data was information developed and submitted by eight trailer manufacturers who are members of the Truck Trailer Manufacturers Association (TTMA). The author of this report requested certain cost, weight, and dimensional data for current rear impact guard designs from trailer manufacturers, using outside legal counsel to TTMA to obtain the data. Data were subsequently submitted from eight trailer manufacturers, without their individual identities known to this author. The data were also compared to NHTSA's 1995 rear impact guard cost and weight estimates, after updating the NHTSA cost estimates from 1993 economics to 2004 economics. Based on likely side impact guard dimensions, these rear guard estimates were scaled to potential side guard estimates.

The eight trailer manufacturers submitted weight estimates for rear impact guards ranging from 102 to 175 pounds per guard. In comparison, NHTSA's 1995 estimate was 100 pounds, which included attachment hardware. The survey results for rear guard weights are provided below:

Table 3

Rear Impact Guard Weights (pounds)

	Typical	Minimum	Maximum
Manufacturer 1	109.2	106.1	143.1
Manufacturer 2		110	150
Manufacturer 3	165		
Manufacturer 4	163	113	163
Manufacturer 5	102		
Manufacturer 6	123		
Manufacturer 7	120	115	125
Manufacturer 8	___	168.5	175.5
AVERAGES	130	123	151

For purposes of this analysis, a typical rear impact guard weight value of 115 pounds was used when scaling the weights of rear impact guards to potential side impact guards. This

figure is approximately the average of the four lightest "typical" rear impact guards, and is similar to NHTSA's 100-pound estimate.

The eight trailer manufacturers submitted data on the widths of the rear impact guards they installed. These widths ranged from 70 to 102 inches. The survey results for rear impact guard widths are provided below:

Table 4

Rear Impact Guard Widths (inches)

	Typical	Minimum	Maximum
Manufacturer 1	95	89	95
Manufacturer 2		96	102
Manufacturer 3	95.4		
Manufacturer 4	102.3	96	102.3
Manufacturer 5		88	94
Manufacturer 6	94.4		
Manufacturer 7	94.5	94	95
Manufacturer 8	___	70	76
AVERAGES	96	89	94

The typical rear impact guard is 96 inches wide, so this is the value that will be used to scale rear impact guard width to potential side impact guard length along the side of a trailer.

The trailer manufacturers were also asked to provide data on the length of potential side coverage area on their trailers, for potential mounting of side impact guards. This dimension was defined as the distance, along the side of a trailer from back to front, between (1) the forwardmost edge of the front tire on the rear slider (in its typically forwardmost position allowed in operation) to (2) the expected rearwardmost edge of the attached tractor. The survey results are provided in the next table.

Table 5

Potential Side Impact Guard Lengths (per side, in feet)

	Typical	Minimum	Maximum
Manufacturer 1	26.2		
Manufacturer 2		22	28
Manufacturer 3	20		
Manufacturer 4	30.3		
Manufacturer 5	26		
Manufacturer 6	21		
Manufacturer 7	30		
Manufacturer 8	___	5	35
AVERAGE	25.6		

Based on this survey, a typical length of 26 feet was chosen for a potential side impact guard, for each of two sides to a trailer.

The above results are used to estimate the typical weight that side impact guards could potentially add to an average trailer. A typical rear impact guard is assumed to be 8 feet (96 inches) wide and weigh 115 pounds. Thus, its weight is about 14.4 pounds per foot. Assuming a potential side impact guard length of 26 feet, its weight would be about 375 pounds (26 times 14.4 pounds) per side, or about 750 pounds per trailer. Note that this estimate does not include any additional supporting structure needed to attach and adequately support the side impact guard to the trailer, any needed "beefing up" of side guard structure to absorb the energy of a striking vehicle, or any other needed trailer design changes to accommodate side impact guards.

To determine cost estimates for potential side impact guards, the original plan for this analysis was to subdivide the costs of rear impact guards into (1) materials cost, (2) assembly cost, (3) attachment hardware cost, (4) installation cost, and (5) certification cost. Then, these individual costs estimates would be compared with the values estimated by NHTSA in 1995 before making decisions as to what cost values to use for the side impact guard analysis. However, although this author requested in the trailer manufacturer survey that costs be segregated in this fashion, some manufacturers found it infeasible to categorize costs this way. For example, Manufacturer 1 indicated that its costs for attachment hardware were included in its material and assembly cost estimates. As another example, Manufacturer 3 indicated that its assembly costs were included in its installation costs estimates because of the approach it used to assemble and install its rear impact guards. Thus, it was more feasible to compare the total rear impact guard cost estimates provided by the eight trailer manufacturers with the total cost estimate made by NHTSA in 1995.

The cost estimates are provided in Table 6, below. Note that these costs are costs to retail consumers, the trailer purchasers. They include overhead, normal profit, and other cost factors that are considered to determine final retail prices. This is the same approach taken by NHTSA in its regulatory analyses.

Table 6

Hardware and Installation Costs for Rear Impact Guards (at retail, 2004 dollars)

	TTMA Survey	NHTSA[34]
Material cost	$62-295	$116
Assembly cost	0-235	94
Attachment hardware cost	0- 45	9
Installation cost	10-270	not included
Certification costs	1- 34	6
TOTAL	$151-660[35]	$225

Although the consumer cost estimate from TTMA members averaged $320 per unit for rear impact guards, the variation was quite wide. Therefore, this author started with the NHTSA estimate of $225 per unit as the assumed typical consumer cost for a rear impact guard. However, the NHTSA cost estimate did not include installation costs for rear impact guards because NHTSA was looking at substituting a rear impact guard meeting its new requirements for a rear impact guard meeting the older ICC requirements. Therefore, there was no anticipated change in installation costs for the new NHTSA rear impact guard requirement. As a potential side impact guard would be new, not a substitute for an existing guard, a cost for installation is needed. This analyst decided to use $20 per guard, which is the average of the five lowest TTMA-member estimates for rear impact guard installation costs. This yields a revised, installed-cost, estimate of $245 per rear impact guard ($225 plus $20). One additional adjustment was made. It was assumed by this analyst that the cost of certifying[36] a guard to any potential side guard performance requirements would be a fixed cost per trailer, not a cost per individual side guard and, also, would not vary by a side guard's dimensions. Thus, the $6 certification

[34] Total (not incremental over previous ICC guard) from 1995 NHTSA analysis, updated to 2004 economics, using Gross Domestic Product implicit price deflator, except for steel costs (due to recent sharp price increases), which uses the Producer Price Index for steel mill products. GDP deflator data from U.S. Department of Commerce. Producer Price Index data from U.S. Department of Labor. See Table A-3 (page 61 of this report) for data.

[35] Average is $320. Note that "zeroes" in cost estimates from some TTMA members generally mean that these particular costs were included in other categories.

[36] "Certifying" could mean testing to the performance requirements of a side impact guard FMVSS, if NHTSA were to promulgate one, or, if side impact guards were voluntarily installed, testing to any relevant performance parameters for side impact guards.

cost[37] estimated by NHTSA was deleted from the rear guard cost, to yield $239 per rear guard.

To translate these rear impact guard cost estimates into potential side impact guard estimates, it was assumed that the costs would be proportionate to the length of the potential side guard. Thus, with an assumed typical side impact guard length of 26 feet, as opposed to a rear impact guard width of 8 feet, the cost per side for a potential side guard would be $777 per side (26 divided by 8 times $239). Doubling this figure to cover both left and right sides of a trailer yields $1,554 per trailer. Then, adding the $6 certification cost estimate back in results in a total assumed hardware, installation, and certification consumer cost of $1,560 per trailer for potential side impact guards.

Increased Fuel Use

To estimate the increase in fuel use due to the weight added to a trailer for potential side impact guards, an approach was used that was similar to that used by NHTSA in 1995 for its analysis of rear impact guards. As noted above, NHTSA assumed that the average "in use" weight of a Class 8 tractor-trailer combination was 65,000 pounds. NHTSA also concluded that adding 1,000 pounds to a 65,000 pound tractor-trailer would raise fuel consumption by 0.5 percent. Thus, using this same approach, adding 750 pounds for potential side guards would raise fuel consumption by 0.375 percent. Federal Highway Administration (FHWA) data[38] for calendar year 2003 indicate that the average fuel economy for combination trucks was 5.1 miles per gallon (mpg). Using the above relationship, potential side guards would reduce this value to 5.081 mpg.

Next, assumptions need to be made about the typical operating lifetimes and annual vehicle miles traveled (VMT) for trailers. In its 1995 analysis, NHTSA used VMT by vehicle age for combination trucks "...based on the 1982 Truck Inventory and Use Study... The agency is not aware of any sources of trailer VMT or survivability data by age, therefore, tractor VMT was used as the appropriate proxy."[39]

This side impact guard analysis derives miles traveled by tractor-trailer combinations in a manner comparable to the 1995 NHTSA analysis. In this case, data were taken from the 1997 Vehicle Inventory and Use Survey (VIUS), a study performed every five years by

[37] For purposes of this analysis, NHTSA's estimates for "compliance test cost" and "amortization of static test fixture" were added together and treated as "certification costs" because they are both related and also are very small dollar figures (average of $3.41 for compliance test cost and $1.31 for amortization of static test fixture in NHTSA's 1995 analysis (1993 dollars)).
[38] Federal Highway Administration, "Highway Statistics 2003," Table VM-1, "Annual Vehicle Distance Traveled in Miles and Related Data – 2003 – By Highway Category and Vehicle Type," December 2004.
[39] NHTSA 1995 FRE, page VI-9.

the U.S. Census Bureau (1997 data were the latest completely available when this side impact guard analysis was performed). As noted by the Census Bureau,

> The 1997 VIUS is a probability sample of private and commercial trucks registered (or licensed) in the United States as of July 1, 1997. This survey excludes vehicles owned by Federal, state, or local governments; ambulances; buses; motor homes; farm tractors; unpowered trailer units; and trucks reported to have been sold, junked, or wrecked prior to July 1, 1996. A sample of about 131,000 trucks was surveyed to measure the characteristics of nearly 75 million trucks registered in the United States.[40]

As the VMT data used by NHTSA in 1995 were presumed to be outdated by now (NHTSA used 1982 data), a new set of VMT-by-vehicle-age estimates were developed for this side impact guard analysis. A regression equation was used on raw data taken from the 1997 VIUS to create these estimates. The development of these estimates is outlined below. First, total miles driven by age of "heavy-heavy trucks"[41] were divided by vehicle registrations to estimate average miles traveled per unit, as shown in following table:

Table 7

Miles per Heavy-Heavy Vehicle by Age in 1997

Vehicle Model Year	Total Miles Driven[42] (millions)	Registrations[43] (thousands)	Derived Miles per Unit[44]	Assumed Year of Operation
1997	12,591.5	160.0	78,907	1
1996	16,358.2	192.7	84,889	2
1995	17,404.8	231.2	75,280	3
1994	12,175.0	167.9	72,513	4
1993	9,457.7	136.1	69,491	5
1992	6,332.4	101.0	62,697	6
1991	5,400.7	103.9	51,980	7
1990	5,803.9	120.0	48,366	8
1989	5,790.7	131.1	44,170	9
1988	4,981.0	131.7	37,821	10

[40] U.S. Census Bureau, "1997 Economic Census, Vehicle Inventory and Use Survey, Geographic Area Studies," EC97TV-US, October 1999, page 1.
[41] Census defines heavy-heavy trucks as the "average vehicle weight is 26,001 pounds or more." See 1997 VIUS, page 2. Heavy-heavy trucks are primarily tractor-trailer combinations.
[42] 1997 VIUS, Table 8, "Truck Miles by Vehicle Size," page 58.
[43] 1997 VIUS, Table 4, "Trucks by Vehicle Size," page 34.
[44] Total Miles Driven divided by Registrations.

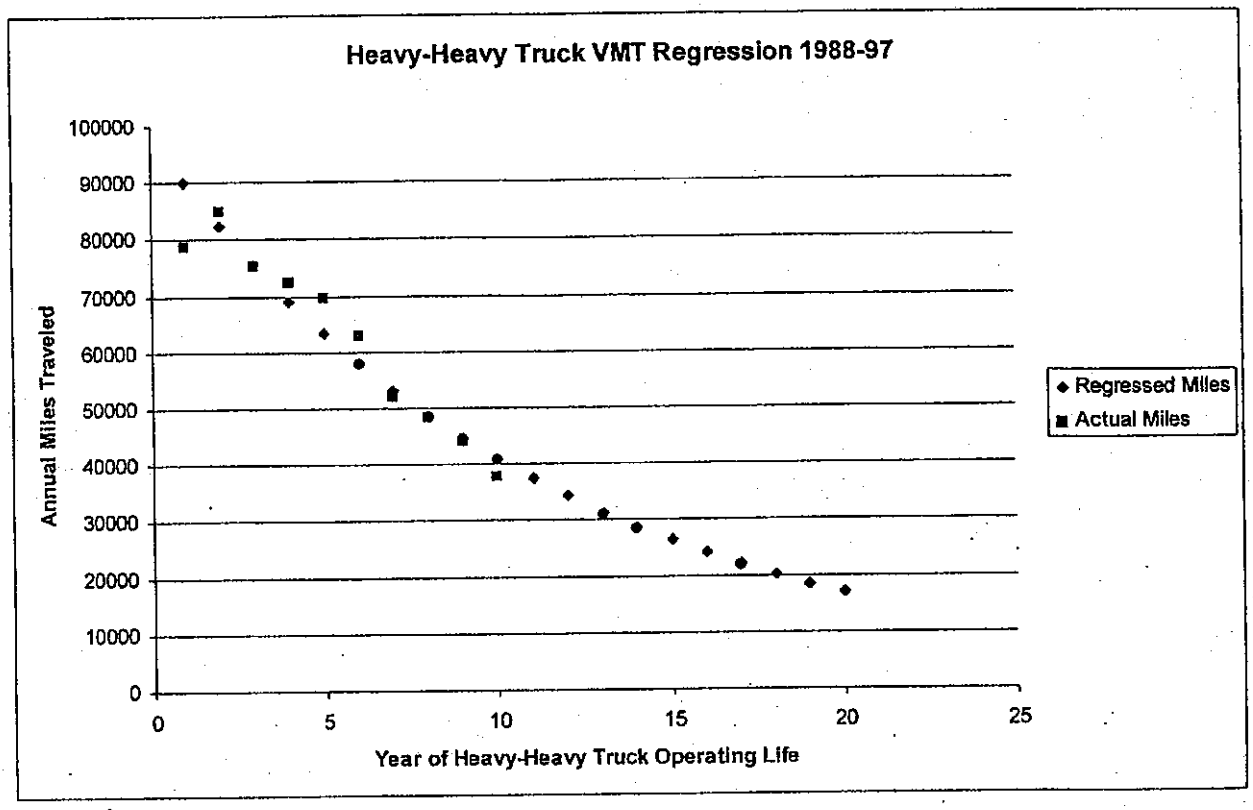
Using the data from Table 7, a regression equation was developed by regressing the natural logarithms of "Derived Miles per Unit" against "Assumed Year of Operation." The resulting regression equation took the form:

$$\text{Miles Driven} = e^{(-0.087767 * \text{year of operation}) + 11.49467}$$

The constant "e" is the base of the natural logarithm, and equals approximately 2.718282. The results are displayed visually below:

Graph 1

1997 VIUS VMT Data Compared to Regression Equation



Note that the regression was limited to 20 years; TTMA members indicated that trailers rarely are used after exceeding 20 years of age. The data are listed in a tabular form in Table 8.

Table 8

Assumed Tractor-Trailer Annual Mileage versus Year of Operation

Year of Operation	Miles Driven
1	89,940
2	82,383
3	75,461
4	69,120
5	63,312
6	57,992
7	53,120
8	48,656
9	44,568
10	40,823
11	37,393
12	34,251
13	31,373
14	28,737
15	26,322
16	24,110
17	22,084
18	20,229
19	18,529
20	16,972

These figures above are used as typical miles traveled annually assuming a trailer actually survives to year 20 of its operating life. In reality, many will not. Trailers may be retired because of crashes, because they simply wear out, are no longer useful, and for other reasons. Thus, a "survivability schedule" (i.e., what percentage of trailers originally sold in year x will still be in operation in year x+y) needs to be applied to the above annual-miles-traveled estimates. As noted on page 14 of this report, NHTSA's 1995 analysis indicated a lack of available data on trailer survivability by year. NHTSA chose to use a survivability schedule the agency had previously used in light truck Corporate Average Fuel Economy rulemakings.

This lack of available data on trailer survivability still appears to be the case. This analyst could not locate such data. One option considered for this side impact guard analysis was to use the light truck survivability schedule used by NHTSA in its 1995 analysis. However, one problem with this schedule is that it assumed a 25-year

maximum operating life for light trucks. As noted above, TTMA members indicated to this analyst that trailer life very rarely exceeds 20 years. Another option examined was to use one of the three heavy truck survivability schedules developed by the Oak Ridge National Laboratory (ORNL) for the Department of Energy, as cited in the "Transportation Energy Data Book: Edition 23," October 2003, page 3-17. However, these schedules all went out to year 30, and thus were inconsistent with the typical maximum 20-year trailer lifespan provided by TTMA members. Thus, this analyst decided to use a 20-year survivability schedule.

One option for a 20-year survivability schedule would be simply to cut off NHTSA's 25-year light-truck schedule after the 20th year. However, this would result in about 27 percent of trailers surviving to year 20, and then suddenly they would all disappear. This appears to be too abrupt a cut-off. An even-greater similar effect would occur with the ORNL estimates. Instead, this analyst decided to use a schedule that NHTSA has used for passenger cars, which ends relatively smoothly after operating year 20. This survivability schedule was taken from NHTSA's "Preliminary Regulatory Impact Analysis, NPRM on Tire Pressure Monitoring System, FMVSS No. 138," September 2004, page V-56. These survivability assumptions are added to Table 8's annual miles traveled assumptions in Table 9, on the subsequent page.

Table 9

Assumed Tractor-Trailer Annual Mileage versus Year of Operation

Year of Operation	Miles Driven	Survivability	Survivability-Weighted Miles Driven
1	89,940	0.995	89,490
2	82,383	0.988	81,394
3	75,461	0.978	73,801
4	69,120	0.962	66,493
5	63,312	0.938	59,387
6	57,992	0.908	52,657
7	53,120	0.870	46,214
8	48,656	0.825	40,141
9	44,568	0.775	34,540
10	40,823	0.721	29,433
11	37,393	0.644	24,081
12	34,251	0.541	18,530
13	31,373	0.445	13,961
14	28,737	0.358	10,288
15	26,322	0.285	7,502
16	24,110	0.223	5,377
17	22,084	0.174	3,843
18	20,229	0.134	2,711
19	18,529	0.103	1,908
20	16,972	0.079	1,341
TOTAL			663,092

This calculated typical 663,092-miles operating life is slightly lower than the 690,848-miles operating life assumed by NHTSA in its 1995 rear impact guard analysis.

The next component necessary to estimate the increased-fuel-consumption penalty for potential side impact guards is an estimate of future fuel costs. To estimate future diesel fuel costs per gallon, the analysis develops assumptions based on the U.S. Department of Energy's (DOE) "Annual Energy Outlook 2005."[45] For purposes of this side impact guard analysis, estimates of future diesel fuel costs per gallon, without considering state, local, and Federal fuel taxes[46], are needed, in constant 2004 dollars. In addition, an

[45] Energy Information Administration, U.S. Department of Energy, "Annual Energy Outlook 2005: With Projections to 2025," DOE/EIA-0383(2005), February 2005.

[46] State, local, and Federal fuel taxes are excluded from the social cost of the additional fuel use because they represent a transfer payment; the costs to society of additional revenues generated by these fuel taxes

adjustment is necessary, consistent with recent NHTSA regulatory analyses, to the fuel-cost-per-gallon projections to consider the economic costs of externalities generated during fuel production and use. These costs include "...higher costs for oil imports resulting from the combined effect of U.S. oil demand and OPEC market power on the world oil price... [and] ...the risks of reductions in U.S. economic output and disruption of the domestic economy caused by sudden reductions in the supply of imported oil to the U.S..."[47] NHTSA estimates these costs at 8.3¢ per gallon, in 2000 economics. This translates to 9¢ per gallon in 2004 dollars.

DOE's Annual Energy Outlook 2005 provides several alternative sets of potential future oil prices. DOE's "Reference Case" world oil price projection was chosen for use in this side impact guard analysis. As stated by DOE, the "...projections in the *Annual Energy Outlook 2005* are not statements of what will happen but of what might happen, given the assumptions and methodologies used. The projections are business-as-usual trend forecasts, given known technology, technological and demographic trends, and current laws and regulations. Thus, they provide a policy-neutral reference case that can be used to analyze policy initiatives."[48] As DOE describes the assumptions underlying its Reference Case, "World oil prices... are set in an environment where the members of OPEC [Organization of Petroleum Exporting Countries] are assumed to act as the dominant producers, with lower production costs than other supply regions or countries. Non-OPEC oil producers are assumed to behave competitively, producing as much oil as they can profitably extract at the market price oil. As a result, the OPEC member countries will be able effectively to set the price of oil when they act in concert by varying their aggregate production. Alternatively, OPEC members could target a fixed level of production and let the world market determine the price... The ...reference case assumes a moderate market strategy between low-price, low-risk market share maximization and high-price, high-risk profit maximization."[49]

The DOE 2005 Reference Case values for future world oil prices are provide in Table 10.

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are offset by the benefits to society of the government programs (constructing and maintaining roads) these taxes finance.

[47] NHTSA, "Preliminary Economic Assessment, Corporate Average Fuel Economy Standards for MY 2005-2007 Light Trucks," December 2002, page VII-14. See pages VII-4 through VII-28 of this NHTSA Assessment for a more complete discussion of these factors.

[48] "Annual Energy Outlook 2005," page ii.

[49] "Annual Energy Outlook 2005," page 40.

Table 10

DOE 2005 "Reference Case" World Oil Prices[50]
(2003 dollars)

Year	Price per Barrel
2010	$25.00
2015	26.75
2020	28.50
2025	30.31

A 20-year time frame for fuel prices is needed for this side impact guard analysis, due to the 20-year trailer operating lifetime outlined in Table 9. The 2010-2030 time frame was used[51], with the oil price projection for 2030 determined by extending DOE's projected average annual growth in world oil prices from 2020-2025 to the 2025-2030 time frame. This results in a projected world oil price of $32.23 per barrel (2003 dollars) in the year 2030.

Oil price per barrel can be converted into oil price per gallon by dividing the price per barrel by 42. In addition, refining, distribution, and marketing costs need to be considered to determine an appropriate diesel fuel price projection.

Monthly data for calendar year 2004 on diesel fuel prices and refining, distribution, and marketing costs, from the Department of Energy's Energy Information Administration, are provided in Table 11.

[50] DOE "Annual Energy Outlook 2005," page 114.
[51] This does not mean that it has been judged feasible to install potential side impact guards on trailers by the year 2010. The 2010-2030 time frame was chosen simply to have a future 20-year period of time for which oil price projections were generally available at the time this side impact guard analysis was performed.

Table 11

Diesel Fuel Prices and Refining, Distribution, and Marketing Costs[52]

Month (2004)	Retail Price (cents per gallon)	Refining (percentage)	Distribution and Marketing (percentage)
January	155.1	13.1	7.7
February	158.2	11.8	9.6
March	162.9	11.7	10.1
April	169.2	14.7	9.4
May	174.6	17.5	9.0
June	171.1	14.3	10.6
July	173.9	15.4	6.5
August	183.3	14.2	6.7
September	191.7	17.3	5.3
October	213.4	18.0	6.2
November	214.7	15.2	13.0
December	200.9	16.2	13.8
AVERAGES	180.8¢	15.0%	9.0%

The average diesel fuel refining, distribution, and marketing cost in 2004 was 24 percent of $1.808 per gallon, or 43.4¢ per gallon.

The final set of fuel price projections for use in this side impact guard analysis is developed in Table 12.

[52] "Diesel Fuel Components History," downloaded from www.eia.doe.gov on April 18, 2005.

Table 12

Development of Diesel Fuel Price Projections

Year	Oil Price per Barrel[53] ($2004)	Oil Price per Gallon[54] ($2004)		Refining, Distribution, and Marketing Costs per Gallon of Diesel ($2004)		Externalities ($2004)		Final Diesel Cost per Gallon ($2004)
2010	$25.53	$0.608	+	$0.434	+	$0.090	=	$1.132
2011	25.88	0.616		0.434		0.090		1.140
2012	26.23	0.625		0.434		0.090		1.149
2013	26.59	0.633		0.434		0.090		1.157
2014	26.95	0.642		0.434		0.090		1.166
2015	27.32	0.650		0.434		0.090		1.174
2016	27.66	0.659		0.434		0.090		1.183
2017	28.02	0.667		0.434		0.090		1.191
2018	28.38	0.676		0.434		0.090		1.200
2019	28.73	0.684		0.434		0.090		1.208
2020	29.10	0.693		0.434		0.090		1.217
2021	29.46	0.701		0.434		0.090		1.225
2022	29.83	0.710		0.434		0.090		1.234
2023	30.19	0.719		0.434		0.090		1.243
2024	30.57	0.728		0.434		0.090		1.252
2025	30.95	0.737		0.434		0.090		1.261
2026	31.34	0.746		0.434		0.090		1.270
2027	31.73	0.755		0.434		0.090		1.279
2028	32.11	0.765		0.434		0.090		1.289
2029	32.51	0.774		0.434		0.090		1.298
2030	32.91	0.784		0.434		0.090		1.308

NOTE: Numbers may not add exactly due to rounding.

[53] Oil prices per barrel between 5-year increments (such as prices for years 2011 through 2014, between the years 2010 and 2015) were developed based on the average annual price growth rates between the 5-year increments.

[54] Oil price per barrel divided by 42 gallons per barrel.

Now that the average annual miles traveled, survivability rates, and fuel price assumptions have been determined, it is possible to estimate the potential lifetime fuel cost penalty for adding 750-pound side impact guards to a typical trailer. First, the value of the total lifetime fuel consumption for a baseline (without side impact guards) tractor-trailer is estimated in Table 13, using FHWA's 2003 fuel economy estimate of 5.1 mpg. This includes a 7 percent annual discount rate adjustment so that out-year fuel expenditures can be properly compared to increased costs for side impact guards incurred when the trailer is first purchased.

Table 13

Value of Lifetime Fuel Consumption For Baseline Tractor-Trailer, Without Side Impact Guards (5.1 mpg)

Year of Operation	Survivability-Weighted Miles Driven[56]	Non-discounted Value[55] with Baseline Fuel Economy	7 Percent Mid-Year Discount Factor	Discounted Value with Baseline Fuel Economy
1 (2010)	89,490	$19,863.27	0.9667	$19,201.82
2	81,394	18,193.95	0.9035	16,438.24
3	73,901	16,626.93	0.8444	14,039.78
4	66,493	15,084.78	0.7891	11,903.40
5	59,387	13,577.50	0.7375	10,013.41
6	52,657	12,121.43	0.6893	8,355.31
7	46,214	10,719.84	0.6442	6,905.72
8	40,141	9,374.10	0.6020	5,643.21
9	34,540	8,127.06	0.5626	4,572.28
10	29,433	6,971.58	0.5258	3,665.66
11	24,081	5,746.39	0.4914	2,823.77
12	18,530	4,450.83	0.4593	2,044.27
13	13,961	3,378.01	0.4292	1,449.84
14	10,288	2,507.45	0.4012	1,005.99
15	7,502	1,841.67	0.3749	690.44
16	5,377	1,329.49	0.3504	465.85
17	3,843	956.98	0.3275	313.41
18	2,711	679.88	0.3060	208.04
19	1,908	482.24	0.2860	137.92
20 (2029)	1,341	341.30	0.2673	91.23
TOTALS		$152,374.68		$109,969.59

[55] "Survivability-Weighted Miles Driven" divided by "5.1 mpg" times "Fuel Price per Gallon" (Table 12) in each "Year of Operation."
[56] From Table 9.

The same calculations are provided for the 750-pound side impact guard case, with the average fuel economy value lowered to 5.081 mpg, in Table 14, below:

Table 14

Value of Lifetime Fuel Consumption
For Tractor-Trailer,
With Potential 750-Pound Side Impact Guards
(5.081 mpg)

Year of Operation	Survivability-Weighted Miles Driven[58]	Non-discounted Value[57] with 5.081 mpg Fuel Economy	7 Percent Mid-Year Discount Factor	Discounted Value with 5.081 mpg Fuel Economy
1 (2010)	89,490	$19,937.55	0.9667	$19,273.63
2	81,394	18,261.99	0.9035	16,499.71
3	73,901	16,689.11	0.8444	14,092.28
4	66,493	15,141.19	0.7891	11,947.92
5	59,387	13,628.27	0.7375	10,050.85
6	52,657	12,166.76	0.6893	8,386.55
7	46,214	10,759.92	0.6442	6,931.54
8	40,141	9,409.16	0.6020	5,664.31
9	34,540	8,157.45	0.5626	4,589.38
10	29,433	6,997.65	0.5258	3,679.36
11	24,081	5,767.88	0.4914	2,834.33
12	18,530	4,467.48	0.4593	2,051.91
13	13,961	3,390.65	0.4292	1,455.27
14	10,288	2,516.82	0.4012	1,009.75
15	7,502	1,848.55	0.3749	693.02
16	5,377	1,334.46	0.3504	467.60
17	3,843	960.56	0.3275	314.58
18	2,711	682.42	0.3060	208.82
19	1,908	484.04	0.2860	138.44
20 (2029)	1,341	342.57	0.2673	91.57
TOTALS		$152,944.48		$110,380.82

[57] "Survivability-Weighted Miles Driven" divided by "5.081 mpg" times "Fuel Price per Gallon" (Table 12) in each "Year of Operation."
[58] From Table 9.

Thus, the present value of the lifetime fuel penalty for potential 750-pound side impact guards is calculated to be $411. This is derived by subtracting the present value of the baseline (without side impact guards) tractor-trailer lifetime fuel consumption ($109,969.59) from the present value of the 750-pound-potential-side-impact-guard-equipped tractor-trailer lifetime fuel consumption ($110,380.82), and rounding to the nearest dollar. This $411 figure is the present value of the added fuel cost over a trailer's operating lifetime of carrying the 750-pound side impact guards.

Payload Displacement

As noted in the earlier discussion of NHTSA's 1995 estimates of the costs of rear impact guards, to the extent that some tractor-trailer combinations are operated at, or close to, the maximum weight allowed by state laws (typically 80,000 pounds), if weight has to be added for a side impact guard, the maximum payload would be reduced to compensate for this weight increase. This means that part of a full-load payload would have to be diverted into additional shipments, resulting in increased costs for shippers.

This analysis of potential side impact guards uses the same approach for estimating the costs of payload displacement as NHTSA did in its 1995 rear impact guards analysis. The only difference is the use of substantially updated data. NHTSA used the following formula to estimate payload displacement costs:

Payload Displacement = Percentage of cargo in "critical weight class"

times

Percentage of cases affected within critical weight class

times

Percentage of payload displaced when displacement occurs

times

Applicable total annual operating revenue

These terms will be defined and quantified below.

NHTSA considered the "critical weight class" to be the tractor-trailers weighing, with cargo, between 75,000 and 80,000 pounds. The critical weight class is the weight class where payload displacement may occur because of the added weight of potential side impact guards. In estimating the percentage of cargo carried each year in various tractor-trailer weight classes, 5,000-pound increments were apparently the smallest weight increments available to NHTSA at the time of its analysis (the agency relied on a 1980 study by a contractor, Corporate-Tech Planning, Inc., for its data[59]).

As the Corporate-Tech Planning study was based on "weight in motion" data from the late 1970s, a source of better and more recent data was sought for this potential side impact guards analysis. The Census Bureau 1997 VIUS data, discussed above in the *Increased Fuel Use* section, turned out to be a better data source. Although not provided in their written reports, Census is able to provide data, on special request, on the percentage of truck travel in weight increment classes as fine as 1,000 pounds. This allowed the "critical weight class" to be defined as the 79,000 to 80,000 pound weight class in this analysis, a much finer breakdown of the weight-in-motion data.

This definitional change is important in accurately estimating the payload displacement value. In 1995, when NHTSA performed its rear impact guard analysis, the agency implicitly assumed that tractor-trailer weights in the 75,000-to-80,000-pounds weight class were evenly distributed across that class. That is, NHTSA implicitly assumed that, of the total amount of truck travel in this weight class, one-fifth was in the 75,000-to-76,000-pound weight class, one-fifth was in the 76,000-77,000-pound weight class, etc. The crucial part of this assumption was that one-fifth of the truck travel in the 75,000-to-80,000-pounds weight class occurs in the 79,000-to-80,000 weight class.

The Census 1997 VIUS data contradict this implicit assumption by NHTSA.[60] Tractor-trailer operators try to carry the maximum payload in their vehicles. This means that tractor-trailer operators try to operate as close to the maximum allowable weight as possible. To the extent that the maximum allowable weight is 80,000 pounds, operators try to operate as close as feasible to that value. Table 15 provides the Census data on the distribution of truck travel miles between 75,000 and 80,000 pounds.

[59]CorporateTech Planning Inc., "Design and Cost Analysis of Truck/Trailer Rear-Underride Guards," DOT HS-805 483, March 1980.

[60] Because NHTSA apparently was not aware of weight-in-motion data in increments smaller than 5,000-pound classes, this was a reasonable approach at the time.

Table 15

Distribution of Truck Travel Miles Between 75,000 and 80,000 (75K-80K) Pounds (Census 1997 VIUS data)[61]

Weight Class (pounds)	Miles Driven	Percent of Travel between 75K and 80K pounds
75K-76K	2,675,998,386	6.3%
76K-77K	1,895,998,386	4.4
77K-78K	9,041,237,482	21.1
78K-79K	5,260,266,367	12.3
79K-80K	23,917,068,744	55.9

This "bunching" of the data close to 80,000 pounds results in a greater payload displacement effect than if the truck weight data are assumed to be evenly distributed across the 75,000-to-80,000-pound weight class, because more cargo is being carried close to the maximum weight allowed. Thus, as weight is assumed to be added to a trailer due to installing potential side impact guards it is more likely that the maximum truck weight will be exceeded, requiring additional shipments to carry the same amount of cargo.

The 1997 VIUS data indicate that about 20 percent of total "over 26,000 pounds" truck travel miles are in the 79,000-to-80,000-pound weight class[62]. Once the weights of the tractor and trailer are removed (as outlined in Table 16), about 29 percent of total truck cargo is carried in the 79,000-to-80,000-pound truck weight class. This "29 percent" figure[63] becomes the value for the "Percentage of Cargo in Critical Weight Class" used in the payload displacement formula on page 26 of this report.

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[61] Data run done by Census Bureau on special request, October 17, 2004. Data from Table 8 (page 58) of 1997 VIUS report.

[62] 23,917 million miles (see Table 15 above) divided by 117,930 million truck miles over 26,000 pounds (see 1997 VIUS report, Table 8).

[63] This ratio of 29-percent-of-total-cargo to 20-percent-of-total-travel-miles (1.45) is similar to the ratio of 20-percent-total-cargo to 13.1-percent-of-total-travel-miles (1.53) in the 1980 Corporate-Tech Planning report (see pages 7-7 and 7-8) relied upon by NHTSA in its 1995 analysis of rear impact guards.

Table 16

Estimated Percent of Total Payload By Weight Class (based on Census 1997 VIUS data)

Weight Class (pounds)	Estimated Average Total Truck Weight[64] (pounds)	Assumed "Truck-Only" Weight[65] (pounds)	Derived Payload Weight (pounds)	Total Miles Driven[66] (millions)	Percent of Payload-Miles[67]
26K-33K	29,500	26,000	3,500	7,092.0	0.7%
33K-40K	36,500	32,000	4,500	6,594.0	0.8%
40K-50K	45,000	34,000	11,000	13,078.1	3.9%
50K-60K	55,000	34,000	21,000	12,652.5	7.1%
60K-79K	72,780	34,000	38,780	50,806.5	52.9%
79K-80K	79,500	34,000	45,500	23,917.1	29.2%
over 80K	100,400	48,000	52,400	3,789.6	5.3%

The next part of the payload displacement formula (on page 26 of this report) to address is the "Percentage of Cases Affected Within Critical Weight Class." This is simply the assumed 750-pound weight of the potential side impact guard per trailer divided by the 1,000-pound range of the 79,000-to-80,000-pound truck weight class, or 75 percent.

Subsequently, the "Percentage of Payload Displaced When Displacement Occurs" is derived. This figure is developed by dividing the assumed 750-pound weight penalty for side impact guards by 2, and then dividing this 375-pound figure[68] by the assumed average payload (45,500 pounds) in the critical weight class. This yields a value of 0.8242 percent for "Percentage of Payload Displaced When Displacement Occurs."

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[64] "Average Total Truck Weight" for trucks in weight classes below 60,000 pounds based on mid-point of each weight class. "Average Total Truck Weight" for trucks in weight classes over 60,000 pounds derived from special request Census data run described on page 28 of this report.

[65] "Truck-Only" weights between 40K and 80K pounds weight classes assume one 20,000-pound tractor, and one 14,000-pound trailer. "Truck-Only" weights in "over 80K pounds" weight class assume one 20,000-pound tractor and two 14,000-pound trailers. "Truck-Only" weights in weight classes below 40K pounds assume single-unit trucks or lighter tractor-trailer combinations.

[66] Census 1997 VIUS Table 8, except for "79K-80K" data, which came from the October 17, 2004 special data run request.

[67] Based on sum of "Derived Payload Weight" times "Total Miles Driven" values.

[68] This will be the average payload displaced, when payload is displaced, to keep each affected vehicle's total weight below 80,000 pounds, assuming gross weights are evenly distributed within the 79K-80K pounds critical weight class. That is, the displaced payload could range from as little as 1 pound to as much as 750 pounds, with 375 pounds being the median value. In reality, this value is likely to be higher. For example, if a trailer is full of 50 pound boxes, if the trailer is 10 pounds overweight, one 50-pound box would have to be removed; the driver could not take out one-fifth of a box to remove exactly 10 pounds.

Next, the "Applicable Total Annual Operating Revenue" must be determined. NHTSA used 1992 operating revenue data from the American Trucking Associations in calculating this value. Similarly, this new analysis uses American Trucking Associations' data for calendar year 2002, as reported in its data compact disc "Motor Carrier Annual Reports 2002." Summary Table 0, Line 11, of that document (page xxiii) reports "Total Operating Revenue" for 2,250 carriers of $92.86641 billion for year 2002. NHTSA, in its 1995 rear impact guard analysis, adjusted its operating revenue estimate downward because the operating revenue figure included revenues for both single-unit trucks and tractor-trailer combinations, and the rear impact guard requirement applied only to trailers. As it is assumed that potential side impact guards would also only be applicable to trailers, a comparable adjustment was made in this analysis. NHTSA multiplied its revenue figure by 64.3 percent, which was the combination truck share of total truck miles traveled, on the assumption that "...operating revenue is proportional to VMT."[69]

This "proportional to VMT" revenue adjustment likely understates revenues attributable to the use of tractor-trailers, because tractor trailers will, on average be carrying far more cargo per unit than can single-unit trucks. Nevertheless, this approach also was used in this side impact guard analysis to be consistent with NHTSA's approach in its rear impact guard analysis. For 2002, FHWA estimated that 64.65 percent of total "single-unit 2-axle 6-tire and combination truck" VMT was in combination trucks.[70] This percentage multiplied by $92.86641 billion equals $60.04 billion in "Applicable Total Annual Operating Revenue."

Thus, payload displacement for potential side impact guards can now be calculated:

Payload Displacement = Percentage of cargo in "critical weight class" (29%)

times

Percentage of cases affected within critical weight class (75%)

times

Percentage of payload displaced
when displacement occurs (0.8242%)

times

Applicable total annual operating revenue ($60.04 billion)

equals $107.63 million

[69] NHTSA 1995 FRE, page VI-13.
[70] FMWA Table VM-1, December 2003.

This $107.63 million figure, in 2002 dollars, is the total annual value of the payload displaced into additional shipments due to the 750-pound assumed per-trailer weight of potential side impact guards. Adjusting to 2004 dollars would convert it to $111.92 million.

This total annual cost for payload displacement needs to be allocated on a per-trailer basis as part of the process of determining the total potential per-trailer costs for side impact guards. Provided below, in Table 17, are Census Bureau data for trailer sales during the 1990-2000 time frame. The Census Bureau stopped collecting this data after the year 2000.

Table 17

Complete Trailer Shipments
(Census Bureau data)

Year	Shipments
1990	149,117
1991	122,361
1992	165,268
1993	185,741
1994	234,287
1995	279,144
1996	202,912
1997	231,555
1998	273,338
1999	296,338
2000	250,752

For the purposes of this side impact guard analysis, an annual trailer sales level of 250,000 units was used. This was approximately the average level of sales from the mid-1990s to the year 2000.

Allocating the $111.92 million annual cost (2004 dollars) for payload displacement across annual trailer sales of 250,000 units results in a per-trailer payload-displacement estimate of $448. Discounting this figure by 7 percent annually to reflect the fact that this payload displacement costs will occur over the trailer's total operating life yields a cost estimate of $323.[71]

[71] The 7 percent annual factor for discounting future costs or benefits to the initial purchase year of the trailer is 0.722 times the undiscounted future stream of costs or benefits. This can be seen, for example, in Table 13, where the discounted value of the baseline tractor-trailer's lifetime fuel consumption is $109,969.52, or about 72.2 percent of the nondiscounted value of $152,374.68.

Field Replacement of Damaged Guards

Over the operating life of a trailer, some potential side impact guards would have to be repaired or replaced due to collisions with other vehicles or other side impacts. As noted previously, in NHTSA's 1995 rear impact guard assessment, the agency concluded that the overwhelming majority of rear impact guards were repaired, rather than replaced, and that the typical repair was replacement of a crossbar. The agency also assumed that one replacement would typically be required over a trailer's operating lifetime.

Estimating possible field replacement frequencies and costs for potential side impact guards proved problematical. First, it is not clear how often potential side impact guards might be damaged. NHTSA data on police-reported crashes (its General Estimates System (GES)) suggest that tractor-trailers are more likely to be struck in the side than the rear. For example, 1999-2003 GES data on property-damage-only crashes involving tractor-trailers as the "struck" vehicle indicate 59,997 rear crashes and 138,168 side crashes (right and left sides combined).[72] Yet, it is likely that many rear crashes that would damage rear impact guards would be "backing into loading dock" crashes, which probably would not be reported to police. Thus, the relative frequency of side versus rear crashes that could damage impact guards is indeterminate.

As part of the survey of eight TTMA trailer manufacturers, data were requested by this author on typical repair costs for rear impact guards. Only one manufacturer provided data on rear impact guard repair costs, so data appeared inadequate to develop a possible repair cost estimate for potential side impact guards.

Ultimately, a decision was made not to estimate possible costs for field replacement of damaged potential side impact guards for purposes of this analysis. Nevertheless, this cost potentially could be significant. Side impact guards would be much longer (an average of 26 feet per side) than rear impact guards are wide (an average of 8 feet); thus, they have a far greater area exposed to possible collision damage, given a crash. This factor alone could substantially drive up relative repair costs. In addition, because there would be a guard on each of 2 sides of a trailer, the GES crash data above suggest a potential higher likelihood of being involved in relatively-serious side crashes than in rear crashes.

[72] Data provided to author by NHTSA's National Center for Statistics and Analysis, October 27, 2004.

Total Cost Estimates for Side Impact Guards

Table 18 provides a summary of the total cost estimates for potential side impact guards, with added lifetime fuel consumption and payload displacement discounted back to the trailer's initial purchase year using a 7 percent annual discount rate.

Table 18

Total Cost Estimate for Side Impact Guards
(per trailer, 2004 dollars)

Side impact guards (installed)	$1,554
Certification costs	6
Added fuel consumption (lifetime)	411
Payload displacement (lifetime)	323
Damage guard replacement	not estimated
Total cost per trailer	$2,294

With an annual sales rate of 250,000 trailers, the potential yearly cost for side impact guards would be $573.5 million.

The next section of this report will examine the potential safety benefits for side impact guards.

[73] JP Research, Inc., "Large Truck Side Underride Data Analysis," December 3, 2004, page ii.
[74] See Table 3 in the JP Research report.

Table 19

Average Annual
Injured Light Vehicle Occupants
in Combination Truck Side Collisions
with Trailer Underride

MAIS	Occupants
1	5,663
2	263
3	321
4	160
5	0

In estimating the potential effectiveness of upgraded rear impact guards in reducing fatalities, NHTSA in 1995 relied primarily on two studies performed in England on the benefits of upgraded rear underride guards introduced there in 1984. Based on those two studies, NHTSA estimated a potential fatality-reduction benefit for upgraded rear underride guards of 10-25 percent.[75] As another approach, NHTSA examined rear impact "closing speed" estimates from a 1979 Michigan study[76] of crashes in that State during the early-to-mid-1970s. NHTSA indicated that, in the 1979 Michigan study, about 30 percent of fatal rear-impact crashes in that study occurred at a closing speed of 30 miles per hour (mph) or below, which NHTSA stated "...appears to be the maximum effective speed (for the average car) of the mandated guard. Assuming the [upgraded rear impact] guard would be 100 percent effective at preventing PCI at speeds of 30 mph or less results in the probably optimistic assumption that the [upgraded rear impact] guard would be 30 percent effective in all fatal crashes."[77] Ultimately, however, the agency used a fatality-reduction effectiveness rate of 10-25 percent in its 1995 analysis.

For this side impact guard analysis, in estimating their potential fatality-reduction benefits, this author took an approach similar to NHTSA's analysis of the 1979 Michigan data. JP Research, in their December 2004 report, provided a table (see Appendix B of that report), on reported "striking" and "struck" vehicle travel speeds[78] for 393 fatal combination truck side impact crashes in FARS during 1994-2003. Most (224) of these 393 cases do not include an estimated travel speed value for the striking vehicle, but 169 of these cases do have an estimate of the striking vehicle travel speed. Of those 169

[75] NHTSA 1995 FRE, page V-5.
[76] Daniel J. Minahan and James O'Day, Highway Safety Research Institute, University of Michigan, "Comparison of Michigan Fatal and Non-Fatal Car-into-Truck Accidents," August 1979.
[77] NHTSA 1995 rear impact guard analysis, page V-4.
[78] For purposes of this analysis, "travel speeds" are assumed to be comparable to "closing speeds" in the 1979 Michigan analysis.

cases, 24 cases (14.2 percent) have a striking vehicle travel speed of 35 mph or less. Of the 145 cases that have estimates of both striking and struck vehicle speeds, 21cases (14.5 percent) have a striking vehicle travel speed of 35 mph or less.

This higher speed value of 35 mph for maximum effective impact speed for an impact guard, as opposed to NHTSA's 1995 assumption of 30 mph, reflects improvements in new vehicle crashworthiness over the past decade. Essentially all cars and light trucks now perform well in NHTSA's New Car Assessment Program frontal crashworthiness rating program, which rates vehicles from one to five stars (with five stars being best) based on seat-belted front-seat test dummy injury readings in a 35-mph barrier impact crash test. In addition, NHTSA's new requirements for advanced air bags in FMVSS 208, "Occupant crash protection," will raise the required frontal crash test speed in that safety standard from 30 mph to 35 mph by model year 2007.

Thus, if potential side impact guards are assumed to prevent all fatalities up to a striking-vehicle speed of 35 mph or less, the possible fatality benefits for side impact guards could be as high as 11 lives (14.5 percent of 77 side PCI fatalities) saved annually, once all trailers on the road were side-guard equipped. However, this estimate does not consider the negative safety effects of payload displacement, which are discussed starting on page 38 of this report.

In estimating the effectiveness of upgraded rear impact guards in reducing injuries, NHTSA relied primarily on computer-based crash simulations for a model year 1993 Honda Civic. The agency simulated crashes into two rear impact guards at 30 mph, one representing the requirements of NHTSA's 1996 rear impact guard final rule and the other representing a "pre-1996-requirements" rear impact guard. Based on these crash simulations, NHTSA estimated that upgraded rear impact guards would reduce MAIS 2-5 injuries by 7 percent. The agency assumed 10 percent effectiveness for upgraded rear impact guards in reducing MAIS-1 injuries.[79]

In determining injury-reduction benefits for upgraded rear impact guards, NHTSA concluded they would be effective against injuries produced in rear underride crashes both with and without PCI. As to the non-PCI rear underride crashes, the agency stated in its 1995 analysis, "For this case, the underride guard will absorb some of the crash energy, thus lowering the impact velocity, before the passenger car or light truck strikes the tires of the rear...[axle assembly]. Compared to striking the rear... [axle assembly] tires alone, the presence of a guard will lower energy levels prior to impact and thus lower HIC [Head Injury Criterion], chest g's, and femur loads."[80]

It should be reiterated that NHTSA's 7-10 percent injury-reduction estimates were for the benefits of a strengthened rear impact guard over an existing rear impact guard. They were not the estimated injury-reduction benefits of a rear impact guard compared to no rear impact guard. Therefore, in estimating the potential injury-reduction benefits of installing side impact guards over the current "no side impact guard" situation, if one

[79] NHTSA 1995 FRE, page V-20.
[80] NHTSA 1995 FRE, page V-8.

uses the NHTSA injury-reduction estimates, these estimates need to be increased to reflect this situation.

For purposes of this side impact guard analysis, it was decided to double[81] the NHTSA 7-10 percent injury reduction effectiveness estimates to 14-20 percent for potential side impact guards. This adjustment makes the assumed injury-reduction effectiveness for potential side impact guards roughly comparable to, or slightly higher than, the 14.5 percent value used for fatality reduction benefits. As a sensitivity analysis later in this report, a higher injury-reduction benefit assumption is tested to determine the effect on the potential cost-effectiveness of side impact guards.

Applying the 14-20 percent effectiveness estimates against the side impact injury numbers from Table 19 yields the gross injury-reduction benefits in Table 20, below.

Table 20

Potential Average Annual
Gross Injury-Reduction Benefits for Light Vehicle Occupants
in Combination Truck Side Collisions
with Underride
(without payload displacement)

MAIS	Injured Occupants	Assumed Injury-Reduction Effectiveness	Injury Reduction Benefits
1	5,663	20%	1,132
2	263	14%	37
3	321	14%	45
4	160	14%	22
5	0	14%	0
TOTAL			1,236

Thus, the estimated average annual potential injury reduction benefits for side impact guards would be 1,132 minor (MAIS-1) injuries and 104 moderate-to-critical (MAIS 2-5) injuries, if all trailers on the road had side impact guards. However, these estimates do not consider the negative safety effects of payload displacement, which will be discussed in the following section.

[81] This doubling implies that the ICC rear impact guard was about 7-10 percent effective, and that the NHTSA upgrade added another 7-10 percent. Doubts have been raised, however, about the effectiveness of the ICC guards. For example, Braver et al., (see footnote 93 on page 48 of this report) stated, "...these guards have long been recognized as too high and too weak to be effective" (Braver, et al, page 28). If true, this doubling assumption may overestimate potential injury-reduction benefits for side impact guards.

Payload displacement safety disbenefits

As mentioned earlier in this report, one effect of adding potential 750-pound side impact guards to trailers is that some payload currently carried in tractor-trailers loaded to close to maximum weight limits would have to be displaced to additional shipments. This means more tractor-trailers being driven more miles, which means the likelihood of additional crashes, injuries, and fatalities. These effects can be estimated starting with the following formula to determine the additional combination-truck miles driven:

Additional miles driven = Miles traveled in critical weight class

times

Average payload in critical weight class

equals

Total pound-miles in critical weight class

times

Percent of cases affected in critical weight class

times

Percent of payload displaced when displacement occurs

equals

Displaced pound-miles from critical weight class

divided by

Average combination-truck payload

The additional crashes, injuries, and fatalities due to payload displacement can then be estimated by multiplying the additional miles driven from the formula above by crash, injury, and fatality rates per miles driven for combination trucks.

The values for the formula above are determined below.

Because this analysis will use combination-truck crash, injury, and fatality rates for calendar year 2003, "miles traveled in critical weight class" needs to be estimated for that year, as opposed to the 1997 data used in Table 15 previously (see page 28). The critical weight class is still the 79,000-to-80,000-pound weight class. The 2003 estimate for

tractor-trailer miles traveled in this weight class is determined by multiplying the 1997 Census VIUS figure of 23,917,068,744 miles traveled (see Table 15) in this weight class by the ratio of total combination-truck miles driven in 2003 divided by total combination-truck miles driven in 1997.[82] This ratio is 1.111, so the estimated 2003 value for "miles traveled in critical weight class" is 26,571,863,375.

The "average payload in critical weight class" is estimated to be 45,500 pounds per combination truck (see Table 16 on page 29). Thus, the "total pound-miles in critical weight class" is 26,571,863,375 times 45,500, which equals 1209.02 trillion pound-miles.

The "percent of cases affected in critical weight class" is 75 percent (see page 30). The "percent of payload displaced when displacement occurs" is 0.8242 percent[83] (see page 30). Multiplying these two values by the 1209.02 trillion pound-miles figure above yields 7.4736 trillion "displaced pound-miles from critical weight class." Dividing this latter figure by an assumed "average combination-truck payload" of 31,000 pounds[84] yields 241.08 million extra miles driven annually by combination trucks because of payload displacement.

This calculation is replicated on the following page.

[82] FHWA (Table VM-1 from their "Highway Statistics" report) has 138,322 million miles traveled by combination trucks in 2003 and 124,500 million miles traveled by combination trucks in 1997. Thus, 2003 combination-truck miles traveled is 1.111 (138,322 million divided by 124,500 million) times the 1997 value.

[83] As noted on page 29 (see footnote 68) of this report, this figure is actually likely to be higher, because payloads realistically cannot be reduced in pound-for-pound increments as trucks exceed maximum weight limits. If this figure were higher, the safety disbenefits of payload displacement would also be larger.

[84] As noted on page 6 of this report, the NHTSA 1995 FRE assumed the average weight of a tractor-trailer combination in its typically-loaded state to be 65,000 pounds (see 1995 FRE, page VI-7). Subtracting a typical weight of 20,000 pounds for the tractor and 14,000 pounds for a typical empty van-type trailer yields a payload weight of 31,000 pounds.

Additional miles driven = Miles traveled in critical weight class (26,571,863,375)

times

Average payload in critical weight class (45,500 lbs.)

equals

Total pound-miles in critical weight class
(1209.02 trillion pound-miles)

times

Percent of cases affected in critical weight class
(75 percent)

times

Percent of payload displaced when displacement occurs
(0.8242%)

equals

Displaced pound-miles from critical weight class
(7.4736 trillion pound-miles)

divided by

Average combination-truck payload (31,000 lbs.)

equals

241.08 million additional combination-truck miles
driven annually

NHTSA 2003 crash, injury, and fatality data for crashes involving at least one tractor trailer are provided in Table 21.[85]

Table 21

Motor Vehicle Traffic Crashes, Fatalities, and Injuries in 2003 Involving at Least One Tractor-Trailer (with or without trailer)

Fatalities	3,587
Injuries	62,047
Total Crashes	198,399

The data in Table 21 include crashes, injuries, and fatalities that involved truck-tractors traveling without trailers; such travel will result from the payload displacement potentially resulting from side impact guards because of inevitably-imperfect matching of shippers' needs and trucking capacity. Dividing the data in Table 21 by the FHWA figure of 138,322 million miles traveled by combination trucks in 2003 yields the following crash, fatality, and injury rates per 100 million miles traveled:

Table 22

Motor Vehicle Traffic Crash, Injury, and Fatality Rates for 2003 Involving at Least One Tractor-Trailer per 100 Million Miles Traveled (with or without trailer)

Fatalities	2.59
Injuries	44.86
Total Crashes	143.43

With payload displacement potentially necessitating 241.08 million more miles of combination-truck travel, these rates translate into 6 more fatalities, 108 more injuries, and 346 crashes involving combination trucks annually (as noted before, the payload displacement safety losses are actually likely to be greater than these numbers because payloads typically cannot be reduced on a pound-for-pound basis as truck weights exceed maximum weight limits). These injury and fatality values need to be subtracted from the potential gross safety benefits for side impact guards (11 lives saved and 1,236 injuries prevented) calculated on pages 36 and 37. This subtraction results in estimated 5 lives potentially saved and 1,128 injuries potentially prevented, on balance, annually by side impact guards. This is shown in Table 23, on the following page.

[85] Provided by NHTSA National Center for Statistics and Analysis, October 19, 2004.

Table 23

Potential Net Safety Benefits for Side Impact Guards

	Side Impact Underride Gross Safety Benefits	Payload Displacement Safety Disbenefits	Net Safety Benefits
Fatalities	11	6	5
Injuries	1,236	108	1,128

The 108 payload-displacement injury disbenefits are allocated among the various MAIS levels in Table 24 on the following page. They are allocated among the MAIS levels based on injuries in all combination truck crashes, not just side impact crashes, because these payload-displacement extra-travel injuries would occur in all types of crashes involving combination trucks. The net potential injury-reduction benefits for side impact guards become 1,043 minor injuries and 85 moderate-to-critical injuries annually.

Table 24

Allocation of Payload Displacement Injury Disbenefits Among MAIS Levels To Determine Potential Side Impact Guard Net Injury-Reduction Benefits

MAIS	Gross Side Impact Injury Benefits	Payload Displacement Injury Disbenefits[86]	Net Injury Reduction Benefits
1	1,132	89	1,043
2	37	11	26
3	45	5	40
4	22	2	20
5	0	1	-1
TOTAL			1,128

[86] The distribution of injuries by MAIS level for all combination crashes, using 1995-2002 NASS data, is taken from Table 5, page 11, in the JP Research report. The injury distribution is 82.85% MAIS-1, 10.25% MAIS-2, 4.19% MAIS-3, 1.77% MAIS-4, and 0.95% MAIS-5.

Potential Side Impact Guard Cost-Effectiveness

This section combines the costs and benefits estimates for potential side impact guards to determine their cost-effectiveness. NHTSA historically has taken an approach to measuring cost-effectiveness for its rules and rulemaking proposals by estimating the "cost per equivalent fatality prevented" for these rules and rulemaking proposals. NHTSA described this process in a September 2004 rulemaking proposal:

> An equivalent fatality is defined as the sum of: (1) fatalities and (2) nonfatal injuries prevented converted into fatality equivalents. This conversion is accomplished using the relative values of fatalities measured using a "willingness to pay" approach. This approach measures individuals' willingness to pay to avoid the risk of death or injury based on societal behavior measures, such as pay differentials for more risky jobs.[87]

Table 25 provides NHTSA's "relative estimated rational investment level to prevent one injury, by maximum injury severity." The data represent average relative costs for crash victims of all ages.

Table 25

Comprehensive Fatality and Injury Relative Values

Injury Severity	2000 Relative Value* per Injury[88]
MAIS 1	0.0031
MAIS 2	0.0458
MAIS 3	0.0916
MAIS 4	0.2153
MAIS 5	0.7124
Fatality	1.000

*Includes the economic cost components and valuation for reduced quality of life.

Table 26 applies these relative values to the net safety benefit estimates from Tables 23 and 24.

[87] NHTSA, Preliminary Regulatory Impact Analysis, "NPRM on Tire Pressure Monitoring System, FMVSS No. 138," September 2004, page VII-1.
[88] From NHTSA, "The Economic Impact of Motor Vehicle Crashes, 2000," May 2002, DOT HS 809 446, as quoted in the FMVSS 138 PRIA cited immediately above (page VII-2).

Table 26

Conversion of Net Fatality and Injury Benefits into Equivalent Fatalities (not discounted)

Injury Severity	Net Benefits	Relative Value	Equivalent Fatalities
MAIS 1	1043	0.0031	3.2
MAIS 2	26	0.0458	1.2
MAIS 3	40	0.0916	3.7
MAIS 4	20	0.2153	4.3
MAIS 5	-1	0.7124	-0.7
Fatalities	5	1.000	5.0
TOTAL			16.7

Multiplying the 16.7 equivalent fatalities prevented above by 0.722 (see the footnote on page 31) to discount these net benefits, at a 7 percent annual rate, back to the trailers' initial purchase years yields an estimated net 12.1 equivalent fatalities potentially saved by side impact guards annually. Dividing this figure by the total projected annual cost for side impact guards of $573.5 million (see page 33) results in an estimated cost per equivalent fatality prevented of $47 million (rounded to the nearest $1 million), in 2004 dollars, for potential side impact guards.

This $47 million cost-per-equivalent-fatality-prevented figure is far higher than the typical cost-per-equivalent-fatality-prevented for NHTSA rulemakings in recent years. Table A-2 in the Appendix to this report provides cost-per-equivalent-prevented estimates, in constant 2004 dollars, for all NHTSA safety rulemakings in which the agency prepared a formal regulatory evaluation or regulatory impact analysis between September 1992 and September 2004. The average cost-per-equivalent-fatality-prevented for these NHTSA safety rulemakings, using a consistent 7 percent discount rate to standardize comparisons, is $3.2 million, or about one-fifteenth the above-calculated value for potential side impact guards. The highest overall cost estimate for any of the 1992-2004 NHTSA safety rulemakings was about $14.8 million for one school bus safety rulemaking, still less than one-third of the estimated potential cost-per-equivalent-fatality-prevented for side impact guards.[89] NHTSA explicitly rejected two

[89] As is evident in Table A-2, some of the NHTSA rulemakings had components to them with higher costs-per-equivalent-prevented. However, the appropriate standard of comparison to this side impact guard analysis is the overall cost estimate for each of the NHTSA rulemakings. This side impact guard analysis is an overall analysis for all trailers; if separate cost-per-equivalent-fatality-prevented estimates were made for each trailer type (i.e., van-type trailer, pole trailer, etc.) a wide range of cost-per-equivalent-fatality-prevented estimates among the various trailer types would be expected.

rulemaking proposals with costs-per-equivalent-fatality-prevented relatively close to the $47 million value: one was a proposal (December 2000) to require front-center-seating-position head restraints (cost-per-equivalent-fatality-prevented of $37-59 million) and the other was a proposal (June 1994) to use a side impact test barrier for light trucks that would have been heavier and taller than the barrier used for passenger cars (cost-per-equivalent-fatality-prevented of up to $57 million).

A more recent example of NHTSA rejecting a rulemaking option because of a high cost-per-equivalent-fatality-prevented estimate is provided in the agency's final rule, published in the *Federal Register* on December 8, 2004, requiring all designated seating positions in rear seats (other than side-facing seats) to be equipped with lap/shoulder belts. NHTSA explicitly rejected the option of requiring lap/shoulder belts in front-center seating positions because of a high cost-per-equivalent-fatality-prevented estimate. In that decision, the agency stated:

> If Type 2 [lap/shoulder] belts were required for the front inboard seats in passenger cars and LTVs [light trucks], the estimated cost per equivalent life saved would be $10.50 million compared to $4.57 million for the rear inboard seats in those vehicles... Accordingly, NHTSA does not believe it can justify the cost associated with mandating lap/shoulder belts in the front seat...[90]

This $10.5 million estimate for the cost-per-equivalent-fatality-prevented for lap-shoulder belts in center-front seating positions is well below the $47 million estimate for potential side impact guards on trailers.

For many years, in performing its cost-benefit analyses, NHTSA did not place a value on a human life. Instead, the agency staff would calculate the cost-per-equivalent-fatality-prevented for potential rulemaking proposals and then let the final policy-level decisionmaker (typically, the NHTSA Administrator) determine whether the proposal was worth pursuing. Recently, however, NHTSA has been placing a value on a human life to quantify the safety benefits of its rulemaking proposals in dollar terms. An example of this is NHTSA's "Preliminary Regulatory Impact Analysis, NPRM on Tire Pressure Monitoring System, FMVSS No. 138, September 2004." This report used a value of $3.5 million (2001 dollars) per "statistical life." This value translates into $3.7 million in 2004 dollars. The $47 million cost-per-equivalent-fatality-prevented estimate for potential side impact guards greatly exceeds this value.

[90] 69 FR 70907.

Comparison to Upgraded Rear Impact Guards

Table 27, below, compares the results of this side impact guards analysis to NHTSA's 1995 estimates for its rule upgrading rear impact guards.

Table 27

Comparison of Cost and Benefit Estimates for Potential Side Impact Guards vs. Upgraded Rear Impact Guards (2004 dollars)

	Side Impact Guards	Upgraded Rear Impact Guards
Guards (installed)	$1,554	$103-126
Certification costs	6	5-7
Added fuel consumption (lifetime)	411	28
Payload displacement (lifetime)	323	1
Damage guard replacement	not estimated	20
Total cost per trailer:	$2,294	$157-181
Total annual cost:	$573.5 million	$14.6-16.8 million
Potential lives saved/year	5	4-15
Potential injuries saved/year	1,128	174
Cost/equiv. fatality saved:	$47 million	$1.1-3.4 million

As is shown in Table 27, above, the costs of potential side impact guards, even without considering field replacement of damaged side impact guards, are much higher than NHTSA's 1995 estimates (updated to 2004 economics) for upgraded rear impact guards. Potential lives saved per year are lower for side impact guards than upgraded rear guards, but injuries saved may be higher. Cost-effectiveness is much better for upgraded rear impact guards than for potential side impact guards. The results of this side impact guards analysis are consistent with NHTSA's 1991 statement (see page 4 of this report), "Combination truck side underride countermeasures have been determined not to be cost-effective."

Sensitivity Analyses

This section of the report tests the sensitivity of the previous estimates of costs, benefits, and cost-effectiveness of potential side impact guards to changes in three factors used in the analysis: (1) the discount rate used to make costs and benefits that accrue over a trailer's operating lifetime comparable to costs incurred in a trailer's initial purchase year, (2) the number of fatalities that occur annually in trailer side underride crashes with passenger compartment intrusion, and (3) the potential effectiveness of side impact guards in reducing trailer side impact injuries.

Discount rate

The Federal government's Office of Management and Budget (OMB) provides guidance to Federal agencies in the preparation of regulatory analyses. OMB's guidance documents, Circular A-4 (September 17, 2003) and Circular A-94 (October 29, 1992), recommend that a real discount rate of 7 percent be used as the base case for regulatory analysis. OMB also recommends performing calculations using a 3 percent real discount rate. Table 28 below provides calculations of costs, benefits, and cost-effectiveness for potential side impact guards using a 3 percent discount rate, and compares those results to the previous calculations using a 7 percent rate.

Table 28

Effects of Alternate Discount Rates on Total Cost and Benefit Estimates for Side Impact Guards (2004 dollars)

	7 Percent Discount Rate	3 Percent Discount Rate
Side impact guards (installed)	$1,554	$1,554
Certification costs	6	6
Added fuel consumption (lifetime)	411	490
Payload displacement (lifetime)	323	385
Damage guard replacement	not estimated	not estimated
Total cost per trailer:	$2,294	$2,435
Total annual cost: (250,000 trailers/year)	$573.5 million	$608.75 million
Equivalent fatalities saved:	12.1	14.4
Cost/equiv. fatality saved:	$47 million	$42 million

As indicated in Table 28, using a 3 percent discount rate raises both costs and benefits compared to using a 7 percent rate. The costs increase because the added fuel consumption and payload displacement costs that occur in the later years of a trailer's operating life are worth more (i.e., discounted less) using a 3 percent discount rate than they are using a 7 percent rate. The benefits increase because the lives and injuries prevented in the later years of a trailer's operating life similarly are worth more using a 3 percent rate. The cost-effectiveness changes little, improving slightly to $42 million per equivalent fatality saved.

Number of Annual Side Underride Fatalities

In its 1995 rear impact guard analysis, NHTSA noted that it had received comments that the agency had undercounted the number of underride crashes. In particular, the agency cited comments by the Insurance Institute for Highway Safety (IIHS) that "... as many as 151 deaths in [rear] underride crashes may be occurring each year – not the 72 NHTSA recognizes – if the proportion of underride crashes in California holds true for the nation as a whole."[91]

In its 1995 analysis, NHTSA disputed the national representativeness of the California experience. However, the agency went on to state, "IIHS suggested that undercoding by FARS analysts may be responsible for the low counts. The agency agrees with the commenters that underride fatalities may be undercounted. NHTSA revised the 1994 'underride' variable in FARS and re-trained its state FARS analysts with the expectation of obtaining better quality HDV [Heavy Duty Vehicle] side and rear underride fatality information."[92]

A 1997 paper[93], primarily authored by the Insurance Institute for Highway Safety, claimed that, based on an analysis of 1988-93 FARS and NASS data, NHTSA was undercounting truck underride crashes in FARS. The paper included an estimate of 179 annual fatal crashes (not fatalities – there may be more than one fatality per fatal crash) for side underride of tractor-trailers (see Table 3 in that paper).

As a sensitivity analysis, Table 29 provides calculations of costs, benefits, and cost-effectiveness for potential side impact guards if average annual combination-truck side impact fatalities in the United States were three times the level used in the "base case" analysis. This is 231 side impact underride fatalities annually, instead of the 77 fatalities from the JP Research report. If this 231 side impact underride fatalities figure were accurate, gross side impact underride safety benefits would be 33 lives annually (14.5%

[91] Insurance Institute for Highway Safety, "Status Report," July 11, 1992, as quoted on page IV-13 in NHTSA's 1995 rear impact guards FRE.
[92] NHTSA 1995 rear impact guards FRE, page IV-14.
[93] E. R. Braver, M. X. Cammisa, A. K. Lund, N. Early, M. R. Powell (Insurance Institute for Highway Safety), and E. L. Mitter (Transportation Research Center, Indiana University), "Incidence of Large Truck-Passenger Vehicle Underride Crashes in Fatal Accident Reporting System and National Accident Sampling System," Transportation Research Record 1595 (1997), Transportation Research Board, National Research Council, Washington, DC.

of 231, and rounded to the nearest whole life), minus 6 lives lost due to payload displacement, or a net of 27 lives saved. As this is greater than the total "base case" lives saved shown in Table 26, the undiscounted "equivalent fatalities saved" would increase from 16.7 in Table 26 to 39.1 "equivalent fatalities saved." Multiplying 39.1 by 0.722 (to adjust for a 7 percent annual discount rate) or 0.86 (to adjust for a 3 percent annual discount rate) yields the "equivalent fatalities saved" estimates in Table 29 below.

Table 29

Effects of "Three Times" Fatality Count on Total Cost and Benefit Estimates for Side Impact Guards (2004 dollars)

	7 Percent Discount Rate	3 Percent Discount Rate
Side impact guards (installed)	$1,554	$1,554
Certification costs	6	6
Added fuel consumption (lifetime)	411	490
Payload displacement (lifetime)	323	385
Damage guard replacement	not estimated	not estimated
Total cost per trailer:	$2,294	$2,435
Total annual cost: (250,000 trailers/year)	$573.5 million	$608.75 million
Equivalent fatalities saved:	28.2	33.6
Cost/equiv. fatality saved:	$20 million	$18 million

Effectiveness in Reducing Injuries

As noted on page 37 of this report, the "base case" side impact guards analysis assumed they would be 14-20 percent effective at reducing injuries in trailer side impact underride crashes. For the purposes of sensitivity analysis, the calculations in Table 30 examine the impacts on benefits and cost-effectiveness if side impact guards were assumed to be three times more effective at reducing injuries, i.e., 42-60 percent effective. This would triple the gross injury-reduction benefits of 1,236 injuries (see Table 23) to 3,708. Subtracting the 108 additional injuries due to payload displacement yields 3,600 net injuries

prevented annually. These injury benefits are then allocated among the various MAIS levels, and converted into equivalent fatalities.

Table 30

Effects of "Three Times" Injury-Reduction Effectiveness on Total Cost and Benefit Estimates for Side Impact Guards (2004 dollars)

	7 Percent Discount Rate	3 Percent Discount Rate
Side impact guards (installed)	$1,554	$1,554
Certification costs	6	6
Added fuel consumption (lifetime)	411	490
Payload displacement (lifetime)	323	385
Damage guard replacement	not estimated	not estimated
Total cost per trailer:	$2,294	$2,435
Total annual cost: (250,000 trailers/year)	$573.5 million	$608.75 million
Equivalent fatalities saved:	32.4	38.6
Cost/equiv. fatality saved:	$18 million	$16 million

Finally, solely for the purposes of sensitivity analysis, Table 31 combines the "three times fatality count" and "three times injury effectiveness" sensitivity analyses into a combined analysis if both factors are considered simultaneously.

Table 31

Effects of
"Three Times" Fatality Count plus
"Three Times" Injury-Reduction Effectiveness on
Total Cost and Benefit Estimates
for Side Impact Guards
(2004 dollars)

	7 Percent Discount Rate	3 Percent Discount Rate
Side impact guards (installed)	$1,554	$1,554
Certification costs	6	6
Added fuel consumption (lifetime)	411	490
Payload displacement (lifetime)	323	385
Damage guard replacement	not estimated	not estimated
Total cost per trailer:	$2,294	$2,435
Total annual cost: (250,000 trailers/year)	$573.5 million	$608.75 million
Equivalent fatalities saved:	48.6	57.9
Cost/equiv. fatality saved:	$12 million	$11 million

Even at these levels of sensitivity analysis, side impact guards do not meet the typical NHTSA levels of cost-effectiveness.

The Appendix to this report provides several tables. The first table (A-1) provides NHTSA's estimates of the cost-effectiveness of its rulemakings during the September 1992 to September 2004 time frame. The second table (A-2) updates the data in Table A-1 to constant 2004 dollars. The third table (A-3) provides the inflation adjustment factors used in this analysis to convert older dollar figures to 2004 dollars.

Appendix

Table A-1

NHTSA Estimates of Cost per Equivalent Fatality Saved for Safety Regulatory Proposals or Final Rules (1992 to September 2004)[94] (7 percent discount rate, if applicable) (economics as reported by NHTSA)

Regulation	Date	Cost/Equiv. Fatality Saved
Proposed rule – tire pressure monitoring requirements for cars and light trucks (FMVSS 138)	Sept 2004	$2.9-8.7 million ($2001)
Proposed upgrade to side impact standard for passenger cars and light trucks (FMVSS 214)	May 2004	$2.2-3.7 million ($2002)
Final rule – upgrade to fuel system integrity standard (FMVSS 301)	Nov 2003	$1.96-5.13 million ($2002)
Proposal to require lap/shoulder belts in center rear seating positions (FMVSS 208)	July 2003	$1.48-5.96 million ($2000)
NHTSA-rejected proposal to require lap/shoulder belts in center front seating positions (FMVSS 208)	**July 2003**	**$6.04-9.29 million ($2000)**
Final rule – upgrade tire standards for light vehicles (FMVSS 139)	June 2003	$4.99 million ($2002)

[94] Before 1992, NHTSA did not consistently adjust costs and benefits to the initial purchase year by discounting. Therefore, values from earlier analyses are not shown here, as they would not have been calculated in a comparable fashion.

Regulation	Date	Cost/Equiv. Fatality Saved
Proposal to add 35 mph belted crash test for 5th percentile female test dummy (FMVSS 208)	May 2003	$0-6.14 million ($2002)
Proposal to add side impact test to child restraint standard (FMVSS 213)	Feb 2002	$0.19-7.83 million ($2000)
Proposal to upgrade head restraints standard (FMVSS 202)	Dec 2000	$3.0-9.0 million ($1998)
NHTSA-rejected proposal to require center-seating position head restraints	**Dec 2000**	**$32.67-52.40 million ($1998)**
Final rule – advanced air bag requirements (FMVSS 208)	May 2000	$0.0-9.0 million ($1997)
Final rule – uniform child restraint anchorages (FMVSS 213/225)	Feb 1999	$2.1-3.7 million ($1996)
Final rule – retroreflective conspicuity material on rears of truck tractors (FMVSS 108)	July 1996	no net cost (paid for by property damage savings)
Final rule – upper interior head protection for small buses and large passenger vans (FMVSS 201)	June 1996	
- overall		$ 7.86-12.10 million ($1993)
- large vans		$ 3.99-7.98 million ($1993)
- small buses		$10.11-11.86 million ($1993)
- small school buses		$35.38-37.40 million ($1993)

Regulation	Date	Cost/Equiv. Fatality Saved
Final rule – rear impact guards for trailers (FMVSS 223/224)	Dec 1995	$0.92-2.74 million ($1993)
Final rule – upper interior head protection for light trucks and passenger cars (FMVSS 201)	June 1995	
- overall		$ 0.78-0.87 million ($1993)
- cars, front seats		$ 0.32-0.36 million ($1993)
- cars, rear seats		$ 1.71-2.10 million ($1993)
- trucks, front seats		$ 0.74-0.78 million ($1993)
- trucks, rear seats		$24.22-26.83 million ($1993)
Final rule – anti-lock brake and stopping distance requirements for medium and heavy trucks (FMVSS 105 and 121)	Feb 1995	$0.24-0.56 million ($1993)
Final rule – improved designs for seat belts (FMVSS 208)	July 1994	$0.36-3.58 million ($1993)
NHTSA-rejected proposal for different barrier weights and heights for dynamic side impact test requirement for light trucks (FMVSS 214)	**June 1994**	**$0.76-46.41 million ($1993)**
Final rule – warning labels on rear-facing child restraints for vehicles with air bags (FMVSS 213)	Jan 1994	$0.05-0.12 million ($1992)
Final rule – retroreflective conspicuity material on sides and rears of heavy trailers (FMVSS 108)	Sept 1992	no net cost (paid for by property damage savings)

Table A-2

NHTSA Estimates of Cost per Equivalent Fatality Saved for Safety Regulatory Proposals or Final Rules (1992 to September 2004) (7 percent discount rate, if applicable) (constant 2004 economics)[95]

Regulation	Date	Cost/Equiv. Fatality Saved ($2004)
Proposed rule – tire pressure monitoring requirements for cars and light trucks (FMVSS 138)	Sept 2004	$3.07-9.20 million
Proposed upgrade to side impact standard for passenger cars and light trucks (FMVSS 214)	May 2004	$2.29-3.85 million
Final rule – upgrade to fuel system integrity standard (FMVSS 301)	Nov 2003	$2.04-5.34 million
Proposal to require lap/shoulder belts in center rear seating positions (FMVSS 208)	July 2003	$1.60-6.45 million
NHTSA-rejected proposal to require lap/shoulder belts in center front seating positions (FMVSS 208)	**July 2003**	**$6.54-10.05 million**
Final rule – upgrade tire standards for light vehicles (FMVSS 139)	June 2003	$5.19 million

[95] Inflation adjustments use the Implicit Price Deflator for Gross Domestic Product, from Bureau of Economic Analysis, U.S. Department of Commerce, April 2005.

Regulation	Date	Cost/Equiv. Fatality Saved ($2004)
Proposal to add 35 mph belted crash test for 5th percentile female test dummy (FMVSS 208)	May 2003	$0-6.39 million
Proposal to add side impact test to child restraint standard (FMVSS 213)	Feb 2002	$0.21-8.47 million
Proposal to upgrade head restraints standard (FMVSS 202)	Dec 2000	$3.37-10.10 million
NHTSA-rejected proposal to require center-seating position head restraints	**Dec 2000**	**$36.66-58.79 million**
Final rule – advanced air bag requirements (FMVSS 208)	May 2000	$0.0-10.21 million
Final rule – uniform child restraint anchorages (FMVSS 213/225)	Feb 1999	$2.42-4.27 million
Final rule – retroreflective conspicuity material on rears of truck tractors (FMVSS 108)	July 1996	no net cost (paid for by property damage savings)
Final rule – upper interior head protection for small buses and large passenger vans (FMVSS 201)	June 1996	
- overall		$ 9.63-14.82 million
- large vans		$ 4.89-9.78 million
- small buses		$12.38-14.53 million
- small school buses		$43.34-45.82 million

Regulation	Date	Cost/Equiv. Fatality Saved ($2004)
Final rule – rear impact guards for trailers (FMVSS 223/224)	Dec 1995	$1.13-3.36 million
Final rule – upper interior head protection for light trucks and passenger cars (FMVSS 201)	June 1995	
- overall		$ 0.96-1.07 million
- cars, front seats		$ 0.39-0.44 million
- cars, rear seats		$ 2.09-2.57 million
- trucks, front seats		$ 0.91-0.96 million
- trucks, rear seats		$29.67-32.87 million
Final rule – anti-lock brake and stopping distance requirements for medium and heavy trucks (FMVSS 105 and 121)	Feb 1995	$0.29-0.69 million
Final rule – improved designs for seat belts (FMVSS 208)	July 1994	$0.44-4.39 million
NHTSA-rejected proposal for different barrier weights and heights for dynamic side impact test requirement for light trucks (FMVSS 214)	**June 1994**	**$0.93-56.85 million**
Final rule – warning labels on rear-facing child restraints for vehicles with air bags (FMVSS 213)	Jan 1994	$0.06-0.15 million
Final rule – retroreflective conspicuity material on sides and rears of heavy trailers (FMVSS 108)	Sept 1992	no net cost (paid for by property damage savings)

Regulation	Date	Cost/Equiv. Fatality Saved ($2004)
Final rule – automatic brake adjusters and indicators for medium and heavy trucks (FMVSS 105 and 121)	Sept 1992	approx. $0.76 million (no 7% discount rate calculations provided, value estimated from 4% and 10% discount rate calculations)
Final rule – alcohol-fuel vehicle fuel system integrity requirements (FMVSS 301)	Sept 1992	approx. $0.24-0.36 million (no 7% discount rate calculations provided, value estimated from 4% and 10% discount rate calculations)

Table A-3

Inflation Adjustment Factors

Year	Producer Price Index, Steel Mill Products (Index numbers, 1982=100)[96]	Implicit Price Deflators for Gross Domestic Product (Index numbers, 2000=100)[97]
1990	112.1	81.590
1991	109.5	84.444
1992	106.4	86.385
1993	108.2	88.381
1994	113.4	90.259
1995	120.1	92.106
1996	115.6	93.852
1997	116.4	95.414
1998	113.8	96.472
1999	105.3	97.868
2000	108.4	100
2001	101.3	102.399
2002	104.8	104.092
2003	109.5	105.998
2004	147.0[98]	108.237

[96] U.S. Department of Labor, Bureau of Labor Statistics, Series WPU1017, downloaded from http://data.bls.gov on April 18, 2005

[97] U.S. Department of Commerce, Bureau of Economic Analysis, downloaded from http://www.bea.gov on April 18, 2005

[98] Preliminary value

LARGE TRUCK SIDE UNDERRIDE DATA ANALYSIS

December 3, 2004

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CONTENTS

EXECUTIVE SUMMARY

In response to a request from the Truck Trailer Manufacturers Association (TTMA), JP Research, Inc. undertook a study to estimate the number of fatalities and injuries associated with side underride vehicle collisions with combination trucks.[1] The study involved examining accident data files maintained by the National Highway Traffic Safety Administration (NHTSA) and performing an in-depth review of combination truck crashes using photographs, scene diagrams, and other vehicle and occupant data.

Based on a thorough examination of statistical information on two-vehicle side underride crashes involving combination trucks, the following can be observed:

1. An analysis of Fatality Analysis Reporting System (FARS) data for 1994-2003 shows that an average of 77 side underride fatalities with passenger compartment intrusion (PCI) per year result from collisions with combination trucks. While approximately 2,255 fatalities occur annually in passenger vehicles colliding with combination trucks, less than 4% (77) of these result from side underride with PCI.

2. An analysis of National Automotive Sampling System (NASS) data for 1995-2002 shows that an estimated[2] 1,618 minor (AIS 1[3]) and 316 moderate to severe (AIS 2-5) injuries are sustained annually by occupants in light passenger vehicles involved in side underride/PCI collisions with combination trucks. Thus, of the approximately 30,000 injuries/fatalities (AIS 1-5) that occur annually in passenger vehicles colliding with combination trucks, about 6% (1,934) result from side underride with PCI.

3. A detailed review of the 48 NASS cases for 1995-2002, which involved 73 occupants, shows that 29% of occupants involved in side crashes with minor (AIS 1) injury, and 42% of occupants in side crashes with moderate to severe (AIS 2-5) injuries, were in side underride collisions with PCI.

[1] Combination trucks include Class 7 or 8 (medium/heavy) trucks with one trailer unit.
[2] Using NHTSA's extrapolations from NASS sample cases.
[3] Abbreviated Injury Scale, Association for the Advancement of Automotive Medicine.

1.0 INTRODUCTION

At the request of the Truck Trailer Manufacturers Association (TTMA), JP Research, Inc. performed a study using Fatality Analysis Reporting System (FARS) and National Automotive Sampling System (NASS) data to develop estimates on the number of fatalities and injuries associated with side underride collisions of passenger vehicles with combination trucks (Class 7 or 8 trucks with one trailer unit). This report presents the data sources and methodology used to derive the estimates presented herein.

The methodology used to perform the analysis is similar to that used by the National Highway Traffic Safety Administration (NHTSA) in its "Final Regulatory Evaluation, Rear Impact Guards," Docket No. 01-11, Notice 10, December 1995. In addition, JP Research reviewed technical literature purporting to use field crash data to evaluate the risk associated with underride collisions involving combination trucks.

2.0 DATA SOURCES

Fatal Accident Data

To estimate number of fatalities, FARS data from 1994-2003 was used. The FARS database, maintained by NHTSA, is a census of all vehicle crashes occurring on U.S. public trafficways that result in at least one fatality within 30 days of the crash. The FARS data was used by NHTSA to develop estimates of rear underride fatalities involving combination trucks. Prior to 1994, FARS data files did not contain a code to identify underride crashes with passenger compartment intrusion (PCI).

In 1994, NHTSA revised the FARS "underride" coding scheme based on comments received from other safety research groups on the undercounting of underride crashes. The underride variable was modified to include, for a vehicle in transport:

- PCI,
- No PCI, and
- PCI Unknown.

Similar coding options were included for a parked vehicle. Consequently, the side underride analysis performed by JP Research focused on the years 1994-2003 using these detailed codes to identify underrides with PCI.

Injury Data

NASS data for the years 1995-2002 was the primary source for developing estimates on injuries associated with side underride crashes. The NASS database is a nation-wide representative sample of tow-away crashes investigated in detail by NASS teams consisting of engineers, biomechanical experts, medical personnel, and statisticians. NASS is widely used by NHTSA to examine injury mechanisms; nature of injuries by body region; and other occupant-, vehicle-, and crash-related factors. The NASS Crashworthiness Data System (CDS), used for this study, investigates about 5,000 crashes a year involving passenger cars, light trucks, vans, and utility vehicles.

In addition to examining the statistical NASS data, an in-depth review of every side impact crash involving combination trucks available in NASS was performed to identify

the nature of underride (glancing blow, etc.) and the type of underride (under the wheels, under the tractor, under the trailer, etc.). The in-depth review formed the basis for deriving accurate estimates of the number of injuries associated with side trailer underride with PCI for collisions involving combination trucks.

In addition to using the NASS/CDS data, JP Research repeated the injury analysis using the same procedures NHTSA used in its final regulatory evaluation report. NHTSA used an additional data source called the General Estimates System (GES). The NASS/GES database is a nationally representative probability sample, selected from all police-reported traffic crashes, and is used to obtain national estimates of injuries and crashes. To be included in the database, a crash must have had a police report completed for it and must have involved at least one vehicle traveling on a public roadway and have resulted in a death, injury, or property damage.

In the final regulatory evaluation report, NHTSA used both NASS/GES data and NASS/CDS data to estimate the number of AIS 1-6[4] injuries to occupants of vehicles involved in underride collisions with combination trucks. The procedures involved converting KABCO[5] -coded injuries to AIS injuries to estimate the number of minor/moderate and severe (AIS 1-5) underride injuries. The estimates derived using the NASS/CDS data and in-depth case review were compared to the estimates derived using the NASS/GES and NASS/CDS data for consistency and accuracy.

3.0 METHODOLOGY

FARS Data Analysis

To be included in the FARS data analysis, the striking vehicle had to be a "light vehicle" (passenger car or light truck), and the struck truck had to be a combination truck. The initial impact point for the struck truck had to be at 2, 3, or 4 o'clock or 8, 9, or 10 o'clock. Both "underride with vehicle in transport" and "underride with vehicle not in transport" crashes were included. Crashes with more than two vehicles were excluded. Estimates of "underride with PCI" were derived, as were estimates to address the number of fatalities resulting from side underride collisions with parked combination trucks.

FARS has very limited information on parked vehicle collisions. Data on vehicle body type (single unit truck or combination truck) and impact point of contact are not coded in FARS for parked vehicles. Consequently, JP Research used the methodology NHTSA used in the final regulatory evaluation report to estimate the number of parked side underride collision fatalities. For 1994, NHTSA estimated there were 29 parked rear and side underride collisions (see Table IV-2, NHTSA). Of these, NHTSA estimated 80% (24) were combination trucks. It was assumed that, of these underride crashes with parked combination trucks, 20% (5) were side underrides and 80% (19) were rear

[4] Abbreviated Injury Scale (AIS) and Maximum Abbreviated Injury Scale (MAIS) are used in this study; both injury scales are copyrighted by the Association for the Advancement of Automotive Medicine. The scales rank injury from minor (AIS/MAIS 1) to unsurvivable/fatal (AIS/MAIS 6).

[5] Observational injury classification used in police reports: K = killed, A = incapacitating injury, B = non-incapacitating injury, C = possible injury, O = no injury, U = injury, severity unknown.

underrides. For each year from 1994 to 2003, five parked vehicle side underride fatalities were added to the estimates of side underrides with vehicle in transport.

NASS Data Analysis

To be included in the NASS data analysis, the striking vehicle, again, had to be a passenger car or light truck, and the struck truck had to be a combination truck. The NASS data does not identify impact points for combination trucks but contains information on accident configurations (frontal, rear, side swipe, etc.). To select side impact crashes from NASS, accident configurations that would include possible side impacts and sideswipes were included in the study. The NASS accident configurations selected for the study are presented in Appendix A. As in the FARS analysis, crashes with more than two vehicles were excluded, and estimates of "underride with PCI" were derived.

The NASS derivation of underride with PCI involved in-depth case review of all available NASS cases that are side impacts and coded as "underride." Validation of underride codes was made by reviewing case photographs and scene diagrams and sketches. For the years 1997-2001, the NASS data with photographs and scene diagrams were available electronically, and JP Research used this data to determine underride crashes with PCI. The detailed case review — which consisted of examination of each case to verify the extent and location of underride[6] and whether PCI was present at/over the occupant's seat position — was made for 73 light vehicle occupants involved in side impact underride crashes.[7] The percentage of underride crashes with PCI was then estimated for each AIS injury level (AIS 1-5). Due to paucity of data, AIS levels 2-5 were grouped to derive the percentages of underrides with PCI. As Table 1 shows, about 50% of the side underrides involved trailer underride, and about 40% involved tractor underride.

Table 1. NASS-Coded Underrides by Impact Location

Impact Location	Count
Trailer	37
Tractor	29
Tractor – Wheel	3
Tractor – Rear Corner	2
Trailer – Load	1
Other (not trailer)	1
Total	*73*

Source: In-depth review of NASS accident data, 1997-2001.

Delta V Estimates

In addition to analyzing crash and injury/fatality data from FARS and NASS, JP Research collected data on delta-V for a cost-benefit analyses associated with installing

[6] A vehicle was considered to have valid coded trailer underride if any portion of the vehicle had underridden any area of the trailer at any point during the crash.

[7] A CD-ROM containing the complete case review is attached as Appendix C.

side impact/underride guards. Although FARS does not include information on delta-V, for about 40% of the fatal side impact crashes involving combination trucks and light vehicles, FARS data *was* available on impact speed for the striking and struck vehicles. Appendix B presents the impact speed distribution for striking and struck vehicles in fatal side underride collisions involving combination trucks. This data was used to perform the cost-benefit analyses. (For more on the analysis, see Section 5.)

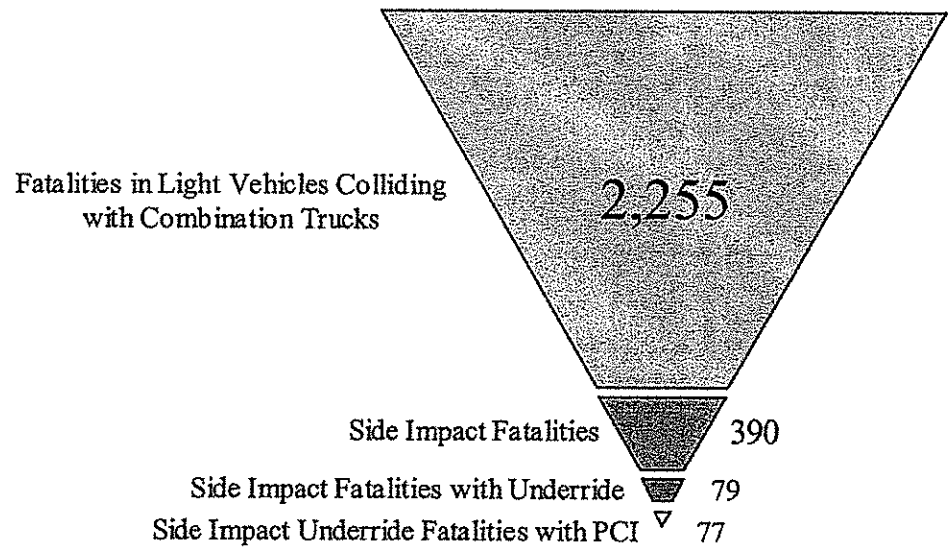
4.0 RESULTS

The key results of JP Research's statistical analyses of two-vehicle side underride crashes involving combination trucks are summarized in this section.

Fatality Estimates

Figure 1 presents the annual number of light vehicle occupant fatalities in side underride crashes involving combination trucks. Annually, 2,255 fatalities occur in light vehicles colliding with combination trucks. Of those, 390 are side impact crashes and about 77 are side underride fatalities with PCI.

Figure 1. Annual Number of Fatalities in Side Underride Collisions

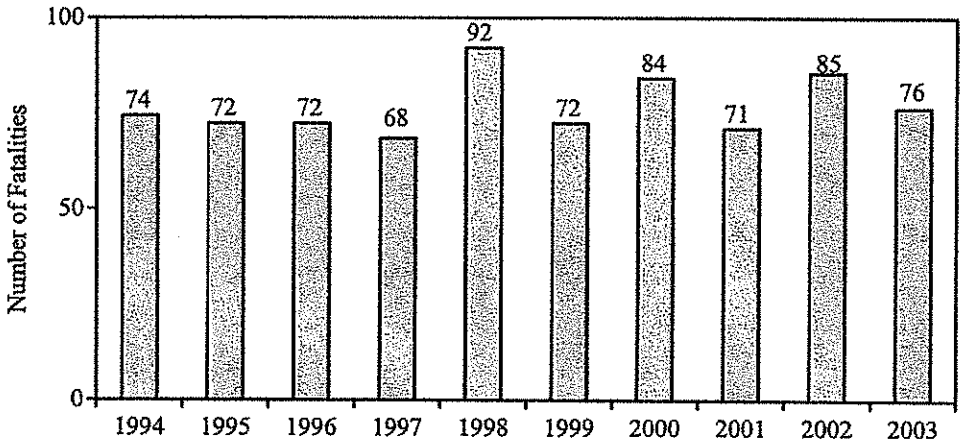


Source: FARS, 1994-2003. Combination trucks are medium/heavy trucks towing a single trailer. Includes side impact underride with parked combination trucks.

The number of side underride/PCI fatalities, by year, are shown in Figure 2. Annual estimates of fatalities from side underride crashes with and without PCI are presented in

Tables 2a and 2b. The unknown PCI cases were distributed using known proportions of PCI for side underride crashes.

Figure 2. Number of Side Underride Fatalities with PCI, by Year



Source: FARS, 1994-2003. Includes side impact underride with parked combination trucks.

Table 2a. Fatalities in Side Underride Crashes Involving a Light Vehicle and a Combination Truck

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	Total
Underride (w/ PCI)	52	39	41	38	63	34	59	44	60	46	476
Underride (No PCI)	5	2	4	2	12	3	6	5	9	2	50
Underride (PCI Unknown)	19	29	28	26	29	36	22	25	23	26	263
Total	***76***	***70***	***73***	***66***	***104***	***73***	***87***	***74***	***92***	***74***	***789***
Total Underride (w/ PCI) + Total Underride (No PCI)	57	41	45	40	75	37	65	49	69	48	—
% Underride (w/ PCI)	91.2	95.1	91.1	95.0	84.0	91.9	90.8	89.8	87.0	95.8	—
% Underride (No PCI)	8.8	4.9	8.9	5.0	16.0	8.1	9.2	10.2	13.0	4.2	—

Source: FARS, 1994-2003.

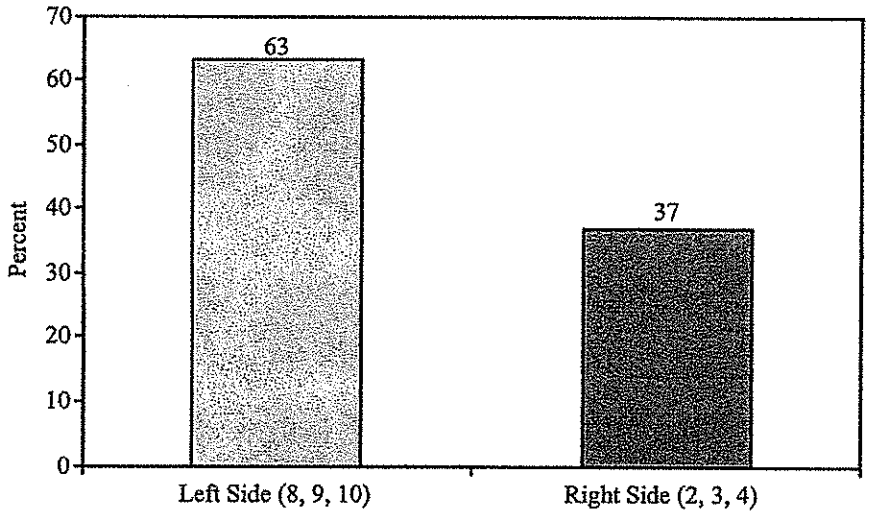
Table 2b. Using Known Properties to Redistribute Fatalities from Underrides with Unknown PCI

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	Total	Avg.
Underride (w/ PCI)	69	67	67	63	87	67	79	66	80	71	716	72
Underride (No PCI)	7	3	6	3	17	6	8	8	12	3	73	7
Total	*76*	*70*	*73*	*66*	*104*	*73*	*87*	*74*	*92*	*74*	*789*	*79*
Underride of Parked Combination Truck	5	5	5	5	5	5	5	5	5	5	50	5
Total Number of Side Underride Fatalities Involving a Combination Truck with PCI	74	72	72	68	92	72	84	71	85	76	766	77

Source: FARS, 1994-2003

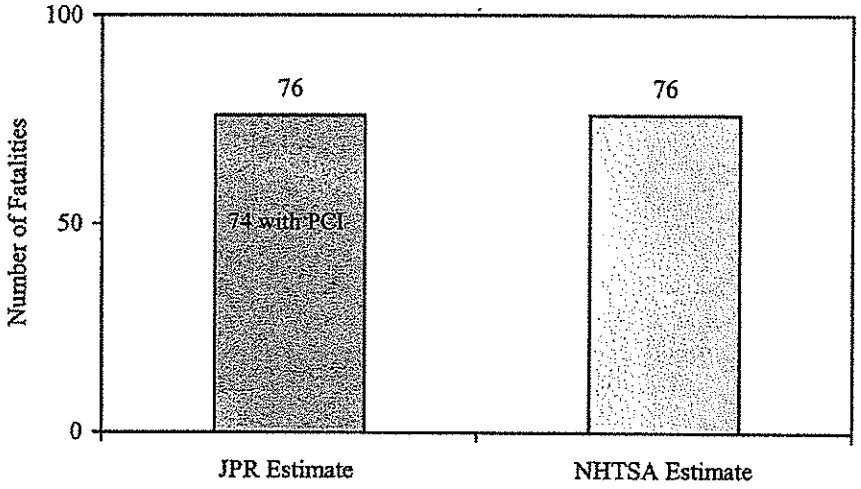
Figure 3 presents the side underride fatalities with PCI by direction of impact (2, 3, and 4 o'clock points; 8, 9, and 10 o'clock points) with the combination truck. Sixty-three percent (63%) of side impact underride fatalities were associated with left side (8, 9, and 10 o'clock) impacts. JP Research also repeated NHTSA's analysis on side underride fatality estimates for the year 1994 (Table IV-3, NHTSA) and obtained consistent results (Figure 4).

Figure 3. Side Underride Fatalities with PCI, by Impact Direction



Source: FARS, 1994-2003.

Figure 4. NHTSA and JP Research Estimates on Side Underride Fatalities Involving Combination Trucks (with and without PCI)



Source: FARS, 1994. Includes side underride collisions with parked combination trucks.

Injury Estimates

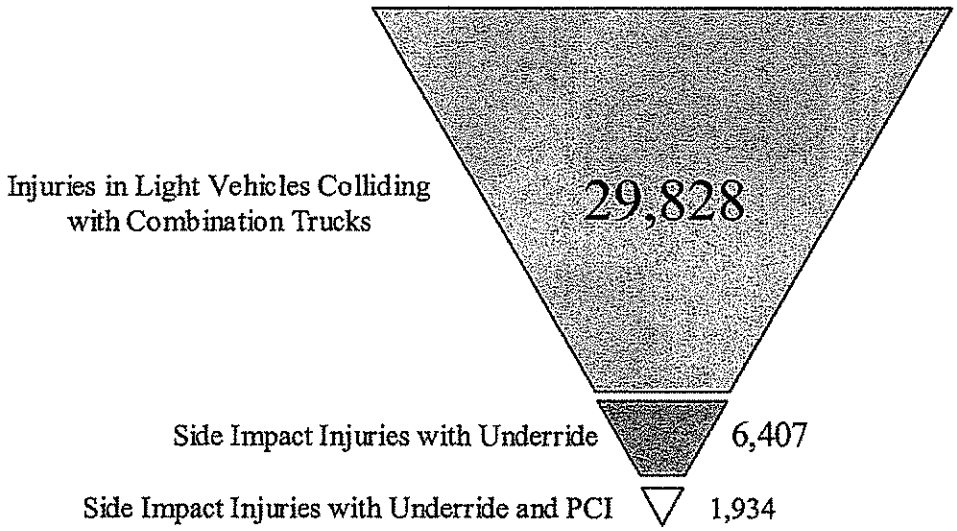
Using the methodology discussed, annual estimates of occupant injuries from side underride collisions with PCI were derived. These estimates used the maximum recorded injury for occupants of light vehicles involved in combination truck collisions and are presented in Table 3. The injury levels MAIS 2 through MAIS 5 were grouped to produce estimates of moderate to severe injuries in side underride crashes. The annual number of injuries in side underride collisions are shown generally in Figure 5, and by injury level in Figure 6.

Table 3. Annual Estimates of Occupant Injuries

Injured Occupants in Combination Truck Collisions		Injured Occupants in Combination Truck Collisions with Trailer Underride and PCI at Position	
MAIS	Occupants	%	Occupants
1	5,663	29%	1,618
2	263	42%	111
3	321	42%	136
4	160	42%	68
5	0	-	0
Combined 2-5	744	42%	316

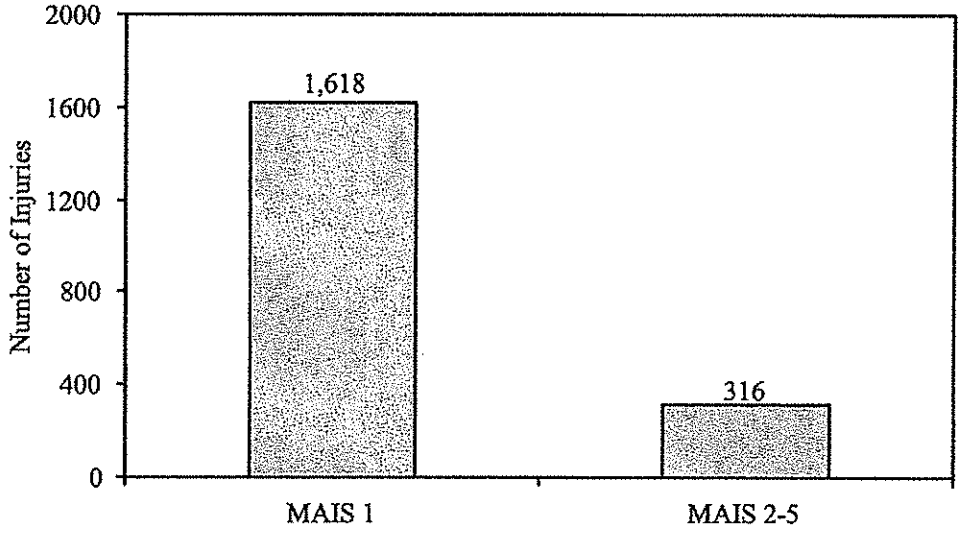
Source: NASS, 1995-2002 and detailed case review of 1997-2001. Annualized weighted counts.

Figure 5. Annual Number of Injuries in Side Underride Collisions



Source: NASS, 1995-2002 and detailed case review of 1997-2001.
Combination trucks are medium/heavy trucks towing a single trailer.

Figure 6. Annual Number of Injuries in Side Underride Collisions with PCI, by MAIS



Source: NASS, 1997-2001.

5.0 GENERAL CRASH AND INJURY STATISTICS

Data on total number of combination truck crashes by crash type (front/side/rear) and number of injuries by injury severity were derived using the NASS/GES and NASS/CDS data, respectively. These estimates were used to perform a cost-benefit analysis of installing side impact/underride guards.

For the purposes of the cost-benefit study, *all* combination truck collisions (crashes with 2 or more vehicles) and all light vehicle occupant injuries were included. The results are presented in subsequent paragraphs.

Combination Truck Crashes, by Crash Type

NASS/GES data for 1994-2002 was used to identify crashes involving combination trucks by crash type (defined by impact direction). As shown in Table 4, 46% of the combination truck crashes were side impact crashes.

Table 4. Combination Truck Crashes, by Crash Type

Impact Direction	Collisions	%
No Damage or Non Collision	177,915	9.6%
Front	460,799	24.9%
Right Side	**490,127**	**26.5%**
Left Side	**363,058**	**19.6%**
Back	231,153	12.5%
Top	19,629	1.1%
Undercarriage	16,145	0.9%
Front Right Corner	14,614	0.8%
Front Left Corner	7,310	0.4%
Back Right Corner	4,161	0.2%
Back Left Corner	2,756	0.1%
Unknown	63,940	3.4%

Source: NASS/GES, 1994-2002.

Combination Truck Crashes, by Injury Severity

Table 5 gives injury estimates by injury severity level for occupants of light vehicles colliding with combination trucks.

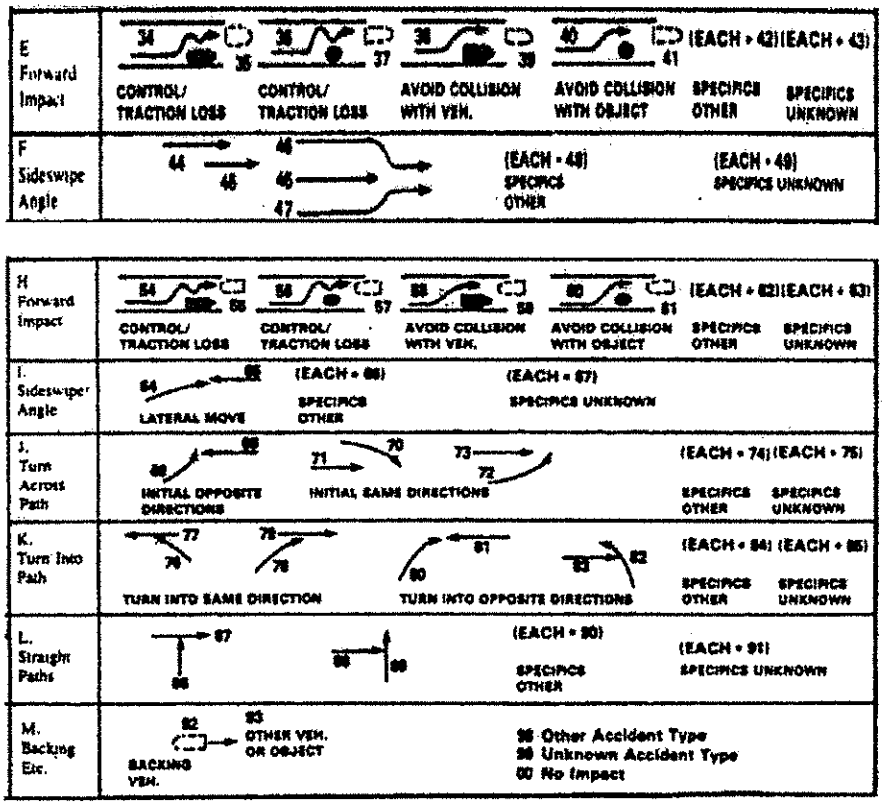
Table 5. Estimates of Occupant Injuries, All Combination Truck Crashes

MAIS	Occupants
1	274,970
2	34,032
3	13,894
4	5,862
5	3,147
Combined 2-5	56,935

Source: NASS, 1995-2002.

Appendix A.
NASS ACCIDENT CONFIGURATION SELECTED FOR THE STUDY

The following figure shows Categories E-F and H-M of the NASS/CDS "General Vehicle Form." Categories A-D and G identify single-vehicle, rear-end, and head-on accident configurations and, therefore, were excluded from the study.



Source: National Accident Sampling System/Crashworthiness Data System.

Appendix B.
FARS DATA FILES: IMPACT SPEED DISTRIBUTION FOR STRIKING AND STRUCK VEHICLES IN FATAL COMBINATION TRUCK SIDE UNDERRIDES

FARS 1994-2003: Travel Speed of STRIKING VEHICLE, STRUCK VEHICLE and initial impact point of STRIKING VEHICLE for trailer-truck side underrides.

	Travel Speed of Striking Vehicle (MPH)	Travel Speed of Struck Vehicle (MPH)	Initial Impact Point of Striking Vehicle
1			12
2		0	12
3			12
4		0	12
5			2
6			12
7			12
8		15	12
9		25	1
10			12
11			12
12		40	12
13			12
14		5	12
15			12
16			12
17			12
18			12
19			12
20			12
21			12
22		50	12
23			12
24		0	12
25		0	13
26			12
27			12
28			12
29			13
30			12
31			12
32		10	12
33			12
34		0	13
35			12
36			12
37			12
38			12

39			12
40		0	13
41			12
42			12
43			13
44			12
45			12
46		5	1
47			13
48			12
49			12
50			12
51			12
52			12
53			12
54			12
55		55	12
56			12
57		35	12
58		30	12
59			12
60			12
61			12
62			13
63			12
64			11
65			12
66			12
67			12
68			12
69			12
70			12
71			11
72			12
73			12
74			11
75			12
76		3	12
77			12
78		40	12
79		55	12
80			12
81			12
82			12
83			12
84			13
85			12
86			12

87			12
88			12
89		0	12
90			12
91			12
92		31	12
93			12
94			12
95			11
96			13
97		15	12
98			12
99			12
100			12
101			12
102			12
103			12
104			12
105			12
106			12
107			12
108		43	12
109		50	12
110			11
111			11
112			12
113			12
114		0	12
115			12
116			12
117			1
118		0	12
119			12
120			12
121		4	12
122		57	9
123			12
124		40	12
125			11
126			12
127		0	3
128			12
129			12
130			12
131			12
132		55	2
133		10	12
134			13

135			12
136			12
137			12
138			12
139			12
140			12
141			12
142			12
143			12
144			12
145			12
146			12
147		15	12
148		5	12
149			12
150			12
151			11
152			11
153			12
154			12
155			12
156			12
157			12
158			12
159		60	12
160		50	12
161			12
162		0	1
163			12
164			12
165			12
166			12
167			12
168			12
169		5	12
170			12
171			12
172			12
173		5	12
174		0	12
175			12
176			12
177			12
178			12
179			12
180			12
181			12
182			12

183			4
184			12
185		45	12
186			12
187		5	12
188			12
189		63	12
190		5	13
191			12
192			12
193			12
194			12
195			12
196			12
197		55	12
198			12
199			12
200		55	12
201			12
202			12
203			12
204			11
205			12
206			12
207			11
208			12
209			11
210			12
211			12
212		5	12
213		53	10
214		55	11
215			12
216		50	12
217			12
218			11
219			12
220		35	12
221			12
222			12
223		30	12
224			12
225	5	30	12
226	5	48	12
227	9	38	12
228	10	65	2
229	10	60	7
230	15	40	3

231	15		12
232	15	55	12
233	30	5	12
234	30	40	12
235	33	46	11
236	33		12
237	33	38	12
238	34	3	12
239	35	45	12
240	35	55	12
241	35	40	11
242	35		12
243	35	2	13
244	35	5	12
245	35	55	12
246	35	10	1
247	35	35	11
248	35	45	12
249	36		12
250	36	10	12
251	38	35	12
252	38	8	12
253	39	1	12
254	40	40	12
255	40	55	12
256	40		12
257	40		12
258	40		13
259	40	45	12
260	40	55	12
261	40	65	11
262	40	40	12
263	40	35	12
264	42		12
265	43	0	12
266	43	0	12
267	45	10	12
268	45		12
269	45	5	12
270	45	3	12
271	45	0	12
272	45	50	12
273	45	5	13
274	45	50	12
275	45	55	12
276	45	3	12
277	45	50	11
278	45	0	12

279	45	5	12
280	45	2	12
281	45	8	12
282	45	0	12
283	45	15	12
284	45	5	12
285	45	40	11
286	46		12
287	48	45	12
288	48	68	12
289	48	50	12
290	48	4	12
291	49	15	12
292	50	45	12
293	50	5	12
294	50	3	13
295	50	55	12
296	50	5	12
297	50		13
298	50	45	12
299	50	5	12
300	50	0	12
301	50	10	12
302	50	55	12
303	50		12
304	50	0	12
305	50	10	12
306	50		12
307	50	15	12
308	50	45	10
309	50	55	11
310	53		12
311	54	5	13
312	54	15	12
313	54	10	12
314	55	0	12
315	55	50	1
316	55	2	12
317	55	5	12
318	55	60	13
319	55	3	12
320	55	10	12
321	55	55	12
322	55	15	12
323	55	40	12
324	55	1	12
325	55		12
326	55	5	12

327	55	10	12
328	55	45	11
329	55	1	14
330	55	20	12
331	55	0	12
332	55	5	13
333	55	10	12
334	55	15	12
335	55	5	12
336	55	0	12
337	55		12
338	55		12
339	55	10	12
340	55	5	12
341	55	55	12
342	55	45	12
343	57	3	12
344	58		12
345	58	53	12
346	59	38	12
347	60		12
348	60	15	12
349	60	60	11
350	60	65	12
351	60	65	12
352	60	35	1
353	60	7	12
354	60		12
355	60	65	12
356	60	10	12
357	60	15	12
358	60	50	12
359	60	10	12
360	62	62	1
361	63	65	12
362	65	55	12
363	65	3	12
364	65	1	12
365	65	5	12
366	65	17	12
367	65	10	12
368	65	15	12
369	65	15	12
370	65	60	12
371	65	0	12
372	65	70	7
373	67		12
374	68		12

375	68		10
376	70	15	12
377	70	55	12
378	70	70	2
379	70	70	1
380	70	15	12
381	70	55	12
382	70	40	12
383	72	30	12
384	74		12
385	75	55	12
386	75	70	12
387	75	15	12
388	80	5	12
389	80	55	12
390	85	10	12
391	85	10	12
392	90	15	12
393	90	5	12

Appendix C.
DETAILED NASS CASE REVIEW

The NASS case review is available on the attached CD-ROM.

TTMA Exhibit B

Combination Truck Side Underride Analysis

By James Simons

January 2016

My name is James Simons; I am an economist. I worked at the National Highway Traffic Safety Administration (NHTSA) from June 1976 to January 2014 and my job was to analyze the costs and benefits of future safety standards so that NHTSA could determine whether a rule was cost beneficial. In addition, for planning and priority setting purposes, I often did cost benefit analyses to determine whether NHTSA should pursue research or rulemaking in an area. I supervised the work of the 1991 Preliminary Regulatory Evaluation (1991 PRE) on combination truck rear underride guards. I performed the analysis on a potential future side underride guard rulemaking coming to the conclusion that side underride guards were not cost beneficial for society. A statement to that fact was included in the 1991 PRE without all of the background analysis behind its reasons. At the request of the Truck Trailers Manufacturing Association, I have gone back to the 1991 PRE, remembering my rationales for that conclusion and have redone the analysis coming to the same conclusions that side underride guards were not even close to being cost-beneficial for society (costs outweighing benefits by a factor of 3.4 to 6.5). This report presents the data used, the assumptions made, the rationales followed, and the assessments made for the statement in the 1991 PRE that side underride guards were not cost beneficial for society.

I have also examined the 1995 Final Regulatory Evaluation (1995 FRE) on rear underride guards and applying the same rationales to the newer data in the 1995 FRE have come to the same conclusion that I came to in 1995 - that side underride guards were not close to being cost-beneficial for society (costs outweighing benefits by a factor of 5.2 to 17.1).

Finally, I have examined the important information on the subject of combination truck side underride that has been published since 1995 and have made comments on and in some cases analyzed their impacts.

1991 PRE Analysis

For this cost-benefit analysis on side underride guards, NHTSA defined a target area, a countermeasure, and a test procedure. In this case, we were interested in applying side underride guards to the trailer of a combination truck. The side underride guard would need to be robust enough to stop a 3,000 pound vehicle going 30 mph from having passenger compartment intrusion. In other words, the pass/fail criteria in a dynamic test would be if the windshield were intruded upon by the trailer.

On the benefits side, based on the data available, I viewed the number of fatalities and injuries[1] to light vehicle occupants in combination truck rear underrides with passenger compartment intrusion essentially equal to the number of fatalities and injuries in side underrides to the trailer with passenger compartment intrusion. After combining several analyses, the 1991 PRE came to the conclusion that the range of fatalities in rear underride with PCI was 50 to 72 per year. There was no similar analysis for side underride guards, however, from FARS there were an estimated 59.25 fatalities in rear underrides and 56.6 fatalities in side underrides to the trailer. Thus, I assumed that the range of fatalities of 50 to 72 annually was applicable for side underrides with PCI.

Passenger compartment intrusion was the main injury mechanism that rear and side underride guards can protect against. In the 1991 PRE, the incremental effectiveness for rear underride guards, over the effectiveness of the baseline guards, was estimated to be 18 to 27 percent. There was no baseline underride guard for side underride, thus we needed an estimate of the total effectiveness of side underride guards and not an incremental effectiveness. In 1991, I assumed that side underride guards that meet the same requirements as rear underride guards, compared to no baseline guard on the sides of trailers, would be 20 to 30 percent effective. I believed that a 30 percent effectiveness rate was probably optimistic because of the difference in the side structure of a trailer being weaker than the structure at the rear of a trailer and a side underride guard might have less capability of reducing PCI than a rear underride guard, even if it could meet the same minimum standard test. Of the estimated 50 to 72 fatalities per year from side underride to the trailer with PCI, an estimated 9 to 20 fatalities could be prevented by side underride guards, after taking into account the 9.8 percent reduction in the target population by conspicuity tape.

On the cost side, we were concerned that the side frames of trailers were not strong enough for an underride guard that was capable of withstanding a 30 mph dynamic test with a 3,000 pound moving deformable barrier and there would be unknown costs to bolster the frames. There was a substantial frame at the rear of the trailer to attach an underride guard to, however, there was no similar structure on the side of a trailer. Thus, I believed that our cost estimates (based on rear underride guards where there was proven structure) were probably low for side underride guards. Without better knowledge, we took a conservative approach on costs and assumed that the frames were strong enough and that the costs were the same for a rear underride guard as for a side underride guard on a per foot basis. Even with this conservative assumption, the total costs for side underride guards was many times the cost for a rear underride guard for three main reasons:

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[1] To simplify the discussion, I do not present any of the data on injuries. I assumed that there would be a similar number and severity level of injuries for side underride as was found in rear underride crash data. Of the 1,290 annual rear underride injuries, the 1991 PRE estimated 210 to 314 injuries could be reduced in severity. For cost-benefit purposes injuries are translated into equivalent fatalities, based on the methodology provided in the 1991 PRE.

First, the number of trailers that would be required to meet a side underride guard rulemaking would be twice the number required to meet a rear underride guard requirement. Trailers with their rear wheels within 12 inches of the rear of the trailer were exempt from having rear underride guards, since the wheels themselves would stop a vehicle from underride. No such exemption for trailers with side underride guards would be necessary.

Second, there were already rear underrides guards as a baseline on trailers. The 1991 PRE proposed to make them wider, stronger and have energy absorbing features. There were no side underride guards, so the costs for side underride were a total cost, not just an incremental cost. Thus, for example, the incremental cost for the rear underride guard that covers an 8 foot section of the back of the trailer (all in 1989 economics) was $67, and the total cost for the side underride guard to cover the 8 foot area was $114. The incremental weight for the rear underride guard was 55 pounds, and the weight for the total guard was 100 pounds. This weight increase affects the present discounted value[2] of fuel costs over the lifetime of the vehicle, with estimates of $30 in fuel costs for the incremental rear underride guards and $54 for side underride guards for covering an equivalent 8 foot area.

Third, side underride guards needed to cover 6 times as much area as a rear underride guard, considering both sides of the trailer, the average length of trailers, and not covering areas around the wheels, since the wheels could stop intrusion.

For all trailers sold in a year, the total present discounted value of costs for side underride guards based on the 1991 PRE ($172.7 million per year at a 10% discount rate and $195.1 million at a 2% discount rate) were about 18.5 times the incremental cost for rear underride guards ($9.4 million at a 10% discount rate and $10.5 million at a 2% discount rate).

There were some cost areas for rear underride guards that I did not include with side underride guards. For example, trailers were sometimes backed into loading docks resulting in the rear underride guards being damaged. An estimate was made that maintenance repairs would cost the incremental rear underride guards an additional $13 over their lifetime to repair this type of damage. We were concerned that side underride guards would have problems with getting stuck "high centering" on a raised railroad track or being damaged by raised railroad tracks. This would likely require trucks to be diverted around those areas or possibly some warehouses that couldn't be served by trucks with side underride guards. We were also concerned that side underride guards might impact roll on and roll off operations, and that there would probably be some warehouses with a downward angled dock pit where the trucks with side underride guards would not be able to back down into the dock pit. However, we couldn't estimate the national

[2] We use the term "present discounted value" because this estimate includes fuel costs which are increased by weight increases over the 25 year lifetime of the trailer and these future costs are discounted back to present value

impact of these unintended consequences. Thus, we did not include a maintenance cost for side underride guards.

Based on the 1991 PRE and my analysis, on a cost effectiveness basis, the cost per equivalent life saved was

$437,000 – $828,000 for incremental rear underride guards and

$7.5 million to $14.3 million for side underride guards

The comprehensive value of a statistical life at the time of the 1991 PRE in 1989 dollars was $2.2 million.

Thus, rear underride guards were cost beneficial because they cost less than $2.2 million per equivalent life saved, while side underride guards were not cost beneficial by a factor of 3.4 ($7.5/$2.2 million) to 6.5 ($14.3/$2.2 million). The 1991 PRE estimates were all in 1989 dollars.

Another way to summarize the analysis is to compare side underride guards to a rear underride guard. The lifetime costs of side underride guards were 18.5 times higher than the lifetime costs of a rear underride guard, while the benefits of side underride guards were 11 percent higher than the benefits of a rear underride guard.

1995 FRE Analysis

For the 1995 FRE, there were several different estimates made in both the cost and benefit sections (e.g., the comprehensive value of a statistical life was increased to $2.6 million based on 1993 dollars). One of the more important changes was in the benefit section. Based on a 1992 study, the effectiveness estimates for rear underride guards were changed from 18 to 27 percent to 10 to 25 percent. Based on the 1995 FRE and my analysis, the cost per equivalent life saved for side underride guards ranged from $13.7 million to $44.9 million. Thus, side underride guards were not cost beneficial by a factor of 5.2 ($13.7/$2.6 million) to 17.1 ($44.9/$2.6 million). The 1995 FRE were all in 1993 dollars.

Rulemaking/Research Considerations

NHTSA is a government agency, a part of the Department of Transportation. The rulemaking process includes a Notice of Proposed Rulemaking (NPRM), which is accompanied by a Preliminary Regulatory Evaluation (PRE, which is a cost-benefit analysis). Anyone in the world

can submit comments on the NPRM and PRE to a transparent public docket. Those comments are considered and NHTSA then publishes a final rule, which is accompanied by a Final Regulatory Evaluation (FRE, which is a cost-benefit analysis). NHTSA is an independent safety agency, not controlled in any way by any industry, created by Congress to reduce the number of fatalities, injuries, and crashes on the nation's highways. NHTSA develops its own plans (at times under the direction of Congress) of what safety issues to research and to develop into rulemakings. Anyone can petition NHTSA to develop a rulemaking on any motor vehicle safety subject.

NHTSA addressed side underride in the 1991 PRE regarding rear underrides, because of the fatalities that were occurring in side underrides. NHTSA analyzed the fatality target population of all underrides involving medium to heavy trucks. Fatalities were divided into single unit versus combination trucks and by rear and side underride. Table 4 of the 1991 PRE showed that an annual average of only 12.5 fatalities to passenger car and light truck occupants occurred in single unit trucks in rear underrides, while 59.25 occurred in combination trucks. Thus, single unit trucks were not included in the notice of proposed rulemaking (NPRM). On the other hand, there were 56.6 average annual fatalities in combination trucks in side underrides. NHTSA did not propose in the NPRM a side underride regulation because it found it not to be potentially cost effective from a societal perspective.

In order for NHTSA to publish an NPRM, it must go through the Office of Management and Budget (OMB). OMB essentially requires that an NPRM be technologically feasible and cost effective. NHTSA is continuously looking at potential rulemakings that can save lives. Based on the 1991 PRE, we had an opportunity to gather all the data available and examine whether side underride could be cost effective and worth the agency investing in research and a rulemaking or not. By making a decision on the cost effectiveness of potential rulemakings before we embark on a research project, NHTSA could prioritize its research and rulemaking plans.

NHTSA did not address side underride in the 1995 FRE because NHTSA did not propose side underride in the NPRM. It had determined that side underride guards were not going to be cost effective. Nothing in the 1995 FRE changed that decision. There was no need to bring up the issue. The focus of the 1995 FRE was on the costs and benefits of the final rule.

At the time that the 1991 PRE and 1995 FRE were written NHTSA knew of no side underride guards commercially produced for trailers anywhere in the world that could withstand a 30 mph dynamic test. Thus, there were no side underride guards that NHTSA could readily test. If NHTSA were interested in a potential side underride guard rulemaking, NHTSA would have to finance a side underride guard program. NHTSA would probably contract with a truck underride manufacturer and a trailer manufacturer to see if they could together develop a side underride guard that could reduce side underride and be energy absorbing to reduce occupant injury in a 30

mph test. NHTSA would test the device and trailer. If a side underride guard system were found sufficient, it would be sent to a NHTSA cost tear down contractor to estimate the cost and determine the weight for use in cost effectiveness analyses. NHTSA would examine other trailer manufacturers to determine whether their trailers also had side structures strong enough to handle a side underride guard and a 30 mph test. Then, a test fleet of 30 or so trailers outfitted with side underride guards would be used for a year or so in a northern state and a southern state to see how well the guards held up in snow/ice in the north and normal driving conditions and heat in the south.

Trailer Types and Sales

In the 1991 time frame NHTSA had not thought through the details of what types of trailers would be required to have side underride guards. For rear underride guards, in the 1991 PRE trailer sales for the last 5 years were averaged for a total sales of 206,898. Trailer sales were divided into those that were exempt from the standard by vehicle type. Some types of trailers were exempt because the rear of the trailer was already low to the ground, but mainly they were exempt because the rear of the trailer was a working area that could not be fitted with an underride guard and still perform the work. Exemptions included auto transporters, low bed heavy haulers, dump, drop frame, bulk commodity, tankers, etc. These exempt trailer types made up 19 percent of sales. This left 167,594 remaining that were not exempt by trailer type. In addition, an estimated 50 percent of the remaining vans and platform trailers were sliders and 50 percent were "wheels back" trailers. Those with wheels within 12 inches of the back of the trailer were exempt because the wheels themselves would prevent underride. As a result, the 1991 PRE estimated the number of trailers that would need to be fitted with underride guards was 83,775 or 40 percent of the total.

For side underride, the agency would need to decide what types of trailers the proposal would apply to, now looking at those types that had low sides already, like auto transporters, drop frame and low bed heavy haulers. For my analysis, I assumed the same types of trailers that were exempt from the rear underride rule would be exempt from the side underride rule. However, there was no reason to exempt the van and platform trailers with wheels back (and not sliders) from a side underride guard rulemaking. Thus, for side underride, the number of vehicles that would be affected by the proposal was estimated to be 167,594. From a cost perspective, it was likely that the slider would result in additional costs to strengthen the attachment places needed to cover the area affected by the sliding mechanism. Not having an estimate of those potential costs, they were not included in the analysis.

The side underride guards would likely be required on all areas of van and platform trailers that were not necessary to keep clear for the tires, under the assumption that the tires themselves

would prevent underride. Research would be needed to determine if the area affected by sliders could meet the compliance test and if the area directly behind the rearmost tires would need to be covered. I did not consider side underride guards for tractors in the analysis.

The Number of Underride Fatalities

The 1991 PRE came to the conclusion that the range of fatalities in rear underride with PCI was 50 to 72 per year. There was no similar analysis for side underride guards, however, from FARS there were an estimated 59.25 fatalities in rear underrides and 56.6 fatalities in side underrides to the trailer. Thus, I assumed that the range of fatalities of 50 to 72 was applicable for side underrides with PCI.

In 1994, FARS added a separate code for underride. In the 1995 FRE, rear underrides in 1994 FARS were 71, and rear underrides with PCI were estimated at 58 for 1994, well within the range of 50 to 72 from the 1991 PRE. After much analysis, including adding parked trailers, the 1995 FRE estimated 54 fatalities as the best estimate for rear underride with PCI for combination trucks based on an average of 1982 to 1994 FARS.

The side underrides for 1994 in FARS were 76 fatalities. Assuming a similar percentage of PCI for side underrides as estimated for rear underrides, the side underrides with PCI for 1994 would be 62. Again, well within the 50 to 72 fatalities used in my analysis.

The July 11, 1992 Status Report by IIHS estimated that there could be as many as 151 rear underride fatalities compared to the 72 used in the 1991 PRE if data from California can be extracted to the nation as a whole. The 1995 FRE gave a variety of reasons why California might not be representative of the nation including the percentage of double trailers and their fatality rate.

Effectiveness

Effectiveness estimates in 1991 PRE relied on the following information:

1. Tomassoni and Bell of NHTSA modeling showed incremental effectiveness of 17 to 25.8 percent.
2. A Great Britain examination of 10 guards showed new guards worked, but it was not a statistical study.
3. A Great Britain study by Riley of TRRL estimated front underrun guards were 18 to 25 percent effective (subjective study of 300 frontal crashes). This would be a total effectiveness, not incremental.
4. Danner of Germany estimated 10-20 percent for front underrun guards. This would be total effectiveness.
5. A Great Britain study of 15 crashes indicate 4 could be saved with underride guards (27%). I'm not sure if this was incremental or total effectiveness.

In the 1991 PRE, NHTSA estimated underride guards would be 18 to 27 percent effective. The 18 and 27 percent were both from Great Britain studies, but they only slightly increased the range found in the NHTSA modeling work. One was total effectiveness and the other I am unsure. The effectiveness range was applied to the 50 to 72 fatalities, which already have underride guards, thus, it was implicitly an incremental effectiveness. However, we didn't know what it was incremental to, or how effective the ICC guards were to reducing fatalities. The effectiveness of ICC guards was never evaluated. The ICC guard were narrow and had no strength requirement. I believed that the ICC guards would do little to stop a 3,000 pound vehicle going 30 or more miles per hour and the effectiveness would be very low. My estimate was that an ICC guard provided possibly 2-3 percent effectiveness. Obviously, the ICC guards weren't doing the job because everyone in the safety community believed they needed to be made stronger and energy absorbing. We believed that around 30 to 35 mph was the limit of speed and effectiveness. Thus, there was a limit on effectiveness you couldn't go above for a total guard. I believed that 30% for total effectiveness compared to no guard in the rear was an upper limit of effectiveness. I based the side underride guard effectiveness on the 1991 PRE, an estimate of the ICC baseline guard effectiveness, and a belief that the total underride guard effectiveness will not be any higher than 30%. I used the total rear underride guard effectiveness estimates compared to no guard of 20 percent (18 + 2 percent) to 30 percent (27 + 3 percent) for a side underride guard.

Effectiveness estimates in the 1995 FRE for rear underride guards

The same two studies (#1 and 2 above) were quoted. However, a 1992 study by Gloyns and Rattenbury (two noted English safety experts) of 22 fatal crashes with and without directive type guards found that the effectiveness for directive type rear underride guards was 10 to 15 percent. This would be an incremental effectiveness.

A 1979 Michigan study was quoted that estimated delta V in fatal crashes and found 30.6 percent were at 30 mph or less, the maximum effective speed for the mandated guard. Assuming the guard was 100 percent effective, the maximum effectiveness would be 30% in all fatal crashes.

The 1995 FRE used 10-25% effectiveness, again this was implicitly an incremental effectiveness. The baseline effectiveness for an ICC guard was not estimated.

For the side underride guard analysis, I estimated the effectiveness of a side underride guard based on the 1995 FRE, 10 - 25% incremental effectiveness for a rear underride guard, plus the 2-3 percent effectiveness for a baseline ICC guard. The resulting effectiveness was 12 – 28% for a side underride guard compared to no guard. Again, I did not believe that the total effectiveness would be any higher than 30 percent (given the impact speeds and likely effectiveness).

<u>Relevant information since 1995 FRE</u>

I also examined new information (since the 1995 FRE) that might be considered.

Undercounting of underride fatalities

In 1997, a study by Elisa Braver, Michael Cammisa, Adrian Lund, Nancy Early, Eric Mitter, and Michael Powell, "Incidence of Large Truck-Passenger Vehicle Underride Crashes in Fatal Accident Reporting System and National Accident Sampling System", 76 Annual Meeting of the Transportation Research Board, Washington DC, 1997a, estimated 226 underride fatalities involved the sides (CI= 110, 341) (CI = a 95% confidence interval) of large trucks.

This study by Braver et al, was missing two key pieces of information needed for a side underride analysis. First, it didn't limit the estimate to passenger compartment intrusion. Second, it didn't limit the underride cases to just the trailer, but included both the tractor and the trailer. Thus, it would be difficult to know how to apply this study without further information. As far as I know, NHTSA never did a detailed analysis of the Braver study along these lines of trying to determine the number of side underride fatalities with PCI to the trailer.

In a 2008 SAE paper "Evaluation of Light Vehicle Side Underride Collisions into Combination Trucks", by Padmanaban, Martz and Salvage, (Society of Automotive Engineers Paper #08CV-0240), bottom of page 3 talking about NASS/CDS coding found that 50% of side underrides examined involved trailer underrides, 40% tractor underrides and 10% involved wheels, corners, or loads. We are only talking about covering the trailer with side underride guards. Thus, the target population for benefits can only be 50% of the side underride fatalities.

A 2013 paper by Jeya Padmanaban (JP Research), "Estimating Side Underride Fatalities Using Field Data" http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3861811/ Annals of Advances in Automotive Medicine, 2013 Sep; 57: 225–232, estimated the annual number of light vehicle side underride fatalities with PCI is estimated to be 202 (CI: 189 – 215). This included an estimate for parked vehicles. Generally, this analysis by Padmanaban is about as good as can be done with current information. It isn't perfect, which would be pictures from the scene investigation, plus event data recorder information. I have some minor issues with the methodology, but they would only reduce the estimate by a minor amount.

Based on what we knew in the 1991 to 1995 time frame, the NHTSA estimate of 50 to 72 fatalities in rear underride PCI was a reasonable estimate for side underride with PCI for the trailers of combination vehicles. Newer information suggests the side underride fatalities could be higher. Braver estimated 226 side underrides, without PCI; certainly that would result in less than the Padmanaban estimate of 202 fatalities with PCI in side underrides to combination trucks. The more important issue is that based on the 2008 Padmanaban report, only half of these side underrides are to the trailer. Thus, based on my analysis of the Padmanaban estimates, the final estimate would be 101 (202*0.5) fatalities with PCI for side underride guards on trailers.

If I increase the target population to 101 fatalities, then benefits would be higher by a factor of 2.02 for the low end of the range and 1.4 times for the high end of the range. For the 1991 PRE, the cost per equivalent life saved changes to $5.3 million to $7.0 million, still significantly higher

(costs are higher than benefits by a factor of 2.4 to 3.2) than the comprehensive costs of a statistical life or $2.2 million (in 1989 dollars). For the 1995 FRE, the cost per equivalent life saved changes to $9.8 million to $22.2 million, still significantly higher (costs are higher than benefits by a factor of 3.7 to 8.5) than the comprehensive costs of a statistical life of $2.6 million (in 1993 dollars).

Payload capacity loss, cost, and safety impacts

Since truck weight is limited by State laws, the effect of having to carry more weight for side underride guards affects payload capacity. This affects both costs and benefits. There is a cost to not being able to carry as much cargo. The Shelton report estimated the payload displacement costs as $323 over the lifetime of an average trailer (in 2004 dollars). There is also a disbenefit. If a second truck is needed, then the second truck has the risk of being involved in a crash, uses fuel etc. This was not included in the 1991 PRE and 1995 FRE, but was estimated in the Shelton analysis. Shelton estimated safety losses of 6 fatalities a year because of increase truck use, and a safety benefit of 11 fatalities per year (based on a 14.5 percent effectiveness), for a net benefit of 5 lives per year. Thus, this disbenefit is very significant.

"Potential Costs, Safety Benefits, and Cost-Effectiveness of Side Impact Guards for Truck Trailers", amended version, April 2006, by Robert Shelton.

The conclusions from the Shelton report are: "The "cost per equivalent fatality prevented," which considers both potential lives saved and injuries prevented, is estimated to be $47 million for side impact guards. This is substantially higher than the $1.1-3.4 million per equivalent fatality prevented estimated for NHTSA's 1996 rear impact guard final rule (from the FRE). It also greatly exceeds the average cost per-equivalent-fatality-prevented of $3.2 million for all NHTSA safety rulemakings for which the agency prepared a formal regulatory analysis or evaluation during September 1992 to September 2004. Finally, it greatly exceeds the $3.7 million value per "statistical life" NHTSA has used in recent regulatory evaluations and assessments (all dollar figures are in 2004 economics)."

I have reviewed the Shelton study. It provides very good information. The results of the 2006 Shelton study confirm what NHTSA found, that side underride guards were not cost beneficial for society.

Effectiveness

The Shelton report estimated the effectiveness of side underride guards as 14.5 percent, based on a JP Research study of travel speeds in FARS and an estimate of 14.5 percent of the striking vehicle's travel speed in FARS was under 35 mph. This is the first analysis I'm aware of that studied the travel speed of side underride cases. This 14.5 percent under 35 mph is lower than

other studies I have seen for rear underride cases, where about 30% of the fatalities in rear underrides occur up to 30 mph.

NHTSA evaluation of the Effectiveness of Rear Underride Guards

Before 1998, trailers and semi-trailers were Federally regulated by Federal Motor Carrier Safety Regulations (FMCSR) that incorporated specifications for rear-impact guards developed by the Interstate Commerce Commission in 1952. The ICC guards were substantially narrower and smaller than those required by the current NHTSA standard and the TTMA recommended practice. The ICC guards were not required to meet strength tests.

The 2010 NHTSA evaluation of the 1996 final rule, by Kirk Allen (who worked for me), *The effectiveness of underride guards for heavy trailers, October 2010.* (Report No. DOT HS 811 375, pp. 16-22), Washington, DC: National Highway Traffic Safety Administration, available at www-nrd.nhtsa.dot.gov/Pubs/811375.pdf, analyzed Florida state data. Florida was the only state to provide trailer VIN numbers, which are essential to determine the model year of the trailers in the crash. The evaluation had the following findings for the new guards - comparing MY 1998+ versus MY 1980-to-1993 trailers, the analysis estimates a 27 percent reduction in rear-impact fatalities with the newer trailers, but the estimate falls short of statistical significance, due to the limited data (chi-square = 0.88, where 3.84 is needed for significance at the two-sided .05 level). A corresponding analysis of the risk of fatalities and serious injuries (categories K and A in the Florida data) shows 6.5 percent lower risk with the newer guards, likewise not statistically significant. The way I interpret these results is that the evaluation suggests, but cannot prove, that the new wider, stronger, and energy absorbing guards were effective in reducing underride fatalities, but an effectiveness estimate cannot be made because the findings are not statistically significant.

Conspicuity tape effectiveness

Conspicuity tape evaluation showed much higher effectiveness than originally thought. Effectiveness was 29 percent for dark conditions compared to the 9.8 percent overall effectiveness assumed. This may not be a factor in a later analysis, since all trailers now have conspicuity tape and would be included in the target population already.

Costs

Truck underride teardown study of cost and weight is now available from NHTSA. The relevant estimate from this study is $259 (2013 economics) and 172 lbs. for Great Dane 2001 guard meeting FMVSS but not Canadian standard. The comparable numbers in the analysis now are $193 (2013 economics) and 100 pounds. Thus, both costs and weight impacts would go up using these estimates.

Trailer sales are higher now, thus, total costs will go up.

Cost per equivalent life saved

The Department of Transportation's new comprehensive value of a statistical life is $9.1 million in 2012 dollars.

NHTSA ANPRM

On July 17, 2015, NHTSA issued an ANPRM (Docket # 2015-0007) on a variety of rear underride issues related to single unit trucks in response to a petition. The ANPRM did not address side underride, possibly implying that NHTSA is still not interested in considering a rulemaking on side underride. The maximum effectiveness estimated for a rear underride guard for a single unit truck is 25 percent, based on estimated travel speeds of striking vehicles (30 percent of all PCI fatalities occur at 30 mph or less and 85 percent of them might be saved (30%*.85 = 25%) as the estimated capability of rear underride guards. NHTSA did not find underride guards for single unit trucks to be cost effective.

An appropriate analysis would be to take all of the latest information and do a cost benefit analysis. That is about a 6 month effort, which I have not undertaken.

Resources

"Preliminary Regulatory Evaluation, Combination Truck Rear Underride Guards, New FMVSS", September 1991, NHTSA.

"Final Regulatory Evaluation, Rear Impact Guards FMVSS 223 and Rear Impact Protection FMVSS 224" December 1995. NHTSA.

Author

James Simons

Former NHTSA Director of the Office of Regulatory Analysis and Evaluation

National Center for Statistics and Analysis

National Highway Traffic Safety Administration

Department of Transportation

TTMA Exhibit C

CAUSE NO. 2004-320

MICHAEL JOSEPH FALCON, TERRENCE BAKER, Guardian of the Person and Estate of KELLEIGH TERRAN FALCON, and as Next Friend for KIERRA FALCON and KELESE FALCON, Minor Children	*	IN THE DISTRICT COURT OF
JAMES WALKER, Individually and as Representative of the Estate of VIRGINIA MARIA WALKER,	*	
Plaintiffs	*	
VS.	*	
LUFKIN INDUSTRIES, INC.	*	
Defendant	*	PANOLA COUNTY, TEXAS

* *

ORAL AND VIDEOTAPED DEPOSITION OF

YORG SANDERS

OCTOBER 21, 2006

* *

ORAL AND VIDEOTAPED DEPOSITION OF YORG SANDERS, produced as a witness at the instance of the Defendant, and duly sworn, was taken in the above-styled and numbered cause on the 21st of October, 2006, from 10:12 p.m. to 1:57 p.m., before Lee Richards, CSR in and for

the State of Texas, reported by machine shorthand, at the offices of Tekell, Book, Matthews & Limmer, 1221 McKinney, Houston, Texas, pursuant to the Texas Rules of Civil Procedure and the provisions stated on the record or attached thereto.

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THE VIDEOGRAPHER:
Mr. Darren Carruth

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EXHIBITS

PROCEEDINGS

THE VIDEOGRAPHER: Today's date is October 21st, 2006. We are on the record at 10:12.

YORG SANDERS,

having been first sworn, testified as follows:

EXAMINATION

BY MR. BOOK:

(Exhibit Nos. 1 through 9 marked.)

Q Tell us your full name, please, sir.

A Yeah. My name?

Q Yes.

A Yorg Sanders. I'm responsible Sales Manager for export in the Krone Company in Germany.

Q Okay. We are going -- you've never done this before, have you?

A No. No. This is the first time.

Q We've got to kind of proceed on questions and -- then there will be direct questions and then you give us your answer. Okay?

A Okay.

Q All right. Your name is Yorg Sanders?

A Correct.

Q And where do you live?

A I live in the area of Osnabruck. That's in the northern part of Germany. Also the vector release are

based in the northern part of Germany. So not too far to Bremen and Hamburg. Talking 100 to 200 kilometers.

Q And who do you work for?

A I work for the Krone Company, trailer company, East Germany.

Q And Krone -- how big, from a standpoint of the number of units that Krone makes a year, how big is Krone?

A The entire Krone Company has two different -- or three different production legs.

One is -- the original one is the retail network for John Deere. We are, in fact, the largest John Deere dealer in Germany.

Secondly is the agriculture side, the agriculture production, where we are producing self-propelled machines and baling presses.

And the third leg, if you want, the third production leg, is the trailer production. Trailer production this year around about 30,000 units.

Q Okay. So Krone sells around 30,000 trailer units a year?

A Correct.

Q Currently?

A Yes.

Q What is your educational background,

Mr. Sanders?

A I'm an engineer from the education point of view, and went straight from the engineering into the sales already nearly 30 years ago.

Q And so it's clear on the record, I represent Lufkin Industries and they are -- there is a suit that's being brought against Lufkin Industries by the Walker family and the Falcon group of plaintiffs.

A Uh-huh.

Q You understand that?

A Yes.

Q Okay. And Mr. Coco here today represents the Falcon group of plaintiffs?

A Uh-huh.

Q And Mr. Gomez, who is on the speaker phone --

A Right.

Q -- represents the Walker group of families. All right?

A Uh-huh. Uh-huh.

Q And I'm not going to go into the details of that accident since that's not the reason that we brought you over here from Germany.

First off, for the -- just a little background. The first time you ever had any conversation with me would have been when?

A It was, in fact, last week that we have had a telephone conference, together with Glen Darbyshire.
Q Okay.
A I know him since -- a long time because we were, in other times, very close with the Wabash trailers in Lafayette because we importing, around about five years, Wabash trailers into Europe.
Q All right. And so the first time you ever talked Bill Book would have been --
A In fact --
Q -- last week?
A -- last week, yes.
Q All right. And you agreed to come from Germany to talk to the jury and to give information concerning the development and the production of the Krone trailer known as the Safe Liner?
A Correct.
Q Is that correct?
A That is absolutely correct, yes.
Q Now, yesterday, we talked, the two of us --
A Uh-huh.
Q -- about -- I tried to explain to you what we would be doing here today?
A Right.
Q And again, you've never done this before?

A No.
Q You have brought with you some documents. Is that correct?
A That is also correct, yes.
Q And the court reporter has marked them as 1 through 9, and we will talk about them in just a little bit, but did you get a list -- and I need to get this marked, if I've got an extra copy. These have all my notes on them.
MR. BOOK: Do you have an extra copy of y'all's list?
MR. COCO: No. I don't have it. I don't have a clean copy.
MR. BOOK: Then I'll have to go get one. Take a break for a minute and go get it. I'm going to run get that other list.
THE WITNESS: Okay.
THE VIDEOGRAPHER: We're off the record at 10:17.
(Recess taken.)
THE VIDEOGRAPHER: We're back on the record at 10:20.
(Exhibit No. 10 marked.)
Q (BY MR. BOOK) Let me show you what the court reporter has marked Exhibit 10 and ask if you got a copy

of this before you left Germany?
A No. No. I heard that only on the phone two hours later that there was just an e-mail coming in with these questions. So I have not seen it. It was presented to my e-mail address in Germany, but I had left already the office.
Q All right. And that came from -- e-mail from Mr. Darbyshire?
A Yes.
Q All right.
A That's what I understood on the phone.
Q Now, you brought with you documents that deal with -- you brought a video?
A Correct. The crash test. That is the Exhibit 1.
Q Okay. Of course, that's one of the items that's asked for?
A Yes.
Q And I think -- they already got, but it's here. Did you bring drawings of the trailers?
A Yes, of course. That was, for me, understandable because otherwise, I don't believe that we have so many technical experts here, that it is better to have a drawing to explain where we have had the problems and the basic construction, of course, of

the Safe Liner. I think the drawing as such is a relatively simple one so that anybody -- everybody can understand that.
Q Okay. Now, how long have you been working for Krone?
A I started in Krone in 19 -- on November, 1982.
Q All right. And in Europe, what is the length of the standard tractor -- tractor trailer -- the trailer?
A So the combination, as such, in Europe is 16.5 meters. That is equivalent, if we look only to the trailer side, to your 45 feet solutions. That means we are 8 foot shorter in Europe than in United States.
Q Okay. Now, I want to talk to you about the Krone Safe Liner just a little bit, and before I get into that, what's your position with Krone? I mean, what do you to do?
A I am responsible for the entire export sales. I am creating new areas, I'm creating new countries where we are going into. We are active, for the time being, in 40 countries, and I'm preparing the opening of the Micoret (Phonetic) states. That means the states in North Africa. We will go into the Arabian world now. So we are based were three offices in Russia. We are in Kazakhstan active, we in Ukraine

active, in all EC countries, of course, and we believe maybe also to extend our business in future to other areas like Afghanistan, if it's coming to a peace. They need, also, trucking equipment. That is the first thing you need.

And also on the frontal and mainland Australia because it's even worse there to go.

Q Do you have a title, like a VP or something like that?

A We call it -- no, we don't have these titles as you have in America. Let's say you can call me the vice-president or something, but we are no so title-minded, specially not in Germany.

In England, it's a little bit different, but in Germany, it is not the case.

Q All right. Did -- did Krone, the trailer arm of Krone, that made commercial trailers, did Krone develop a trailer that had a side guard protection on it and commercially develop such a trailer?

A Yeah. That was the Safe Liner. In fact, that was one of our back reputation points we have had in the past. We are 100 years old, the company, exactly this year, 2006, and that was a very weak point.

And that is also the reason why I came over, to talk to you regarding the Safe Liner

construction.

Q Well, let me ask you, how long -- before Krone put the -- "the Safe Liner" out on the market, how long did they spend in research and development to try to make the Safe Liner, with the side guard protection on it, a commercial, technologically, and economically feasible to go out on the road?

A Oh, it took us, all in all, including the production, seven years, but the production was relatively short.

We started with some prototypes in '99 and we stopped entirely everything in 2003. So with the investigations we made before, with some test runs before, and it was a total time of seven years where this -- let's say idea and the Safe Liner, as such, was existing.

Q Okay. Let me ask you this? Computer programing -- did Krone, before they put the Safe Liner out on the road, did they do a lot of computer modeling to try to determine and make sure that what they thought would be a workable trailer, with side guard restraints, was, in fact, technologically feasible?

MR. COCO: Object to form.

A Yeah. We did it, in fact, because we have, of course, all kind of computer systems there, all kind of

calculation possibilities, and we use it. We have to do so because if we are coming out and bringing this, let's say, to Europe in total, we have, in the different EC countries different locations. So we are not the United States of Europe, so far. Each state has national rights and we have European rights on top. That means you have to go into France with the construction later on to homologate it into Italy, or into Scandinavia, or whatever, so that means you have to do a lot of things before you can go out with any kind of construction in Europe.

Q When the Safe Liner came out -- I know I've seen, and I know that the plaintiffs' experts have copies of a lot of press releases that Krone put out. When Safe Liner came out, were there claims made by Krone as to the capabilities of this trailer from the standpoint of side guard underrides?

A Let's say there was the government as such, the German government, especially at that time, Chancellor Schroder, was behind that in the beginning because the idea was splendid.

You must know that Krone is very well known in the European industry for innovations. The idea came from these crash barriers themselves on motorways and highways that we have said, "Okay. It

must be nearly" -- "after nearly 100 years of normal trailer construction, must be possible, maybe, to create such a space frame where everything is surrounded outside, and we are starting the construction from outside in to inside to the center." And that was the major idea, and the politicians, in fact, were behind us as well, from the idea standpoint.

Q Let me ask you this: The frame of a Krone, for instance, a Krone box trailer --

A Uh-huh.

Q -- is that different than the frame, for instance, on the normal American box trailer? Is our frame -- is our -- the framing on one that you look out the window and see going down 59 different than the Krone frame?

A Yes. From the -- we are, in Europe, mainly -- or nearly 100 percent, it's only one competition who has box trailers, self-supported box trailers. We are running all our trailers in Europe on existing frames. That means we have main beams, two main -- major main beams underneath the chassis. So we are not working with self-supporting boxes.

We have also more Curtainsiders tilt top line worshans. That means soft roof constructions than you have here in the states.

You are running either on platform trailers, on container chassises, of course, or on box trailers, either for dry goods or for resale goods, food stuff.

So all your units from all manufacturers in the states are self- supported boxes. That is entirely unknown in Europe -- not unknown. That is not correct. Not in use construction-wise. Only one competition is using reefer trailers in a self-supported way, but is also offering existing frames underneath the reefer trailer.

Q All right. So the Krone trailer, then, has these two major beams going down the side of the trailer?

A Correct.

Q Is that what you're saying?

A That is correct, and I have also some drawings here which are well documented here --

Q And we'll --

A -- to see the differences.

Q We'll get into that in just a little bit. Bear with me. It's going to take a while. Okay?

A Don't worry.

Q So what did Krone do with these two longitudinal beams, were they -- were they running

inside the tires or outside, before you did the Safe Liner?

A No. The longitudinal beams are always inside the tires, also to the center of the trailer, never outside.

Q Okay. In order to make the Safe Liner operational, what did y'all do with the longitudinal beams? Did you move them?

A No. No. Because we came immediately to a different construction. I said from these crash barriers, steel crash barriers themselves, we came to a so-called space frame construction. That was the major idea.

Q All right. After you did that, were the wheels on the inside of the frame?

A The wheels were inside. It was exactly opposite, if you want, compared to the main steel beams.

Q Okay. So whereas the 100 year old Krone design that had the longitudinal beams inside of the wheels, when you did the Safe Liner, now the longitudinal beams are outside of the wheels?

A Yeah. It's not a longitudinal beam any longer.

Q Okay.

A We don't have any longitudinal beams. You will see that in the drawings --

Q I understand, now, I think.

A It's a complete different. Has nothing to do with the old original construction.

Q Okay. So were there a lot -- just -- was there press releases about this new innovation by Krone?

A Of course, it was, because saying that after so many years, even the truck chassis are similar to the -- to the signature chassises that was a kind of revolution in the trade that somebody was trying to arrange a complete different construction, and I think that was, in mega sense, nearly worldwide shown that Krone has created their -- a new kind of trailer.

Q And did Krone test the aerodynamics of this new Safe Liner in wind tunnels?

A Yes, we did it. Because in Germany it's not such a huge wind tunnel available, so we went into Lelystad in Holland, The Netherlands, because they have the possibilities there to see how the wind flow, and many circulations are going on there. We did it, yes.

Q Did you -- did you do that to see if maybe this new design might even help out on fuel economy?

A That was also one of the ideas behind, that maybe we can also save some fuel on that particular construction because it was more as a closed system.

Q Okay. And so -- but again, you had not tested

it and worked it out on the highway, correct?

A No. No, it was -- that is a chamber where you even test some airplane parts and so on and so forth.

Q And based on those tests, did Krone even have some press releases that this Safe Liner might help out on fuel economy?

A Yes. Definitely.

MR. GOMEZ: Object to form, leading.

A That's a --

Q (BY MR. BOOK) Did -- I'll need to ask you the same question, okay? It's going to be the same question, same answer, but he's made an objection that it's leading. So I need to ask the question again.

Did -- the tests that were done in the wind tunnel, were those done to determine if, perhaps, there might be some fuel economy in the design.

MR. GOMEZ: Objection, form, leading.

A Yes.

Q (BY MR. BOOK) You can go ahead and answer it.

A Yeah. Yeah.

Q And in the wind tunnel, what did the preliminary test indicate to Krone from the standpoint of the possibility that it might be a -- save fuel?

A Well, the outcome was, in the tunnel, that we can save around about 1.2 liters of diesel per 100

kilometers. That means roughly 60, 65 miles, something like that, we can save, but that was only one aspect -- or let's say a side aspect, more or less, to the construction.

Q Okay. Now, eventually, after this seven years of research and development -- and what type of resources, financial resources, did Krone put into the development of the Safe Liner from an economic -- from a dollar standpoint? Do you have an estimate of that?

A We have around about. We have investigated around about 10 million -- 10 million euros into the entire project, in the beginning, but that includes and also the -- the sale back of -- of equipment later on. I think we talked about that.

Q Okay. And so when you brought the Safe Liner out on to the market --

A Uh-huh.

Q -- were you able to sell any of them?

A We were able to sell it because price-wise we did something to push this typical construction to push it. And we were able to offer -- you see, in Europe we have so-called closed pallet boxes underneath the trailer. That is for around about 30, 32 European pallets. The pallets have a size of 80 centimeters by 1.2 meters. And we say a second spare wheel carrier is

merely compensating the costs --

Q Okay.

A -- of a Safe Liner. That we did, in the beginning, to push it as a certain marketing campaign, if you want.

Q Okay. And so the total number of Safe Liners -- how many total numbers of Safe Liners did Krone produce?

A Well, it was -- let's say taking into consideration that we are producing today, or this year, around about 30,000, it was only a very small number. It was, in total, 387 units.

Q Okay. So -- and was that over a period of how many years?

A We started -- we started with the first prototypes, in 1999, with 10 units.

Then in 2000, already, we increase it because there were certain customers behind asking we want such a thing, with around about 210. Exactly 207.

In 2001, we dropped already down to 133.

2002, 30, and 2003, 7.

Q Okay.

A And that is in total, if I calculate that correctly, 387 units in total.

Q And does Krone -- and after 2003, did Krone

make or even offer the Safe Liner?

A No. No. We have stopped that. Even the 2003, the seven ones, were for good old clients that they were asking and badly need because we take only high volume, because the problems were already arising end of 2001, 2000 -- beginning 2002, that we were really --

Q We're going to talk about that.

A Yeah. Bringing the figure down.

Q When you started selling the Safe Liner and put it on the roads in Europe to work it -- for your customers to work it commercially, did you start getting complaints from any of your customers?

A Not right in the beginning. The first complaints were coming by around about 70,000 kilometers equals to around about 50,000 miles, if I'm calculating correctly, that we got problems with some cracks and -- in the frame. That was after 70,000, especially from customers who were using the full payload right from the beginning.

Q Okay. And did you bring some pictures here today, to show to the jury and to the lawyers, of some of the cracks that your customers were reporting that were occurring over the roadways of Europe?

A Yes.

Q Can you pull those out?

A I have the pictures here with me. That is Exhibit 6.

Q All right. Now, Exhibit 6, these pictures --

MR. BOOK: And we might want to make these -- go through them and give them alphabetical 6 so we don't get them mixed up, Mr. Court Reporter, but I guess we can -- let's see how many we got. We're going to renumber -- we're going to number these with -- like 6A through the alphabet. I guess we can -- we need to do it before I start talking to him, I think.

Q (BY MR. BOOK) I show you 6A. What does that show?

A That's construction off blown off tire, which was coming into contact due to some cracks somewhere in the truck -- in the construction as such, in the wheel housing.

Q Okay.

A So that is affecting that immediately the tire.

Q And when the frame would crack, then you're saying that you would start having contact with the side -- the side guard --

A Yes.

Q -- restraint?

A Yes. Yes, because we have -- wheel housing. You will see that on the drawing that's maybe better

understanding. We have wheel housings, and the problem is the frame as such has not normal hanger brackets as we have on mechanical suspension, or aft suspension, and that means, then, the entire frame is turning or twisting in a certain direction, and then you're getting immediately contact with the -- with the housings, the wheel housings.

Q All right. And when this would happen in Germany, or anywhere else, when they would have this truck -- truckers with the Safe Liner would experience this over in Europe, what has to happen to that trailer? Can it keep going down the road?

A No. That -- you have to come -- or the trailer has to come to a full stop. It has to be repaired on the road because you cannot move it.

Of course, you can move it if you organize a crane and you put it somewhere on the low bed trailer later on, but that is relatively complicated and expensive.

So in these cases, you have the only choice then to repair it directly on the road.

Q And here in some of these pictures, do you actually have a gentleman that's shut down on the road and is having to call for help?

A Yes. Total variety I took with me, without

knowing this -- this questionnaire here, to show it, how difficult it was and what kind of problems were arising with this kind of trailer.

Q And was -- were some of the trailers actually experiencing total frame failures through the frame itself?

A Yes.

MR. COCO: Objection, form.

A It was complete crack.

Q (BY MR. BOOK) And do you have copies of that?

A We have also some pictures there were a little bit timber is underneath the trailer because the trailer is already bended so strongly that it would break otherwise if we not reinforce that, at least.

Q Here's one of them. I'm not going to go -- see if I've got a 61 here. I'm not going to go through every one of these.

I've gone through part of them and I'm going to get to the one that's got the man on the side of the road here eventually, maybe. Here we go.

Do these photographs fairly and accurately portray the range of problems that Krone was experiencing --

A Of these --

Q -- dealing with the Safe Liner in the period of

time that Krone had it out on the roadway?

A Yes. Absolutely correct.

Q When a trailer frame cracks -- let me show you one that's part of Exhibit 6 and it's got 14 point -- 11.01 at the bottom. Now, does this show a gentleman out on the roadway?

A Yeah. That is just the motorway. You see that's 200 meters to the exit there.

This -- this particular trailer was parked for two days at the side of the motorway for repairing that because it was not moveable.

Q All right. Let me see if I can get the videographer to kind zoom in on that.

Okay. And in these pictures, are there examples of total cracks that completely separated part of the frame?

MR. COCO: Objection, form.

A That is such a picture, because this is one of the major beams, cross members inside, where you see the entire cracks throughout the profile.

Q (BY MR. BOOK) All right. And when Krone started getting these -- I guess, for a better word, these complaints from its customers, at first, when you -- I believe you said earlier that within seven -- 50,000 miles on fully-loaded trucks --

A Yeah.

Q -- You started getting reports of cracks in the frame?

A Correct. We have -- these reports were coming from all over. We sold these units in around about five to six countries in Europe at that particular time, and the cracks were arising very, very suddenly then. That during, let's say, four weeks we got a lot of information from several areas where there was a report of cracks in the major frame, or wheel and tire -- tire blown off on the tire side. So that was clear that some movements were inside the frame at that time so the tires could blow off or worshans. It could entirely damage such things at that time.

Q If a frame starts coming apart on the highway with a load, is that a concern of Krone's from the standpoint of safety to the traveling public?

A Yes, of course, because let's say with these brakes -- we are talking on these typical units, only disk brakes. That's also something which you don't have, so far, in United States. You're still running on drum brakes.

That means disk brakes are very aggressive and indicates that wiring is disturbed.

The ultimate brake system will start

immediately. That means it comes to an emergency stop, and that could create also problems because if another car or another truck is behind you, he is not expecting, on a freeway, that such thing will happen. So it could come easily to an accident because the trailer is stopped in a very short moment, and the next truck or the next car is crashing into that particular unit.

Q Is there also a possibility of losing an axle?

A Yes. So the problem was that even in the housing, the axle was completely loose, and depending what kind of road conditions so that you have a little bit friction that the trailer is lifted and you have a single axle on -- on the road. So we lost -- we lost also some axles.

Q Did -- did that -- did any of those problems show up when Krone did this seven years of extensive research? Did any of those problems manifest themselves?

A No. No. That was not -- let's say we made also the test runs on our test tracks, but one fourth was maybe also not on the full load, on a full payload.

If we talk payload, it's around about 25 to 26 metric tons, in Europe, to get a -- we have a general rate, included truck unit, of 40 tons, metric tons.

So we did it also not because we were quite sure that the construction, as such, will work because it was strong. It seemed to be strong and it was also a little bit heavier than compared to the normal trailers.

Q Did -- after Krone's customers started experiencing these -- the frame cracking and the blowouts, those types things, did Krone try to fix the frame problem in any way before --

A Of course. Of course. We started immediately because we were believing only in -- in certain areas that maybe something can arise, and that this may be easy to overcome that with some further cross members, some reinforcement on the particular edges and so on, but it was that after further half a year, quite clear that we could not follow because if you reinforce a certain area where you have had some problems, you are only transponding or transferring this to the weaker points in the chassis. So it's only maneuvering from A to B, and all of a sudden the cracks are arising in a different position.

Q Let me ask a question about that, because some of the people in this case have seemed to indicate that if you make a chassis, for instance, more rigid, which I assume is what y'all were doing when you did the

reinforcements --

A Uh-huh.

Q -- correct?

A Correct.

Q Does that necessarily mean that you're going to solve your problem?

MR. COCO: Objection, form.

A No. We were not believing, even after discussing internally, if we put more material onboard. We were talking about -- around about 500 metric kilos, half a ton, on top of it. We were not sure that we could overcome, because in the construction as we saw it, we have -- an engineer knows what is going on if you were put stress by 90 degree angles into a chassis frame, and we were not sure to overcome -- to overcome that problem, and I have here in the drawings some markings, some red spot markings, that you can see the areas where we have had the cracks.

It was, first of all, what we would call the boogy.

Q (BY MR. BOOK) What's a boogy?

A The boogy is the -- what -- a running gear. You may be talking about running gear. That's what we call it in Europe, the boogy.

We are talking here only about three axle

units. In Europe, are running semi trailer only with three axles. That is also the difference to the United States. Single -- super single tires, only air suspension. We don't have any mechanical suspension. And these trailers have disk brakes on top of that. So these are the major differences.

Q Well, when you did this reinforcement, did Krone's customers continue to experience cracks in the reinforced trailers?

A Yes. Yes. It was only transferred -- the movement was, in general, around about 40 to 50 centimeters. That means one and a half foot, something like that, transferred to another -- to another joint.

Q And this -- how much weight did this Safe Liner enclosure add to the trailer? What -- how much weight did it add to it?

A The -- the entire weight was -- for the Safe Liner construction, compared to the same length of the standard chassis construction, around about 1.2 metric tons.

Q And then what does that equate to in American tons?

A That is roughly 3,000 pounds.

Q Okay.

A Around about 3,000 pounds.

Q And that's for a 45-foot trailer?
A Yes. We are talking only 45-foot trailers. It's not allowed in Europe to run 53 feet.
Q So if you added the --
A Eight.
Q -- Safe Liner, you would have another 8 foot of weight, correct?
A That's correct.
Q So I guess you could take 45, divide it by 3, and then that would give you the weight for a 53-foot trailer, or close?
A Correct.
Q Okay.
A Correct. So that was the -- in the general construction the weight increase.
Q Did Krone experience any problems from the standpoint of brake efficiency that they had not experienced before they put this enclosure around the trailer?
MR. COCO: Objection, form.
A That was -- that was one side effect as well, that in the housing, the axles were relatively closed up and we have had not enough problems of wind circulation in these housings. You must know that disk brakes are getting much hotter than drum brakes. So if you go

downhill -- we have in the Alps a lot of motorways, highways, which are going downhill 50 -- 40, 50 kilometers only downhill. That means the trucks are braking the entire unit and the heat was also one problem what was coming up. So that the pads, the brake pads on the disks, were also very easily worn out, or after a relatively short while, indicating that we have too much heat inside the housings.
Q And from the standpoint -- we've talked about this wind tunnel test that Krone did. When the trailers were put out on the highway, did your customers realize the energy efficiency that you -- that you thought the wind tunnel had said they would be able to obtain?
MR. COCO: Objection, form.
A No. Because due to the weight increase of the construction as such, the tire weight was heavier and was eliminating the -- first of all, in theory, discussed in the wind tunnel, discussed a fuel consumption of around about 1.2 liters per 100 kilometers. So it was completely eliminated.
There was, in fact, no -- no differences in fuel consumption on that particular trailer to a normal trailer.
Q Okay. So it was just kind of a -- it was kind of a -- just a -- just a wash?

A Yes.
Q After -- did -- is Krone -- if I understood what you said earlier, Krone started making fewer of the Safe Liners as time went by? Is that correct?
A That is correct.
Q And did the customers that bought the fewer numbers, did they continue to experience the problems with the cracking and with the brake overheating, those type things? Did that -- did those complaints continue to come in?
A Yes.
MR. COCO: Objection, form.
A In fact, we have had the first customers experiencing the Safe Liner around about for a year, that they came back and said, "Is there any possibility that you take these trailers or this trailer back, because we are not happy with it. The maintenance is much higher than on a normal trailer."
So the first ones were already mentioning that after around about 12 months of use.
Q (BY MR. BOOK) Did Krone, in fact -- what did Krone do in order to satisfy their customers in regard to these 387 trailers that Safe Liners that were made?
A Let's say -- first of all, we have said, "Okay. All this -- this money was spent for this development."

It's a good -- it was a good marketing campaign on the one side, but we -- we came already, then, very quickly to the conclusion to buy these trailers back and -- and to change them to new normal trailers. And we did it in a very smooth, quiet way, let's say. We have not, of course, announced anything in the press or something like that. We did it in a very quiet, I think elegant way. The customers were paying only the use of the trailer, let's say for 12 months if they would have rented a trailer. We put that amount, monthly amount, as the basic calculation into consideration. We took these trailers back and we delivered nearly to 100 percent new trailers instead.
Q And the Safe Liner trailer, Krone Safe Liner, that had been out on the road, the steel and everything that was in them, what happened to it?
A We -- we dismantled them completely and they went into steel that's mainly to a steel mill or something, and maybe they are running today as normal trailers again in -- on the road. I don't know.
Q Where they got put back into -- into the trailer?
A Into the trailer, maybe, as the main steel or major steel beams.
Q So if -- if a person were to testify that a

safe side guard restraint design, such -- and point to the Krone Safe Liner as being such a design that's out there in the world today, would that be a correct statement of fact?

MR. COCO: Objection, form.

A Yeah.

Q (BY MR. BOOK) Would that be true, that -- is it out there today?

A That is -- no. There is nothing available in the market today, European or even worldwide. I don't know any case who have anything else or a similar thing created as we have done.

Q Okay. And does Krone -- when is the last time that Krone even offered the Safe Liner to the public?

A That was -- the last seven went in 2003. If I remember correctly, into the Republic of Slovenia because there was a customer using that specially for marketing campaign as well because the lettering was a beautiful thing on the planks, but he was not really -- he explained to us that he is not running them under full load. So we accepted that. That was the last seven units we ever produced, but I must state also that these units came back to us later on, in any case, because the cracks was also arising.

So we have had the first cracks to repeat

that after around about 50,000 miles, the first cracks. These were the customers who were running under full or nearly full payload.

The other ones were running under volume -- with volume goods that took longer before the cracks were arising, but the cracks were all in the same places later on.

I have that here in the -- in the drawing as well to show where we have had all these problems.

Q So was the Safe Liner design -- did it turn out to be technologically feasible?

A It was so that we said, "We have to withdraw it. It's not proper to move further on. We can only lose money with these constructions," and we don't see -- there was even -- in the meantime, so don't forget 2003 we have had the last seven produced. We have now end of 2006, there's no discussion in our house that we will start maybe here in three, four, five years time again. This animal and this test is completely killed.

Q It wasn't a success. Is that correct?

A It was not a success. It was a bad reputation for us because it's the first time that we have to withdraw a complete construction from the market. It was not a good reputation for Krone, and we were quite

proud, later on, that we could cover that a little bit and that this was not coming to the public. So that is it one of the reasons why I came over, because I heard two weeks ago, the first time, with Glen, that he was explaining that somebody wants to create a similar Safe Liner construction, or something like that, in the states.

I said, "Fine, but we will not give any license or whatever to -- or copyrights to somebody else because we know that could kill only our reputation."

Q And did Krone also have concerns, when they withdrew it, from a safety aspect standpoint?

A Yes, because we have also the production reliability in Europe, and that is relatively high from the producer standpoint. So if something arising later on, we are responsible for that. And knowing that it comes to emergency brakes all of a sudden, nobody is aware of such things, it could come to major accidents as well, and we are quite -- no, we are not quite proud. That is wrong, but we are quite happy that no real accidents were arising throughout this time with these trailers.

Q Now, you brought some drawings here. You've made reference to them several times. Is there a drawing -- are there drawings that show, on the frame,

where the various places that Krone was experiencing these cracks in their Safe Liner?

A Yes. That is Exhibit 5 and Exhibit 4, and, of course, Exhibit 3 as well. The drawing, as such, of the Safe Liner without the running gear.

Q And this is Exhibit 5?

A That is Exhibit 5.

Q Okay.

A That's here on the table now.

Q Why don't we see if we can get this shown --

A To the camera.

Q -- for the jury. I'm sure that the judge is going to let us show this to the jury.

A That's the construction as such.

Q Why don't we show the jury the -- what are these red dots on Exhibit 5? What do they show, Mr. Sanders, these red dots? What are those to represent on Exhibit 5?

A So these are the -- the red spots here are showing where we have the cracks. First of all, these three are mentioning the axles over here, three axles.

The major crack was arising in this edge. Even with reinforcements, we were not able to overcome that.

The second was in these areas here,

because the movement and the vibration of the trailer is too -- or the trailer, as such, is too stiff from the construction point of view. So the next cracks were arising here.

And you were asking if would maybe have a complete breakthrough. We have a picture in there, which we showed also to the camera, that's exactly this beam here that can break entirely. So that the crack is going through the floor up to the top, and that means you have two pieces on the road all of the time.

Q What's this dot here?

A So this close to the kingpin area because here we have relatively stiffness due to the 5th wheel plate from the traction -- from the truck unit. So that means all the movement is eliminated over here. We say also this zero line, and, of course, everything is stopping here and creating the next crack over here. Just in the indicated area. That's only the chassis frame as such. We have no -- not the running gear underneath now.

Q We ain't got to the running gear yet. So if we look at cracks that were being experienced and count these dots, there's one, two, three, four --

A Four major dots.

Q -- four --

A Four major dots.

Q -- in the frame. And, of course --

A Yes.

Q -- the other three, you say, are the running gear, and we'll get to that now. And that is Exhibit 4?

A 4. So this running gear will be assembled separately later to the mainframe.

Q And when we say "the running gear," we're talking about getting wheels on the ground?

A Yes.

Q Okay.

A So you see the wheels -- I don't know if the camera can show that.

Q He can slow it. He can show it.

A The wheels are here.

Q All right.

A The tires are running in this framework.

Q Okay.

A So -- and this is then completely fitted underneath. Remember, we don't have any longitudinal beams. Otherwise, you have normally hanger brackets and you weld that to the longitudinal beams.

Q All right.

A In this construction, it is not possible to do so. So here we have the other major joints where we are getting, then, the correction from the running gear from

the axle part.

Q Now, when you ran all this stuff in the computer lab, it didn't tell you about this?

A No. No. You cannot calculate that exactly. You can calculate it under normal stress calculations, yes, but under operational conditions, you cannot calculate anything, all -- all these subjects together.

Q So all the variables that are out there when a trucker is going over the road and loading -- carrying freight all over Europe, there is no way a computer can take all those variables?

A No.

MR. COCO: Objection, form.

A No, no. The technical side has to show -- the operational side has to show it. We have so many different road surfaces in Europe, so many different vibration frequencies in the trailer, twisting, torsion, everything, that only the practical side shows, after a certain while, the existing sophistication of the --

Q (BY MR. BOOK) You've got another drawing there. What does that show?

A That is --

Q Exhibit number on that one?

A This is Exhibit 3.

Q Okay.

A That shows, also, then in combination with the assembly of the running gear now the other major cracks, in which areas they were arising.

Q Are these additional cracks?

A These are additional cracks as well. You see that we are coming here. We've seen an area here in the kingpin. We're talking that we have some problems over here with these -- in this area of the cross members, but you see even just beside the gooseneck here that we have had also some problems there.

Q Okay.

A So if you take all these red spots together, then you see already that only a reinforcement here or there is not helping us in total. So we have to think that the major construction was -- was not correct, unfortunately.

Q And Krone bought all the trailers back?

A We bought them all back, yes.

Q But there -- but there weren't -- you've told us that right now Krone is making around 30,000 units a year?

A Yes.

Q So it was a -- a tiny part of your production. Would that be true?

MR. COCO: Objection, form.

A It was only a small -- it was only a small production, fortunately. Otherwise, it would have changed entirely to a serial production that would have maybe killed, commercial-wise, our company.

We were at least happy that we were only starting with such small proportion so that this investment was not so critical for us financial-wise.

Q (BY MR. BOOK) The current Krone trailer -- does the Krone trailer, of any configuration, be it a box trailer -- and does Krone make a lot of different kind of trailers?

A Yes.

Q Do any of the Krone trailers have a side guard protection to protect from automobile vehicle intrusion?

A No.

Q Now, does Europe require any type of side guard protection, the European -- what do you y'all call it, the EU?

A Yeah.

Q The European Union?

A European Union, yes.

Q Okay. What -- what -- does it require any kind of side guard protection?

A Yes. We have a side guard protection, but we call that only bicycle side guard protection. That

means this side guard has to fulfill, and that has received approval, 200 Kilos, metric kilos. That is around about -- what is that, 300 -- 300 pounds? Around about 300 pounds. So that is only bicycle protection.

That effect -- I have also some drawings here that's, in fact, only a metal plate, nothing else, where you can put low boy or lettering on it, but it is really protecting only bicycles, nothing else.

So in case of a car crash, there's nothing which is protecting or eliminating such an accident in Europe.

Q Now, you have told us about the various parts of the world that Krone's trailers are sold. Do you know any of Krone's competitors, or anywhere in the world that sell a trailer comparable to the Krone that has side underride guards on it?

A No. No. There is nobody. We have only in England, but that has only the sign reasons. We have only in England some plastic skirts outside, but that has nothing to do with any side protections at all. That is a GRP fiberglass that is normally erect. The British side likes that, but has no further -- or safety protections at all.

That looks very similar to a Safe Liner. Maybe you have seen something from magazines in England.

Sometimes you see Eddie Stover, for example, one of the largest transport companies, has that as an image -- or should I say corporate identity on their trailers, but has nothing to do with any protection at all.

Q So that's made out of some type of composite Fiberglas or --

A Fiberglass composite, that is all. So the European community has only this side protection today, in all countries, and that has also been accepted and located in Russia, or Ukraine, or whatever it is, and with these 200 -- 200 kilo side protection, but that is a metal steel and -- steel metal, but not very long. I have some pictures over here --

Q You brought that with you. What exhibit is that that's got the bicycle guard?

A Yes. The exhibit is the Profi Liner, Exhibit 2, where I have done the equal drawings to a Safe Liner, how a normal standard trailer is looking today in Europe.

Q This is a Krone trailer made today?

A This is a Krone trailer today, but I can talk here also for the other trailer manufacturers in Europe. The construction is nearly normal today.

Q All right. Where -- can we -- can we hold this up? Is this what we're talking about? Where is --

A The side protection. It's shown over here, but it may be, for the camera, a little bit too small.

Q He can do that, I believe.

A So that is the entire side protection today.

Q All right.

A That is in front of the spare wheel carrier. So you can't -- that is hingable so you can reach, later on, the spare wheel, and you see the entire protection here, even at the side.

Q Okay. So I -- that's the 200 kilo bicycle guard?

A That is the 200 kilo, and we put normally with -- we print in here our name as well as the side.

Q Okay.

A That's normally a white plate.

Q And that is Exhibit 2?

A 2.

Q Okay. Now --

A That is the -- in comparison.

Q If we look at Exhibit 6 here -- what's Exhibit 6?

A Exhibit 6, that was also a request I saw later on. That is an old Safe Liner leaflet and it's in English, which we have prepared it -- don't kill me, now -- '99, something like that. It's an old Safe Liner

leaflet.
Q Okay.
A Including behind that is also a description, technical description of the vehicle as such.
Q And this Exhibit 6 that actually you brought -- actually, this you brought because you left the office, but you were trying to get what you could get on this list that's reflected in Exhibit 10?
A Yes, correct.
Q And so --
A If I understanding, if I have to explain something, I need some technical details, drawings, or photos, or whatever. Otherwise --
Q And Exhibit 6, if I understand your testimony, this product has been totally withdrawn from the market by Krone?
A Absolutely correct, yes.
Q Okay. Now, what about this exhibit here, No. 8?
A No. 8. I put some marks on it. Disadvantage of Safe Liner again. Additional weight, material, design complexity, limited ramp angle, forklift loading, possible damage of the side covers.
Q Were y'all having those problems?
A That is another problem. And no Huckepack, or

piggyback operation possible. I must state that's maybe not known to you, that around about 40 percent of all the road operated semi-trailers in Europe have to have also possibility for RoRo ferry traffic, because it goes by ferry boat, in Scandinavia, into -- or Northern Africa from Italy into Turkey, and so on. So we have a problem over there with this kind of construction because we are not getting enough ground clearance at the rear, depending what kind of water level we have at the ports, and also, in the center of the trailer because if the rim, due to see level, have a very straight angle forward, they cannot move on to the ships. So a Safe Liner construction is very, very difficult to enter -- to enter a ship.

The second item is we have piggyback or Huckepack traffic that -- we call that railway operated traffic, where we put -- and we lift the entire trailer to a railway wagon.

The so called pocket wagons, as we have them in Europe, have their major steel beams outside and we are then touching, in this moment, with the Safe Liner construction, the wagons, and we cannot feed them into these wagons. So also, this kind of traffic has to be eliminated by Safe Liner construction.
Q Even if you hadn't have had all of the

structural problems, where the frame was cracking or -- on a regular basis, there were other technological problems that you had not kind of foreseen?
A Yeah. We have foreseen. No, no. We have foreseen because we cannot not entirely change only to Safe Liner construction in future because we have a handicap on these particular traffics.

So that means we were not believing that we could maybe move over to Safe Liner constructions in total, let's say, in a couple of years' time.
Q Okay. I think I understand you now.

Even if -- even if this design had been totally engineering technologically feasible, the side underride protection, you were not going to be able to use all Safe Liners?
A No. No.
Q But you weren't -- you weren't --
A That is not possible.
Q You were not able to -- but once you found out about the technological problems, you had to withdraw the product?
A Correct.
Q Okay. Now, this is in German and --
A Yes.
Q -- I'm not too good at speaking German, so --

A So let's say in -- we did a study in 1975, also. You were mentioning that we are a long time investigating in the Safe Liner. So we have had, at that time -- in '75, we were investigating how many people were killed in car/truck accidents in Europe, and we found out from these statistics that by 1 billion kilometers, that is equal to 650,000 miles, 49 people are killed in Europe. That was in 1975.
Q So that's all -- all -- every kind of truck --
A Yes.
Q -- automobile --
A Automobile, everything.
Q Everything.
A 1 -- 1 billion kilometers. So -- and this statistic shows then to 1995 -- or '94, if we look here exactly into the -- including these figures, that this came down to around about 20 persons killed by 1 billion kilometers.
Q So it's coming down?
A So it is coming down without, let's say, a Safe Liner construction. Why? In '75, of course, we have had no airbags or whatever. Even seat belts were not common. So all this crash zones on cars were better and more created than before. So that means the entire traffic figure, or accident figure, came down already

from 49 persons killed in '75 to 1994 to around about 20.
Q Okay.
A So that was a figure we were -- as we started investigating the Safe Liner construction that we were also taking a little bit of review what is the statistic right now.
Q Okay. Now, let me ask you -- well, this trailer -- I don't know if you know this or not, but the trailer that is being -- that's the subject of this lawsuit was made in 1992.
Did Krone, in 1992, even have, in the research and development stages, the Safe Liner in '92?
A No.
Q Okay.
A We were not even thinking about that.
Q Okay. I mean, it wasn't even entering your mind in '92?
A Uh-huh.
Q Correct?
A That's correct.
Q Okay.
A That's absolutely correct.
Q Now, let me just ask you this question. You've got some pictures here, also --

A Yeah.
Q -- of actual crashes?
A Of course, that was, let's say, where we have had some press releases, some conferences that were from November, 1999. So where we have had some -- we indicated some ideas about the Safe Liner construction. What we did here that, unfortunately, all in German, but that is also not important. That also mention even fuel consumption 1.4 liter of 100 kilometers, but that was all in '99.
Q Did that pan out or did that come to fruition?
A No.
Q Okay.
A No. So we have taken out the pictures here that one other aspect was that if you have a wet surface, road surface, that you have no spray because the housings are completely closed. So you see on this photo, this was a certain advantage because if cars are overtaking a Safe Liner combination, there's not so much spray during takeover so that you can really see something.
Q That was something that y'all were kind of promoting when you first started trying to sell this product?
A Product, yeah.

Q Okay.
A So that was only a small part -- aspect as well.
Q Did you find out later, though -- when you were talking to us about these brakes overheating, when you were putting this out when you first started the Safe Liner, did you know about that problem?
A No.
Q Okay.
A No. Not yet. So let's say if you have rain on the road, of course the braking problem is not arising so much because you have a certain cooling.
Q You're water cooling it?
A Water cooling.
Q Okay.
A On that particular subject.
Q Okay.
A So then you see that also here, that is a truck we forced in with a speed of around about 20 miles per hour into the rear part.
Q Okay. You're showing how you can run into it?
A Yes.
Q Okay. This is in '99?
A This was in '99.
Q Okay.

A The second test we did also with a car of 50 kilometers per hour. That is around about 35 miles per hour, from the rear.
Then the tests were made with a car from the side. So that was, of course, our goal, I guess.
Q All this is going on in 1999?
A All in 1999.
Q Is that before you learned about this cracking problem?
A That is absolutely correct.
Q Okay.
A So I told you something about these statistics about killed persons. That makes it maybe also believable where we have the problem altogether, in United States or in Europe doesn't matter. You see here on this particular picture the problem between truck and cars in general.
Q And so --
A The major construction is always in these areas. So -- and the best crash part is always the red -- the red line here.
Q That's the best place, if you're going -- if you're going to run into something --
A Yes.
Q -- that's the best place for you to hit it?

A Of course.
Q Okay.
A The best thing is then, of course, if you take this line and you continue that all the way through here, then you can reach some safety.
Q And so was that another selling point that Krone thought they had --
A Yes.
Q -- for the Safe Liner?
A That is exactly. This picture here, again, this photo here, with a truck at the same time with a car as well --
Q Okay.
A -- that we are talking here about the same -- the same level.
Q And again, these were all good ideas, but when it was put out on the road, did it work? After you put it out on the road, from the standpoint of being technologically feasible, did it work?
A It was work -- it was working in the sense of safety requirements, but it was not working in the sense of construction as such.
Q As far as being able to work the truck?
A Yes.
Q Now, you found another safety problem that was

created, that you weren't aware of, when the frame started cracking, correct?
A Correct.
Q Okay.
A Because that was absolutely not in our mind and in our brain that such things could arise.
I was talking a little bit about the old and still existing construction today. That is more than one 100 years old. Altogether, doesn't matter if we are talking about trucks or trailers in Europe or in United States.
Here, on the other one, on this particular drawing, you see the space frame. That is the truck unit again. Here are the two major beams, cross members in-between. That is the left side drawing. And then you have the space frame.
You see the major difference, because you have no main beams here. That is the Safe Liner. This one is the Safe Liner construction.
Q Okay.
A So the other pictures are only explaining a little bit about side protection by -- with a bicycle.
Q That -- that one showing the bicycle, that's actually what y'all have today, right?
A Yes. So -- and that is maybe also interesting

for you. That is a typical accident arising between truck and car.
Q Okay.
A So these are facts we took into consideration in '99, before we came out with the -- with the Safe Liner construction. So that is all Exhibit 8.
Q Okay.
A Put those into the folder.
Q Was this part of it, too?
A I'm sorry?
Q Was that part of 8 right there?
A No, that was my -- my notification to come today to --
Q Okay. Well, that was in there, though.
A It was in there. That was in there.
Q Well, let's kind of keep it in there.
A Yeah.
Q And I want to ask you a little bit about that.
A So I have again prepared here some drawings without the crack points, that is Exhibit 9, because we're asking, in the beginning, what we call a boogy. That is the running gear again, with the tires in there as shown already in the drawing, without the axle and the tires.
And this is the space frame again.

Q For the Safe Liner?
A For the Safe Liner, in a computer drawing, to make it more transference where the major difference are.
Q Okay.
A So that is all in Exhibit No. 9 again.
Q Okay. In summary, Mr. Sanders, Krone had an idea that -- to try to do something about side underrides and rear underrides on a trailer -- tractor trailer, correct?
A Correct.
Q And they tried to market it commercially but that turned out to be a failure?
MR. COCO: Objection, form.
Q (BY MR. BOOK) Is that correct?
A Absolutely correct. Absolutely correct. That was our tragedy, that the first time in history that we have to took back a complete construction and that would saw no possibility to renovate it or to recondition it -- or reconditioning on the construction to bring it then into the market again.
Q And after 2003, after that year, Krone has not produced any trailers with side underride guard protection for automobile. Is that true?
MR. COCO: Objection, form.

A No. That's absolutely correct. That is absolutely correct.

We are also not showing that on exhibitions, or we are not talking about that any longer. That animal, as I said, is completely dead in our house, and nobody from the business, so we're not starting again with this kind of project.

Q That may sound kind of simple because you've answered the question, but I want to make sure I've got it in a presentable form.

When did Krone discontinue the production of the Safe Liner.

A Yeah. As I say, that was beginning of 2003, with the last seven, which we were normally not producing, but only for a special request we produced that. So let's say the production, as such, ended in end of 2002.

Q Okay. And today, does Krone make any trailers, of these 30,000 that they sell, with side underride guard protection for -- against automobile intrusion?

A No. No. We are sticking to the regulations and the EC laws, which are existing right now, and that's it. We have no -- no further movement, no further activities in this direction.

Q All right.

A In the moment, the entire improvements are going to load securing. That is a huge (Phonetic) in Europe, and to extend longer vehicles to 20.5 meters. What that means, we are not touching the semi trailer as such. We are only coupling two units together.

There is -- also, Krone is heavily involved in the moments, in two and a half years, but we have to convince the politicians to bring that through, and that is not easy.

Q Okay. Now, we're here in Houston, Texas, today, correct?

A Correct.

Q And we're in my office, Bill Book's office, correct?

A Correct.

Q You've come all the way from Germany, correct?

A Correct.

Q You stayed over here and so that everybody understands, our office, if you look out the window, you can see the Four Seasons, right?

A Correct.

Q You stayed over there last night?

A I stayed there overnight.

Q And our law firm is paying your hotel bill, correct?

A Right.

Q And we paid for you an air fare, correct?

A Also correct.

Q We have not offered to pay you one red dime to come over here and give your testimony, have we?

A No. No, because that was our own intention in Krone, that we discussed it, as we heard that this case is going on that we have said, "Okay, come over," because, you know, by internet we have global connections today, and in the world, and we don't want that the Safe Liner discussion is starting again because we have had failed. We have tried to overcome the best reputation we have had at that time. We did it, as I said already, in a, I think, elegant, smoothly way with our customers, fortunately, and we want not to bring that up again because that animal is over and we hope to forget the entire story because it was not such a good thing for the Krone image.

Q And in fairness, I have -- I have advised you that in our case, this case that is being tried in Carthage, Texas, the Lufkin Industries case, that the experts for the plaintiff have referenced the Krone design as being a design that is feasible and that is -- can be used, correct?

A Correct.

Q I've represented that to you?

A Yes.

Q And is that -- is that the case?

A That's absolutely true that you explained that to me what is in the --

Q But is it true that it would be correct or accurate for someone in America to represent to a jury in Carthage, Texas, that the Krone design is a viable and usable design today?

A No.

Q Would that be fair?

A No. Absolutely not. Not the case.

Q Okay.

A Absolutely not the case.

Q And you talked, as you've told the ladies and gentlemen -- or you've talked to me about this, you've talked Glen Darbyshire about this. Are there any other lawyers, dealing with this case, that you've talked to?

A No. Nobody else.

MR. COCO: Five minutes.

MR. BOOK: Okay. I think that's all I have to ask you, Mr. Sanders.

I think we ought to take a break, or at least I need to take a break.

MR. COCO: Yes.

THE VIDEOGRAPHER: We're off the record at 11:40.

(Recess taken.)

THE VIDEOGRAPHER: Beginning of tape 2. We're on the reason at 11:48.

EXAMINATION

BY MR. COCO:

Q Morning, Mr. Sanders. My name is Chris Coco and I represent Kelleigh Falcon and her family in this case that Mr. Book's been talking to you about.

I do have a few questions for you, and if at any point you have any trouble understanding me --

A Yes, sir.

Q -- just please say so --

A Right.

Q -- and I'll try to fix it.

A Okay.

Q And I appreciate your time this morning.

You might see me looking over at my computer every ones in a while. That really doesn't have anything to do with you. I'm just keeping with the score of a football game. Okay?

Now, I believe you told us that you are the Sales Manager For Export for Krone. Is that correct.

A That is correct.

Q Can I take that to mean that you are responsible for the export of Krone trailers outside of the country much Germany, throughout the area that you sell them?

A To all -- all countries, yes.

Q Okay. And you've held that position for how long?

A Since the beginning in November, '80 -- October '80 -- sorry. October, '80 -- 1982.

Q Okay. Now, since the time that you've been at Krone, have you ever worked as an engineer for Krone? I mean --

A I'm influencing because due to my travel and to my contacts, because we have imported our own people all over the places, and I am every week somewhere on the road. And if I see some aspects coming in, technical aspects, then I'm influencing also the construction.

Q Okay.

MR. GOMEZ: Objection, form, responsiveness.

Q (BY MR. COCO) Sir, did -- are you, as an engineer -- or have you ever been an engineer for Krone where you were responsible for the design of any of the

Krone trailers?

A No.

Q Okay. And if I understood your testimony earlier, would it be fair to say that if you saw some innovation or something out there in the field, you would come back --

A Yeah. Because we live from these points where all these discussions with customers, where they have maybe new ideas, so that we are trying to integrate that into our construction.

Q Okay. So if you see something out there, you might it take it back to the engineering department and say, "Hey, I saw this. Y'all might want to think about this"?

A Yeah, or I have already some ideas in my mind on how we can transfer that into our construction.

We have a different world in the trailer business, generally, between European and America. The American trailers are very simple.

In Europe, we have a variety for each and every transport. If it is paper rolls, or if this is a tire transport, or whatever it is, it's a completely different world.

That's also the reason why we are -- cannot export our equipment to the United States --

Q Okay.

A -- today.

Q Okay. Now, with regards to the Safe Liner, did you have any responsibilities at all in the design of that trailer?

A No.

Q Okay. Do you have any engineering responsibilities as that trailer was in production?

A No. No. This was done by separate people in our house.

Q Did you have any involvement in any of the testing of the Safe Liners throughout the production process?

A I was present. I was present in some of the testing facilities we have very close to our factory.

Q Okay. Was that the crash testing?

A That was the crash testing, in fact, and that was also the normal speed running. We have a huge oval that is owned by Mercedes, or was owed by Mercedes, today by Karmann Ghia, and we can use, and we use that facility. That's very nearby our facility.

Q Okay. Now, after the -- that production of the Safe Liner started, and you talked a little bit earlier about the decisions that were made when some of the problems came up, were -- who were the people that were

involved in the decision making process as to pull the plug on the program, so to speak?
A I was there. We are -- we are working as a team. So -- and don't kill me, speak to five, to six, seven persons.
Q Okay.
A I don't remember. That varies a little, but sitting on the table and -- during the entire discussions and decision.
Q Sure. Okay. Now, you mentioned earlier that at least with regards to your participation in this case, that was the result of a phone call from Glen Darbyshire?
A Correct.
Q Okay. And when did that telephone conference take place?
A That was two weeks ago. I think you find that also in some of the --
Q Okay.
A -- because -- that was two -- two weeks ago.
Q Okay. And what did Mr. Darbyshire tell you whenever he called you?
A He said, "First of all, are you quite aware about the Safe Liner aspect?"
I was a little bit shocked because the

Safe Liner thing were dead in our house.
I said, "Glen, what is going on?", knowing him since Wabash times a little bit.
And he told me something, that there was a court case going on, and we discussed it that in our house as well and said, "Okay. That can't be." We -- we have to come over, or somebody has to come over, maybe to explain a little bit verbally and with some documentation why we are not continuing this Safe Liner idea."
Q Now, you mentioned that you worked with Mr. Darbyshire through Wabash or you --
A No. That was only the connection, because he is a friend of John Gams. John Gams is a very -- or the closest friend of the former founder and major shareholder, Jerry Elly. So these are the connections, because as I said, we have imported especially reefers, and they call it dura plate dry liner box vans from the states a couple of years to Europe.
Q Now, how long have you known Mr. Darbyshire?
A I don't know at what time differs to telephone -- I don't know him personally. Only by telephone calls. Maybe two years.
Q Okay. I mean, you know how to get a hold of Mr. Darbyshire if you need to talk to him?

A I have his telephone number, of course.
Q Okay. And he's called you from time to time prior --
A Yes, of course. Why -- he and John Gams. Sometimes John Gams, the old attorney. I think he's not longer active today.
Q Okay. You're talking about in his capacity as an attorney for the Truck Trailer Manufacturers Association?
A Yeah.
Q Here in the United States, correct?
A Correct.
Q Okay. So prior to the two week ago phone call from Mr. Darbyshire, you had talked to him on the phone before that time about various --
A He told me only about this court case. And then there was a second -- or there was a conference call later on that was not reorganized where -- or Mr. Book was in the background as well, wire, the telephone line from Glen Darbyshire.
Q Okay.
MR. GOMEZ: Chris, excuse me, gentlemen.
Mr. Sander, if you could allow Mr. Coco to finish his question before you answer it, because I'm having a little difficulty understanding the question

and then your answer. So you could --
THE WITNESS: Okay.
MR. GOMEZ: -- allow him to finish the entire question and then you can answer his question.
THE WITNESS: Okay. No problem.
Q (BY MR. COCO) It's hard for him to take down as well --
A Yeah --
Q -- when we're both talking.
A He told me that. Sorry.
Q Sir, my questions for you was that I understand two weeks ago Mr. Darbyshire called you about this case. My question was to you, though, prior to that time, had you ever spoken on the phone with Mr. Darbyshire about other issues, not this case?
A No.
Q Okay. So two weeks ago was the first time that you've talked to him, correct?
A Yes.
Q Okay. And now you explained to me that -- I believe that you knew somebody that he knows, or explain to me how the connection was made.
A Yeah. Let's say the connection -- the connection, generally, is coming from Wabash in Lafayette.

Q Okay.
A And -- and John Gams was -- was an attorney there and close friend. I know him personally. Close friend to Jerry Elly, the founder of Wabash.
Q Okay.
A Still the largest producer of trailers in the states --
Q Okay.
A -- to my knowledge.
Q And Mr. Darbyshire knew him and so --
A The world is too small.
Q Yes. Okay. And prior to Mr. Darbyshire's call, you were aware of the Truck Trailer Manufacturers Association here in the United States?
A That is also because I'm getting all the -- the most important magazine for us is Body and Builder that the editor is Paul Shank. We know him personally since long, long time, and he was just over to the automotive exhibition, IAA, in Hanover. We finished that around about three weeks ago on the 29th -- 28th of October -- of September. Sorry. Of September. And we have discussed everything, or a lot of things during even dinner, what is going on in the trade here.
Q Okay.
A Trailer trade, of course, in the United States.

Q Now, when Mr. Darbyshire called you, was it just -- did he just call you out of the blue, or had somebody called you and said, "Hey, this fellow is going to a call you. You need to talk to him," or anything of that nature?
A No. No. He called me on by mobile telephone.
Q Okay. So he was able to find your cell phone number and he called you?
A Correct.
Q Okay. Okay. What did -- and then you told me that sometime later there was a phone conference between Mr. Darbyshire, you, and Mr. Book. Is that correct?
A That is correct. That was last week.
Q Okay. Do you remember what day last week?
A I think that was on Thursday. Is that correct? Because I was in the other factory. It was the first day, also, by mobile -- my mobile.
Q Okay. And what was discussed in that phone conversation?
A It was discussed, first of all, it's maybe worth to come over for two, three days, to Houston. It was discussed where we have had the major problems on the economical said, on the -- on the technical side. That was discussed. I said clearly it's the technical side, first of all.

The economy is a different issue because we have not to talk about economy if the technique is not correct.
Q Okay. So the things that you've talked about today with Mr. Book, in response to his questions, were those the topics that were discussed in this second phone conference between you, Mr. Darbyshire, and Mr. Book?
A Yes. More or less, yes. We had, in fact, no drawings or whatever on the table, so we discuss it only.
Q Now, when you first spoke with Mr. Darbyshire, did you explain to him all the things that you talked about with Mr. Book here today?
A No. No. Not so far in detail.
Q Okay. Was he aware of the problems, or the issues that are the subject of your testimony, when he called you?
A I don't know. If he was aware about everything, I don't know.
Q Okay. Well, when he called you -- I mean, what did -- what did he say to you? Did he say, "Hey, you know, have you had any problems with the Safe Liner?", or did you call you and say, "Hey, you know, I know you might have had some problems. Can I talk to you about

what they were?" I mean, what was the nature of the conversation?
A Well, the nature of the conversation was definitely that he was knowing, maybe, a little bit in the background because, let's say with Jerry Elly, the former owner and founder of Wabash, he was -- he was informed about the Safe Liner construction because it was discussed in 1999, also, to put the box -- the reefer box of Wabash, maybe, on a Safe Liner chassis.
So he was aware that we were failing at that time, definitely. So I think that Mr. Darbyshire was knowing that already. I don't know any details, but he was knowing that at least we have had technical problems.
Q Okay. Now -- and you're aware that Wabash is a member of the TTMA?
A No. I don't know exactly the connections and memberships of the associations and the background.
Q Okay. Now, when did you come to Houston?
A I came on Thursday afternoon.
Q Okay. And I guess when you -- when would it have been that you would have left Germany?
A Thursday morning.
Q Okay. That's what I was thinking.
A I need more -- more on my way back now, because

I'm leaving here tomorrow and I will be back on Monday --
Q Okay.
A -- in Frankfort.
Q Okay. Now, when you arrived here in Houston, did you go straight to the hotel?
A Yes.
Q Okay. And Mr. Book already told us that they put you up in the Four Seasons over here, correct?
A That's correct.
Q Okay. A nice hotel? I'm sure you were comfortable?
A Let's say it's a typical hotel. We have all -- in the entire world, the Four Seasons is very well known, like the Kempinski or whatever.
Q Okay. Now, once you arrived here, did you come over here and meet with Mr. Book, or did you meet with him?
A I was yesterday here. Yes, I did.
Q And how long did you meet with Mr. Book yesterday?
A I don't know how many hours. Was it maybe five hours in total? Four hours, five hours.
Q Okay. And did y'all go over the substance of what it was that you told Mr. Book here today when he

asked you the questions?
A We were talking about items, where we have the problems or how the problems -- yes.
Q Okay. Now, you brought all these materials with you today. How is it that you came to bring those materials with you?
A It's from me so understanding. Let's say that I'm not coming paperless to a meeting to explain something, because I prepare them myself. I think it's understandable.
Q Okay.
A Even not knowing your e-mail, which arrived too late at that time, but I said, "I have something in my briefcase in any case" --
Q Okay.
A -- which you have here on the -- on the desk.
Q Okay. Now, you mentioned earlier that it was represented to you that someone in the United States was trying to utilize the Safe Liner design. Do you remember that testimony?
MR. BOOK: Object to form.
Q (BY MR. COCO) What was it that you told us, if that wasn't it?
A Glen -- Glen, I think in the first telephone conversation, told me that there is a court case going

on, but at that time, I even was not informed about what kind of trailer manufacturers it was or whatever. I heard that only here, that it is Lufkin, and I was asking how many units they are producing so -- to get only a short picture.
Q But what I'm talking about earlier is you testified to the effect that it was your understanding that someone was trying to utilize the Safe Liner design and that, in any event, y'all wouldn't license it. Do you remember that testimony?
A Uh-huh.
Q Okay. Where did you get that understanding from?
A I cannot answer that, quite honestly. I heard -- the entire story was that I heard that there was some accident -- or an accident arising somewhere with a truck -- with a trailer. That it is an old trailer from '92 I heard only here in the states. That this is in question, and I have had no ideas about the background. The question to me was, "Are you still producing Safe Liners in Europe?"
I said clearly, "No."
Q No. And I --
A Yes. And --
Q And I understand that, but what I'm -- what I'm

asking you, and it's on the record, but you testified to the effect that someone told you that -- or it was your understanding that someone was trying to utilize the Safe Liner design and then you specifically said that -- that in any event, you wouldn't license it to them because --
A That's what I said this morning.
Q Right.
A Not -- not before. I said that only here on the table.
Q I understand. But my question to you is is that you said that it was your understanding that someone was trying to utilize this design and I'm trying to get where it is that you got that understanding from?
MR. BOOK: I object to the form.
A Yeah. Somebody told me that this -- that this could be -- maybe happen that such design should be taken as the basic construction over here.
Q (BY MR. COCO) Okay.
A Is that answering your question?
Q Yes. And who told you that?
A I think that was maybe in the first telephone call with Glen that he told me that.
Q Mr. Darbyshire?
A Yes.

Q Okay. I mean, was it your hope that you could come over here and help Mr. Darbyshire with this case?
A No. And I told you that we were discussing that in a -- in a short moment in our house, on our office, and that we have said we don't want this coming up, this entire Safe Liner question is coming up again, talking about global world, internet connections, press releases, or whatever comes up. It is automatically transferred to Europe, or to Asia, or to other places in the world.
Q In trying to prepare for the deposition today, I went on the internet and tried to find some mention or some information regarding Krone's discontinuing of the Safe Liner program, and I'll represent to you that I was not able to find anything. Is that by design or accident?
A No. No, no. That is completely taken out. If you have looked to our home page, or something like that, completely taken out. That's --
Q I understand, but I was looking for articles, or press releases, or anything that talked about you no longer making this trailer and why, and I was not able to find anything.
A No. No. That's what I said. We did it in a -- maybe smooth, eloquent way with our customers.

They were so loyal to us that this was not really published, and why should we then create an official statement saying we have stopped everything due to this and that problem?
Q Okay.
A Makes no sense.
Q Well -- and I guess what I'm trying get at here is is that the average individual over here in the United States, if they wanted to get information about Krone's discontinuing that program, that would be kind of hard to do. Is that correct?
A That is correct.
Q Okay. Now, with regards to the Safe Liner -- and we'll talk about it later, but there was a lot of press and hoopla about it when it first came out. And, you know, I see words like "innovative" and that kind of thing, but my question to you is is that what was the main goal of the Safe Liner? I mean, what was -- what was the purpose of producing that product?
A Safety. Safety on roads.
Q Okay.
A That was even mentioned in some of the press releases.
Q Okay.
A That was the major item. I showed you, and

there is in there, the statistics, how many people were killed in '75 compared to '94. And so these facts were taken together in a basket, plus the basic idea about this space frame solution.
Q Okay. Now, when you say safety was the primary concern, would it be fair to say that what you're speaking of is is that you were trying to prevent accidents where vehicles impact trailers from the side and underride the trailer?
A That is correct.
Q Okay. And you would agree with me, I would -- that under those circumstances, that that presents a severe problem for the motorist in the vehicle, correct? You have to answer out loud.
A No, I -- yes.
Q Okay.
A It is.
Q Now, you mentioned earlier about that looking at the number of fatalities in Europe involving cars and trucks, and the numbers getting better over the years, and you -- I think you attributed that to better technology in the cars, airbags, better seat belts, those sorts of things. Is that correct?
A Uh-huh. Correct.
Q So isn't it true that in your study of side

underride, that those safety mechanisms in cars are usually rendered useless when a car underrides a trailer from the side?
A That is so far correct, yes.
Q Okay. So Krone, as a company, looked at the fact, I'm sure, that you knew that people were dying and being seriously injured in these side underride impacts and you attempted to do something about it. Is that correct?
A That was the idea.
Q Okay.
A Yeah.
Q Because it was important to you as a company, correct?
A Uh-huh.
Q You have to answer out loud. I'm sorry.
A Yes. Sorry.
Q Okay. And it was a big enough problem that you invested a significant amount of money in it to try to address it?
A Of course, we thought that we could maybe influence the industry again in Europe, and that is always creating new reason to turn over the increase, and turn over, if you are coming with a good new subject into the market, but unfortunately, at this time, it was

not the case.
Q Okay. Now, you mentioned earlier about influencing politicians over in Europe. Has Krone taken steps to try to influence the lawmakers in Europe to address this issue of side underride between trailers and automobiles?
A Yes. The trailer was -- which -- or Chancellor Schroder, at that time, he was in power, and if you look in the DVD there, you'll see maybe also our female Minister of Transport and Traffic there. She gave, also, a press statement, but these are, let's say, global statements.
The problem is today that the national regulations alone cannot be influenced, or you can influence them, but then you have only the national things together.
The EC Commission, that is, the EC government, European government in Brussels, has been more involved, and then have you to put, today, all the 25 member states together to come to a result, and to be honest, we have a lot of beaurocracy in -- in these commissions and that takes a long, long period.
I'm part of the EC Commission today, also, in Brussels, and I know -- I'm knowing a little bit about what I'm talking.

We are just working on a study up to the traffic 2020, but if we are able to bring something into the system, it's absolutely not known. We'll see that maybe end of 2007.
Q And is it fair to say that over in Europe, the government moves slowly in response to issues that -- that present in terms of -- of safety?
A Yes. Very, because as I stated, in '94 -- I have not the newest figures with me, let's say for 2005. 2006 is too early. 2005, maybe that went down. We came from 20 killed persons, maybe we are coming down to 15 or whatever.
It's sad to say, but that is then not important enough such a figure, with the total main operation on roads today, to -- to be involved heavily in this matter.
Q But you agree with me that they should be?
A Yes, of course, but if I compare, I said, the trailer side in United States with the trailer technique Europe, there's a world of differences, especially in the brake system, and air suspensions, and so on.
So I think it's -- it's a larger move in the moment in the United States to come up at least to the standards we have in Europe.
Q Okay. Now, from your understanding of the

United States government with regards to the trailer industry, do you have any reason to believe that they are anything but as slow to catch up and address safety concerns as the governments are in Europe?
A Yes, because you have even -- not even -- even a simple single wheelbase together in all the -- in all the states in United States. You know that.
You have this bolted boogy system where you move the wheelbase up and down. So even in the states, you have, if you want, national or local rules, domestic rules, and then the national rule on top of it.
You have, in the states, exactly the same process.
Q Again --
A It's not completely unique.
Q Would you agree with me that, at least in terms of governmental regulations, that there's even more of a beaurocracy in the United States than there is Europe?
A No, not really, because you are talking at least one language. In Europe, I don't know how many languages we have today. We have 24 member states right now, and, of course, Austria, Switzerland, and Germany is talking German, but the rest is talking from Slovenia, Croatia, Estonian language, so even the country of 2 million inhabitants has the right to talk

in their own language. So I would create that -- or I believe that is more complicated.
Q Okay. Now -- but with regards to the Safe Liner, you told me that it was -- it was designed solely to address this issue of side underride between trailers and automobiles, correct?
A Correct.
Q And when you unveiled it, you had the equivalent of our President, in Germany, behind the company on addressing that issue, correct?
A So we introduced -- correct. We introduced it, but you see, then, that they are not powerful enough because you have here delegations, and their delegations, to convince. So a Chancellor, or even your President, can accept it. It can make a statement saying, "Okay, we need more safety on roads in the United States," but he also is not really able to influence that in detail.
Q But my point to you is is that the equivalent of our President, in your home country of Germany, was supportive of your company in addressing this issue that kills and injures people when these types of incidents occur, correct?
A Correct.
Q Okay. Now, when Krone first let it be known

that there were plans in the works, or that you were coming out with this product that prevented side underride of automobiles into trailers, was your customer base excited about that possibility?

A Only a few. That means these are customers who have medium range fleets only.

To convince the large fleets, we have, in Scandinavia, for example, DFDS. That is a large ferry operator and road operator. It's maybe a similar size to G. P. Hunt here in the states.

Don Schneider -- Don Schneider is -- by far, Schneider is by far the largest transport company in the world.

To convince these people for such a construction is very difficult because they are calculating each and every single penny to spend for a trailer or to spend for a truck.

Let's say the large fleets, to convince for such a construction, is much more difficult than a medium size organization.

Q But at the time that you created the Safe Liner, you thought that that was a big enough benefit that given time, you would be able to maybe convince some of these entities to utilize the design?

A Correct.

Q Okay. Now, I've looked through some of the press releases on the Safe Liner and I do find where Krone represents that, you know, "yes, we've had inquiries, and yes, we have customers who are excited about this product that prevents side underride." I mean, would that have been correct?

A That is correct.

Q Okay. So at least in theory, before the problems became known later, I mean, there was -- there was some interest on behalf of your customer base in this product that would prevent these accidents, correct?

A Definitely. Otherwise, we have not sold -- we would not have sold these 387 units in -- in total so far. So we have not really pressed them into the market.

Q Well, in fact, even if -- you would have never undertaken this program, with regards to the Safe Liner, had you not studied the issue and determined that it was important enough to devote a product to prevent these accidents, correct?

A No. The basic -- again, the basic was the -- the space frame, this idea, if we can protect -- can get a safer trailer on to the road. That was the major idea, nothing else. And we have not sought -- involved

alternative construction up to that.

Q No. I understand, but my question to you is is that when any company is thinking about making a new product, one of the first things they have to think about, if you would agree with me, is that is there a demand for this product, correct?

A Correct.

Q Because if there's no demand, you're not going to sell it?

A Correct.

Q Okay. So obviously, in the lead-up or buildup to the Safe Liner, Krone looked at the issue and determined that, yes, there is a need and yes, there is a demand, correct?

A Correct.

Q Okay. And you felt comfortable enough about those two things that you were willing to embark in this program, correct?

A Also correct.

Q And would you agree with me that in thinking about the issue of preventing side underride of automobiles and trailers, Krone was being proactive in terms of trying to innovate and trying to develop a safer product?

A Correct.

Q Okay. And no matter what the outcome was, do you agree with me that it was a noble and worthwhile thought that Krone, as a responsible corporate citizen in Europe, wanted to develop a product to prevent these side underride accidents from occurring?

A The word "noble" is a little bit far away, I would say. We have had economical ideas behind that. So noble --

Q I understand. You wanted to make some money?

A Yes, of course. We are capitalists.

Q Sure. But -- but would you agree with me that as part of that, and as being a responsible corporate citizen in Europe, that Krone wanted to make a difference with regard to these accidents, correct?

A Correct.

Q Okay. Now, the easiest thing to do would have been not to even address this issue of side underride, correct?

A Correct.

Q Krone took the hard road and tried to develop a product?

A Complete product.

Q Okay. Now, in going through some of the other Krone literature, I noticed that it was advertised that the purchasers of -- of the Safe Liner -- well, let me

strike that.

In looking at some of the promotional materials for the Safe Liner, I see that Krone advertised that the insurance industry in Europe caught notice of what it was that you were trying to do and offered a dollar-for-dollar credit on the increased cost of the Safe Liner versus another type of trailer. Is that correct?

A No, that is not correct. So there was a discussion going on only with one insurance company up to that -- at that time, that they came down and said, "Okay. For the monthly fee, we are thinking, in case that the customer is driving a Safe Liner, that we reduce the cost by 10 to maybe 15 percent" --

Q Okay.

A -- "the monthly fee for the insurance rates."

Q And who was that insurance company?

A That was a company, to my knowledge, Provincial, at that time, but I'm not quite sure if this Provincial is a North -- or German insurance company. I think it was Provincial at that time --

Q Okay.

A -- but unfortunately, it never came through because the time was overlapping already the technical results.

Q Sure. But at least in its inception, with regards to the idea that you were producing a product that would prevent these side underride accidents --

A Yeah.

Q -- this insurance company stepped up and said that they would be willing to give a discount to carriers who used this product?

A That was -- that was a discussion we have had with them in several meetings, that they will follow our -- our idea.

Q Okay. Because for them, it was a win situation because if they could prevent these types of accidents, that would then, in turn, lower the risk of injury to folks, and they were willing to pass on that decreased risk to their customer in terms of lower premiums?

A Correct.

Q Okay. And Krone utilized those statements in their advertising?

A That was -- yes, that was -- under discussion at that time, that is absolutely correct.

Q Okay. Okay. Now, you mentioned earlier that the Safe Liner -- I think you talked about a seven-year period.

A Period in total, yeah.

Q Okay. What -- what I want to ask you is is

that how long was the period from idea to production, first production?

A Let's say from the idea to the first prototype, that was around about 24 months.

Q 24 months?

A Yes.

Q Okay.

A From the first idea up to the first prototype, what we call a zero prototype.

Q Okay. So roughly, from the first person at Krone having the idea that, "Hey, we ought to try to develop this product that prevents side underride" to developing its very first prototype model, took two years, correct?

A Yes.

Q Okay. Okay. Then how long did it take to then take that first prototype and develop the first production model?

A These were all handmade ones. The next 10 -- I think it was 10 -- yes, in '99. It was all handmade. All handmade.

So normally, if you produce in series, you have so called jakes, where you feed in all the cross members, all the steel parts, and you do, first of all, a spot welding, later on the complete welding.

So we were never coming to that step that we were producing such jake because such a basic frame for a new model cost around about 200 to 250,000 euros.

Q Okay.

A So that means you must have a serial production or output before you are starting investment off of that item.

Q Okay. So when you gave us the seven-year period, would that include from idea -- first idea --

A First idea.

Q -- all the way to buying back the last trailer?

A Correct.

Q Okay. Now, once the problems first started arising, I think you testified earlier, that y'all looked at kind of re-engineering, or maybe retrofitting those trailers to try to address it, how long of a time period did Krone spend from the time that the problems first arose to reaching the decision that that design could not be fixed?

A The decision was -- let's say we saw the first -- first results early 2002 -- 2001, sorry. 2001, and we stopped the entire production end of 2002. So that means in this time, we were really looking into the construction to find a way out of the disaster.

Q Okay.

A But we realized end of 2002 that we have to stop that idea entirely.
Q Okay. Now, all the problems -- operational problems aside, is it fair to say that the design that Krone implemented and built was effective in preventing side underride, based upon the crash testing that you did?
A Yes.
Q Okay. So from that standpoint, the product worked, correct?
A Correct.
Q Okay. Now, I didn't quite catch it during your earlier examination, but if we look at the typical Krone trailer base frame that was in place prior to the Safe Liner, I assume that's still the same base frame that you're utilizing --
A Today.
Q -- today with regards to your other trailers, correct?
A Correct.
Q Was the Safe Liner's frame -- was it -- and I'm -- and let me kind of back up here because I want to make sure.
I understand that the Safe Liner is equipped essentially with a skirt around the outside?

A Correct.
Q Okay. If you take that off, is that base frame the same that you are utilizing in all your other trucks -- or trailers?
A No. No.
Q Okay.
A That is exactly why I took this picture with me, to see the entire difference --
Q Okay.
A -- between both constructions.
Q So even if you take out the side impact feature of the Safe Liner, you were utilizing a base frame that was different from anything else that y'all had done before?
A Correct.
Q Okay. So it was the first time that this frame had had been utilized?
A Also correct.
Q Okay. Now, in the base frame of the Safe Liner, how does that differ from the typical box trailer that's utilized in the United States?
A That is very simple, because the space frame is still an existing chassis construction, which you don't have in United States. Only in case of platform trailers. You have two longitudinal beams and two axles

with twin tires. And the same with container chassises.
All the rest you have in the states today is running on self-supporting boxes, either reefer boxes or dry cargo boxes.
Q Okay.
A You call it, also, vans.
Q Okay. Now, with regards to the type of box trailers or van trailers that are utilized in the United States -- and have you seen a picture of the trailer that's involved in this case?
A No. No.
Q Has anyone explained to you what that trailer looks like, or what the -- what the features of it are?
A No. I have -- I heard only how heavily people were took -- or injured. That was all. No, I have not seen a picture.
Q Okay. Now, you're here only to testify about Krone's experience, correct?
A I can only say something about the -- the Safe Liner issue.
Q Okay. Now, with regards to other designs or models that are incorporated within the standard box trailer utilized in the United States, you're not here to talk about any of those issues?
A No.

Q Okay.
A No.
Q Nor whether or not it's possible to retrofit one of those trailers with some sort of side impact protection, or modify them in some way?
A No. What we have learned -- and that maybe I can put on to the table as well. What we have learned is after that experience that we have now testing facilities for entire chassises under fully loaded conditions. That software program, that is the most important thing, took us around about seven years. We took Mosaic stones from trailer manufacturers, from component manufacturers, and we brought that together and we are simultaneously starting there and drive under normal operation conditions on roads, so that we can see, after, let's say, 1 million kilometers, what is maybe arising with a chassis, but if you do something, always under full load, that you cannot only calculate that, we have beautiful computer programs today for any kind of stress calculation. No doubt about that.
But the operational side, the daily life, is showing sometimes completely different results, and that is important to know. Whatever you do, you need a certain time, also, to figure out if this is really running or not. That is, what I can give as a

recommendation, and it's maybe quite interesting to see how we are twisting and -- we put vibration, we are twisting the chassises today, and to my knowledge, it's the only testing facility for trailers worldwide we have today in Krone.

Q Okay. But with regards to any type of American trailer with any type of side underride device on them, y'all haven't tested that over there, correct?

A No. We have never tested that because the construction is not -- is not in -- in Europe common.

Q Okay. Is it your testimony here today that it is impossible to design and build a trailer, in the United States, that performs satisfactorily in the field and prevents side underride intrusion by automobiles?

A I think if I see how thick the floor construction and such is on American trailers, for my understanding, technical understanding, I would say it is difficult to create any kind of heavy -- we are talking here about heavy side underride. We are not talking about the EC, the 200 kilo thing, because that is a bicycle protection --

Q I understand.

A -- nothing else. So what you need, then, you need reinforcement -- steel reinforcement, as I see, that -- that you weld to the chassis construction, and

you have problems here because you have a flat floor. Of course, you have some cross members, but I have my doubts that this can run so easily. I don't believe so.

MR. COCO: Object to the responsiveness.

Q (BY MR. MR. COCO) Sir, my question to you is: Are you here to testify that it is impossible for American trailer manufacturers to manufacture a product that works satisfactorily and prevents side underride crashes with automobiles?

A No.

Q Okay. Are you aware at all about anything being done, in the United States, with regards to that issue?

A No.

Q Okay. You're not aware --

A I never seen -- also, as I said, I'm looking in the monthly magazines, American magazines as well, you will see even the last one, there is a small newspaper article about trucks, American trucks, in one of the exhibits there. I have not seen anything mentioned there in the last couple of years.

Q Okay. But in terms of any alternative designs that are floating around the United States or -- you don't know anything about that?

A No.

Q Okay.

MR. COCO: What's our next exhibit number?

MR. BOOK: Should be 11.

(Exhibit No. 11 marked.)

Q (BY MR. COCO) Sir, I'm going to mark four pages of photographs here as Exhibit 11. I'll just ask you to take a look at them, if you could.

A It is a gooseneck portion. That's more or less an open thing --

MR. BOOK: He just wants you to look at them.

I'm going to go tell her we're supposed to have air. It quit.

Well, wait until we get those and then we'll take a quick break.

MR. COCO: 16 to 7 now, Texas.

MR. BOOK: Huh?

MR. COCO: 16 to 7 now, Texas.

MR. COCO: 16 to 7?

MR. COCO: So I'm happy.

MR. BOOK: Okay. Let's take a break, get off the record for a minute.

THE VIDEOGRAPHER: Going off the record at 12:38.

(Recess taken.)

THE VIDEOGRAPHER: Go back on the record at 12:41.

Q (BY MR. COCO) Those pictures that I've showed you there, do you see trailers of that type in Europe?

A Yes.

Q Okay.

A These are so-called what we call low back trailers.

Q Okay. And why is it that they have that name?

A Because -- let's say in Europe, we have the 5th wheel plate very low. We have very deep. So we use that -- and would call that mega trailers as well.

Of course, then, the entire chassis frame is moving downward. That's -- that's -- first is typical what we call it also mega trailer or mega liners.

Q Why don't you show the videographer that picture?

A Yeah. In case of this one here, this yellow green subject, these are only two boxes.

Q Uh-huh. So -- but those are things you see in --

A Two boxes, yes. In different sizes, in Europe as well. For some of these also here, the blue one, North American, also these are two boxes.

Q Okay. Why don't you show those to the videographer so they'll know --
A Okay. These are two boxes here on what I mention here. So, now, the low back vehicles, if something -- even Coca-Cola is driving on -- in Europe as well. But that is not the issue what we are talking about, so even the Safe Liner was not constructed to the -- to -- to this low back trailer.
MR. COCO: I'm going to object to the responsiveness.
Q (BY MR. COCO) Now, sir, where the diagram where you had the impact points of the various vehicles? Do you know what I'm talking about? Where is that?
A What was it?
MR. BOOK: It should be way over in that other stuff, or it might be right here.
A No. Must be somewhere over there. So many things, no? That's the mega liner. That is the German -- it has to be in this one.
Q (BY MR. COCO) Do you know what I'm referring to?
MR. BOOK: Yeah. The different heights of the bumpers?
MR. COCO: Yes.
A Huh?

Q (BY MR. COCO) It was the different heights of the various vehicles --
A Yes, yes, yes.
Q -- relative to a trailer.
A Yes.
MR. BOOK: Let's keep all of this together.
MR. COCO: I don't want to mix it up.
A No. No, no. Is there anything else?
Q (BY MR. COCO) I just want to see if you could find that for me.
A It was, in fact, a plastic folder, at least.
MR. BOOK: It's right here.
THE WITNESS: It's in there?
MR. BOOK: Yeah. I believe I can find it.
THE WITNESS: It's definitely not in here. So have we taken it out?
MR. BOOK: No.
THE WITNESS: That is only pictures.
MR. COCO: There it is.
MR. BOOK: Here you go right here.
MR. COCO: Mr. Book found it for us.
MR. BOOK: That goes back in 8.
Q (BY MR. COCO) Okay. Now, if you could, hold that up for the video.

A Uh-huh.
Q It's my understanding that what's intended to be represented here is that, for example, on the small car here --
A Yeah.
Q -- the red line is where, if you were going to have an impact, that you would want that impact to be --
A Correct.
Q -- correct?
A Correct.
Q And that's because that at that point on the automobile, you're going to -- that the occupants are going to receive the protection of what lies between the bumper and the front part of the car, correct?
A Correct. That is absolutely correct.
Q Okay. And then this is the point where that if there is an impact there, there will be triggering of the airbags, correct?
A Correct.
Q And the harness or seat belts will be allowed to work in their proper manner, correct?
A Yes.
Q And you have your best chance, in this collision, if you strike there, or engage the car there, that there will not be intrusion into the passenger

compartment where the occupants will be hurt?
A Okay.
Q Correct?
A Because all depends for airbags in this -- in the height.
Q All right.
A That's also the meaning. So that means maybe the sensors are still realizing that kind of vehicle in that particular frame height --
Q Sure.
A -- that the meaning here. Different frame heights of the vehicles. But here and there, you have already problems.
Q I understand. But if you're in this car right here --
A Uh-huh.
Q -- and you're going to have a side impact collision with a trailer, and you're going to hit in-between the two wheels in the open space, then you're not going to engage this optimum point of the vehicle, correct?
A Correct.
Q That's what makes side impacts so dangerous?
A That is correct.
Q Okay. Now, with regard to the Exhibit 11

trailer, would you agree with me that in a side impact with one of those trailers, you are going to impact the most optimum part of the automobile as opposed to the higher trailers which allow underrides?
A Okay. That means the sensors here, yes, because here this says if you are coming in this area, at least the sensors can ignore -- cannot ignore that there is something in front.
Q And you're going to get crush absorption in the front of the vehicle which will protect the passengers, correct?
A Correct.
Q And it's going to allow the seat belts to work, correct?
A Uh-huh.
Q You have to answer out loud.
A Yes. Sorry. Yes.
Q So --
A That is correct.
Q So, in the --
A On this one, but on this one, I think that is still too high because we are, with a frame of normal passenger car, lower.
Q Well, the normal passenger car in Europe, correct?

A Okay.
Q In the United States, the cars aren't quite as small, are they?
A But you are driving European standard -- sorry -- or Japanese cars over here. So I don't know where they are placing the sensors. That has to find out, let's say, definitely car expert.
Q But the truth about the designs that are depicted in Exhibit 11 is that they are going to engage the vehicle when it impacts on the side and not allow for the car to go underneath the trailer, correct?
A The car can go because I don't know, the two boxes, how sophisticated they are.
Q Okay.
A At least you have the chance that the car is -- all the sensors are exploding the airbags.
Q But it serves the purpose of filling that gap that allows a car to go underneath the trailer, correct?
A Correct.
Q Okay. And we know that for sure with these models that are lower in profile, correct? Right?
A Right.
Q Okay.
A Absolutely.
Q And with the toolbox, or what we call the belly

box here in the United States, this belly box is a solid unit that goes from one side of the vehicle to the other, correct?
A Uh-huh.
Q You have --
A I don't know. I don't know this kind of -- of toolbox right now.
Q Okay. But if you assume with me that this toolbox, as you're calling it --
A Pallet one.
MR. BOOK: Objection, form.
Q (BY MR. COCO) -- is -- is -- is a solid form that goes from one side to the trailer, it's also going to prevent a vehicle from going underneath the trailer, correct?
MR. BOOK: Object to the form.
A It's a question now to calculate the force which you put in which is able to absorb that. At least you have a chance that the airbags are blown up before you are going completely under.
Q Okay. Well, you studied side underride enough to know that usually when a vehicle underrides a trailer, the first point of impact are the A-pillars of the vehicle, correct?
A Correct.

Q Then the windshield, correct?
A Also.
Q And then the occupant's head?
A Yes.
Q Correct?
A Correct.
Q Okay. That's not going to happen with these in Exhibit 11, is it?
A Huh-uh.
MR. BOOK: Object to the form.
Q (BY MR. COCO) That sequence of crash.
A Uh-huh.
Q Is that correct?
A I think so, yes.
Q You agree with me?
A So far I agree, because it is not tested so it's very hard for me to say if this is really maneuvering, not knowing the solidity of the so-called toolboxes.
Q But if you have a -- okay. And we'll take the toolboxes out for a second, okay?
A Uh-huh.
Q But when you have a trailer designed that is lower in profile, that does not have that big space for a car to underride, you're not going to have an

underride, are you?
A Not so much. If you have a sports car, maybe you still can underride. Let's say a normal limousine definitely is more handicapped, yes.
Q But even that sports car is not going to underride to the extent that it would under the normal box van trailer in the United States, which is much higher in profile, correct?
A Correct.
Q Okay. You're probably not going to reach the A-pillars even in that little sports car, are you?
A Also correct.
Q Do you agree?
A I agree to that.
Q Now, you said that you've seen designs of trailers like are depicted in Exhibit 11 in Europe. These have been around for a long time, haven't they?
A That is especially for the, let's say, mineral water -- mineral water industry, or Coca-Cola industry because the boxes are then just above the floor, packed already, and that is, let's say, only for distribution businesses and purposes.
Q Well, but you understand in the United States these trailers are used for a variety of purposes, correct?

A In the United States, so I don't know the floor. Is the floor that one level inside, or is there even -- even or --
Q Could be either/or.
A So then it's difficult. Let's say for international transport, you put normally load in one -- in one goal on one level only.
Q Okay.
A So otherwise, you have problems because you cannot enter with a forklift truck into these bodies. I would call them, even for United States, very specialized bodies that is not the existing standard today in the states.
MR. COCO: Object to the responsiveness.
Q (BY MR. COCO) Isn't is it true that the lower that you -- that you make the profile of the trailer, the more underride protection you're going to provide?
A No, because we have another problem on the brake thing. On the brakes side, because the drums, diameters of the drums, have to be reduced because otherwise you cannot fit the tires on it.
Q Sir, I'm going to represent to you, and there's going to be testimony in this case --
MR. BOOK: Object. You're interrupting the witness.

Q (BY MR. COCO) -- that these types of trailers have been operating in the United States since the 1960's. Do you disagree with that?
A No. No, no. I don't disagree, but that has nothing to do with the -- from my opinion -- for my opinion, with the international transport also in the United States.
Q Okay. But my question to you is is that these have been operating in the United States for quite some time. You agree with that, correct?
A I believe you.
Q Decades?
A I believe you.
Q Okay. And that there are no complaints about the rotator drums or anything, they've been designed into these trailers, and these trailers, they work, correct?
A I -- I cannot prove that.
Q Okay.
A Sorry.
Q Okay. You can't or you won't?
A But -- no, no. No, no. No, no, because that is a specialty side. We, as Krone, are not producing such.
Q I understand.

A These are, for us, absolutely niche products.
Q In Europe?
A In Europe.
Q Okay.
A In Europe. In Europe.
Q But that's not the case over here. You've testified earlier that in Europe that there are trailers made for just about every different type of application.
A Let's say -- but inside, for load securing and these things, but let's say the standard or the basic frame is very similar.
Q But you've told me, in the United States, that there is a more standard design --
A Much more, yeah.
Q -- that is -- that is used across applications as opposed to what y'all do over in Europe?
A But let's put it in that way. A little bit experience from Wabash. They have not such an animal in their -- in their program.
Q You're sure?
A Yes.
Q Ever?
A Yes. I have never seen such a production, and I was in Lafayette several times, and also on their leaflets. Then it must be changed in the last, let's

say, two years, but I have never seen a Wabash trailer inside the factory.
Q You -- well, I want to -- I want to make sure I understand, because I'm going to spend some time pulling it up, then, if it's your testimony, but it is your testimony that Wabash does not --
A I have never seen such a production line in Wabash, and I have never seen also the leaflets, because we have discussed all the items which are -- may be interested in bring over to Europe.
Q I'm going to ask my question to you, sir. Is it your testimony that Wabash has never made a low profile trailer?
A I have said I have never seen one.
Q Are you trying to tell this jury that it is your testimony that they have never made one?
A I cannot prove that. I cannot prove that.
Q So the answer is you don't know?
A I don't know, then.
Q Okay.
A Yes. So it could be a possibility, maybe.
Q But you don't know?
A I don't -- I have never seen such a thing in -- inside Lafayette.
Q Because I have one on my phone if you want to

see it, a Wabash trailer. I'll show it to you during the break if you want to see it. Got it going down the highway one day.
A Okay. It's -- from what period? New or old?
Q I just saw it on the highway. I mean, that's -- but that's my question to you. You don't really know, do you?
A No. I have -- I said again, I have never seen, and we discussed the entire program at that time in Lafayette.
Q Okay. Now, the documents that you were asked to bring in the e-mail from Mr. Darbyshire, did you -- I mean, did you ever have a chance to go back and look at it, what was asked of you?
A I have seen it yesterday here, but I heard that on the phone, as I said before.
Q Are these all things that Krone has?
A No. No. There are a lot of things in it which we don't have at all.
Q Are there things on here that Krone does have?
A No. What we have here, still on the last documentation on the drawings is here on the table right now.
Q Okay.
A So we have also no press releases any longer

kept somewhere in our -- in our offices or whatever. We are looking forward, not backwards.
Q Okay. Krone didn't do any market studies before they put the Safe Liner into development?
A No. No further -- no further studies at all.
Q No, no, no. Not after -- I'm talking about before it went into production. Did Krone do any market studies?
A No. Not -- no, no. No. It was the idea, first of all, to create a new idea, but to make a market study is very difficult. What kind of results you can expect, if you are coming out with a product which is not known in the market. You cannot make any market studies there.
Q Okay.
A It's only a feeling, a certain feeling that there is maybe a possibility to produce so many trailers.
Q Okay. Would you agree with the statement that the industry in Europe needs to continue to try to innovate to develop something to address had this side underride issue?
A That's a very difficult question. Let's say the trailer manufacturers, for the time being, have absolutely no intention to do something more on that

particular issue.
MR. COCO: Object to the responsiveness.
Q (BY MR. COCO) My question is: As a responsible corporate citizen, do you believe that the trailer manufacturers in Europe should continue thinking and trying to develop an apparatus which would prevent side underride?
A No.
Q Okay. It's not that big a -- big a problem?
A Absolutely not.
Q But it was a big enough problem for your company to try to develop a product that specifically dealt with that issue?
A That was, let's say, in the '90's, yes, that we thought that was something.
Q And what you're here to testify to is that while your design failed -- Krone's design failed --
A Correct.
Q -- that was only Krone's design, correct?
A Yes. Absolutely correct.
Q Okay.
MR. BOOK: Mr. Sanders, this isn't a marathon, so any time you want to take a break --
THE WITNESS: No, no.
MR. BOOK: Okay.

THE WITNESS: No problem.
Q (BY MR. COCO) Was there ever any study or analysis of the issue about whether or not Krone could put a -- some sort of side underride protection on its existing chassis models, rather than change the one that --
Q No, no. We have fulfilled that because as UK came to the EC, because they were not in the first step -- that means Great Brittain -- the first step, a member of the EC, of the European Community, that the side protection, which was not, so far, in the market, was created at that time and that has not changed at all since Great Britain came to the EC.
There is a strict regulation about these side protections that is fulfilled, and that is proven by all the trailer manufacturers in Europe, and that is the only one in use today in Europe. And we have just finished the world's largest commercial vehicle show. There was absolutely no tendency that somebody else is bringing up something because we have undertaken the consideration also about weight problems and weight questions again, plus, of course, size questions.
MR. COCO: Object to the responsiveness.
(Exhibit No. 12 marked.)
Q (BY MR. COCO) I'll show you what we'll mark as

Exhibit 12, and what I'll represent to you, that's something that I pulled off of Krone's website with regards to the Safe Liner. Does that look to be what that is?
A Uh-huh.
Q You have to answer out loud?
A Yes. Yes. Of course.
Q Okay.
A Yes. These are the old figures.
Q Okay.
A From '99.
Q And all the statements that are made there, they were -- they were -- when Krone made them, they were true?
A Let's say we thought that we are coming to these results which are mentioned in there, but we saw later on, of course, that we could not come to all these results. That was one of the first statements we ever made regarding Safe Liners because even the old Krone logo on top of the marketing tilt.
MR. COCO: Object to the responsiveness.
Q (BY MR. COCO) Sir, at the time that Krone made these statements, were they believed to be true?
A Yes, of course, in '99. Yes.
Q Okay. And you mentioned Trailer and Body

Builders as being a publication from the U.S. that y'all look at over in Europe?
A That we are getting in Europe as well, yes.
Q Okay.
(Exhibit No. 13 marked.)
Q (BY MR. COCO) And I'll show you Exhibit 13, which is an article from them about the Safe Liner. Have you seen that before?
A I saw that. That was also in 2000 -- February, 2000, yes.
Q Okay. And at least the statements that were contained therein, at the time, did Krone believed them to be true?
A Yes. Of course, we have had no other things to --
(Exhibit No. 14 marked.)
Q (BY MR. COCO) And I'll show you Exhibit 14, which is something else I pulled off of y'all's website. Have you seen that before?
A Yeah.
Q Okay.
A Also.
MR. BOOK: You're saying you pulled them off the website or Block pulled them off?
MR. COCO: I pulled them off. I had to go

to the way back machine, but I did it.
MR. BOOK: Okay.
A These are all old statements, a couple of years old.
Q (BY MR. COCO) Now -- I understand. These aren't on your website currently. I had to go to the way back machine and pull them off.
A Yeah.
Q But these were on -- all on your website in the past.
A So --
Q Correct?
A -- I would kill the marketing people if they have still something on the web pages somewhere which I have not seen --
Q Well --
A -- because --
MR. COCO: Off the record.
(Discussion off the record.)
Q (BY MR. COCO) But at the time that you made the statements in Exhibit 14, did you believe them to be true?
A Of course.
Q Okay.
A Some of the statements are made by our owner

himself, so that is all in '99, 2000.
(Exhibit No. 15 marked.)
Q (BY MR. COCO) Okay. And then Exhibit 15 is a press release from y'all. You've seen that before?
A Yes. I saw that before as well, and the white Beetle, yes.
Q Okay. And at the time that Krone made the statements in Exhibit 15, they believed them to be true, correct?
A Correct.
MR. COCO: Okay. I think I'm going to pass to Oscar real quick and I'll look through my stuff. Thank you.
THE WITNESS: Okay.
MR. BOOK: Oscar, you're up. Don't mess it up, now.
MR. GOMEZ: You got it. Let me wake up a little bit here.
(Time: 1:05.)
EXAMINATION
BY MR. GOMEZ:
Q Mr. Sanders, can you hear me okay?
A Yes, I hear you.
Q I've got a few follow-up questions and I represent the driver of the Taurus that ran into this

trailer. Do you understand that?
A Sorry?
Q I'm one of the lawyers that represents the plaintiffs in this case. Okay?
A Uh-huh. Uh-huh.
Q All right. And I just have a few follow-up questions for you, sir, just to clarify for myself and clarify the record.
Sir, is it true that the design and the construction of U.S. box van trailer and the European box cargo trailer are designed and constructed differently, correct?
A That is correct, yes.
Q And it's your testimony here today that you're only telling the jury in this case that your Krone Safe Liner trailer is -- was -- was not a success, correct?
A Correct.
Q Okay. And it's also true, sir, that the extent of your experience and training on this Safe Liner is limited to the European market and not the U.S. market. Is that true?
A That is correct. What we said, that you have around about 8 feet longer vehicles over here than we have in Europe.
Q Sir, you never, at any time, tried to market

your Safe Liner here in the U.S., did you?
A No, never, because we have no chance, with the existing market prices over here in United States, to come over with our trailers.
As I mentioned, we are running on super singles air suspension disk trailers today. That is completely different to the technique which is common in United States.
Q So you're not saying that -- or you have absolutely no studies whether or not your Safe Liner would have been a success, either technologically or economically here in the United States, do you?
A No.
Q So as we -- as you sit here today and you testify in your testimony to this jury, you have absolutely no knowledge whether or not the Safe Liner would have been technologically or economically feasible here in the Unites States, correct?
A Correct.
Q Sir, also, I believe it was your testimony, and you can correct me if I'm wrong because I'm not sure if I got it down correctly, that the highway systems are -- there's a wide variety of road conditions and highway systems in Europe, correct?
A Correct.

Q And would you agree that the U.S. highway systems are different than the -- and conditions are different than the European highway systems and conditions?
A Yes, definitely.
Q All right. So at no time did Krone ever attempt to see whether or not the Safe Liner would have actually -- actually worked and been successful here in the United States, right?
A No. No, because we have -- as I said, we have no interest in the United States for -- for trailers because price-wise we are, from the beginning, plus transport absolutely not competitive.
Q All right. So you're not trying to tell this jury that this Krone Safe Liner would not work here in the United States, are you?
A No. No, I would not tell them that, but --
Q All right. Then --
MR. BOOK: Wait a minute. He didn't finish his answer.
A But let's say taking into consideration, again, that the -- your trailer length here varies to the European ones by another 8 feet, and you are working only with twin axles over here, and twin tires per axle. That would mean that I am expecting, as an engineer,

more frequencies, more twisting, more torsions in the -- in the construction.
Q Well, sir --
A Even if you have a better road condition here.
Q All right. At no time, from 1999 to the current, did you ever attempt to study, develop, design, or implement a side guard on a 50 foot -- on a 53-foot trailer, right?
A Right.
Q All right. So your testimony here is absolutely just conjecture and you're assuming and speculating whether or not the side guard for the Safe Liner would actually work on a 53-foot trailer, right?
A Right.
Q Okay. So it's also, true, I guess, that just to sum this up, that Krone never conducted absolutely any studies whatsoever for its product in the U.S. market?
A No, because as I said, we have had no -- no interest in marketing our products in United States in the past.
Q All right. Of the 387 units that were manufactured by Krone, is that -- do you have the number correct?
A That is correct. Absolutely correct.

Q Okay. Of those 387 units that were sold and manufactured, how many of those units were actually returned with what we -- what I guess you would call defects or problems?
A All of them. All of them. We took them all back. We bought them all back.
Q Okay. I understand that you took them all back, and I understand that part of your testimony. And I guess my question is: Were -- were all 387 units damaged after approximately 50,000 miles?
A At least I can tell you the figure was -- which I have in mind was around about 328 was all damaged, and we took them all back because we were not waiting up to the -- to the last cracks also in the other ones. So we -- we said, "Okay. We make Liner now and we take them all back because also the rest." If they would have had not these particular cracks, would have come sooner or later.
Q And did all these cracks -- you say "cracks," and I'm going to use the word "defects" or "problems."
A Defects, yeah, whatever you want.
Q Right. On all these, did they make the trailer unusable?
A Yes, sir.
Q Okay. And did the customer bring this -- did

you supply some type of a warranty on this -- on this particular product to your customers?
A Let's say we have, in general, 12 months of warranty period, and the first trailers were repaired and reinforced. We gave them another 12 months on top of it, so that the customers were absolutely sure that they are protected in one way or the other from us.
Q Does Krone maintain records of these warranty repairs in its files?
A No. No. No. We took them back and went in a very unbroke bureaucratical way that we helped with our old service cars, which have welding equipment on board, and so on and so forth, or we did it with contracted workshops in different areas and countries. That was absolutely decided right on the spot how to help quickly.
Q Okay. So you did receive this list of documents to bring -- I think it's been attached as an exhibit, correct?
A Correct.
Q You left Thursday morning, you arrived here Thursday afternoon?
A Thursday afternoon, yes.
Q All right. And you --
A We have seven hours for the time -- being time

difference between Houston and Frankfort.
Q Okay. So when you arrived and you had some level of communication about this list with Mr. Book or Mr. Darbyshire?
A Yes, yesterday.
Q Okay. Yesterday being Friday, correct?
A Correct.
Q At any time, did you make any effort, with your company in Germany, to fax you any of these documents that were requested for you to bring to your dep --
A No. No. In fact, I was not even phoning the company because my mobile is astonishing not working here in the states.
Q Did you, at any time, ever ask Mr. Book for permission to use his telephone to call your office to attempt to try to obtain some of these documents by fax?
A No. No. I have not even called my wife from here.
Q Well, that wasn't my question. My question was whether or not you tried to contact --
MR. BOOK: He said no.
A No. No. Not one telephone call was made.
Q (BY MR. GOMEZ) Okay. So you made no efforts at all to try to bring any of these documents -- or at least have your company fax any of these documents to

you, correct?
A Correct.
MR. BOOK: Object to the form.
Q (BY MR. GOMEZ) Mr. Sanders, do some of these documents exist in your company, such as press releases?
A No. No. We have not documented that further on. That was our old ones which you have here, the old ones, but I would have difficulties to find them today, and I have here, also on the table, an old leaflet from, I think, '99 or something like that, in English.
Q Are there any documents that exist that are contained with the -- within the list of documents that has been provided to you or that was provided to you yesterday?
A No.
MR. BOOK: Object to form of the question.
A No. No. What I brought, that was my own intention after knowing -- after knowing that this is affecting the Safe Liner issue. I took everything already on my own in my briefcase here to Houston, that was available.
Q BY MR. GOMEZ) And so the documents you actually brought with you, your testimony is that that's the -- those are the only documents that are available to you right now. Is that --

A Correct.
Q Is that your --
A So even -- even if I would have seen the e-mail before I left the office, I would not -- I was not able to carry more with me because that is not existing. Don't forget, it's already some years ago.
Q Okay. How many other e-mails did you receive from Mr. Darbyshire or Mr. Book?
A Only that we have, let's say, a telephone call that is also here in the exhibits, integrated that due to European time we are talking at 3:00 o'clock together.
Q Earlier, you had indicated that you had known Mr. Darbyshire for at least two years, I think you said?
A Yeah. Let's say from telephones, knowing the old connections and the background, so that he phoned me and said there was a case going on and "maybe you are able to come."
Q And there was a connection that you knew Mr. Darbyshire with some -- some relationship as it related to Wabash Industries, is that it?
A Yes. Yes. There was a friendship in-between. So that was the reason why he was knowing my name, maybe, since two years or whatever.
Q And as far as Wabash's work in the European

market, does with Wabash market trailers for the European market?
A No, not any longer, because that disappeared after the dollar was -- the exchange rate dollar to euro or Deutsch mark, at that time, was exploding. So because everything was in dollars, even the freight from Baltimore into Bremerhaven on a RoRo ship was in dollars. So that disappeared and we bought, then, also a plant in Denmark. That was, in fact, called, in the beginning, Krone Wabash, but Wabash had had some economical difficulties in the early 2000's, so that even this name was completely cancelled, then, and it is only named now Krone and not any longer Krone Wabash.
MR. COCO: Oscar?
MR. GOMEZ: Yes.
MR. COCO: Can I ask him a question real quick before my computer runs out of juice?
MR. GOMEZ: Sure.
(Time: 1:18.)
EXAMINATION
BY MR. COCO
Q Sir, I want to show you what I've pulled up on my computer here, have you take a look at that. Tell me what that's a picture of?
A Wabash single drop.

Q What year is it?
A 1992.
Q Okay. And does that look like the type of trailer that we were talking about earlier that you told me that Wabash had never made?
A I said we -- I have never seen that. We are working with Wabash since -- I have to look into my files. Maybe since '97 or something like that.
Q Okay.
A So I have never seen such an animal from 1992. Let's say we produced, in 1992, also different models which are not existing since more than 10 or 15 years.
Q That's a low profile trailer, though, correct?
A That is something, but it is also niche product, I would guess.
Q Well, my question to you is is that's a low profile trailer, correct?
A It is a low profile trailer, correct.
Q Okay. And if a car hits the side of that trailer, that Wabash trailer manufactured in 1992, it's going to engage the front bumper of the vehicle, isn't it?
A That's true.
Q And it's not going to underride it, is it?
A There's no underride may be necessary. You

have to -- I cannot measure that, see it from the picture --
Q Well--
A -- what the ground clearance right now.
Q Well, a car is not going to underride that --
A No.
Q -- 1992 Wabash trailer?
A No, no. That is correct.
MR. COCO: Okay. That's all I have. He's going to change tapes, Oscar.
THE VIDEOGRAPHER: Off the record at 1:20.
(Recess taken.)
THE VIDEOGRAPHER: This is beginning of tape 3. We're on the record at 1:24. Go ahead.
EXAMINATION
BY MR. GOMEZ:
Q All right, Mr. Sanders. This is Oscar Gomez again. I'm just --
A Yes.
Q I'm going to continue asking questions and there -- they don't -- they may not follow each other because I don't want to repeat a lot of the stuff that you've already testified to. Okay?
A Right.
Q All right. Sir, when Krone undertook the

research and development of its Safe Liner trailer or line, that was done even though there was no governmental regulation for side guards sufficient to keep cars from underriding its trailer. Is that true?
A That is true.
Q Okay. And the purpose of developing that, you said earlier, was to try to tap into another market for purposes of, you know, economics, right?
A Correct.
Q Okay. Was it your testimony that your primary concern wasn't safety, but the primary concern was more making money?
A Was it more making money? Of course, that is the reason why we did it, because that was then, let's say, a tremendous difference between us and all the other trailer manufacturers.
Q Did you know of any other trailer manufacturers, in the European market, that had ever tried to research and develop side guards sufficiently enough to keep a car from underriding?
A No. No, not to my knowledge, and I know them all.
Q How many -- when you say "all," about how many are there?
A Yeah. What is interesting for you now, should

we mention only the manufacturers above 1,000 units a year? Because we have a lot. But let's say the major ones, producing up to 6,000 units a year, and I would call them -- they have some global interest, at least European global interest. These are around about, in Europe, six manufacturers right now. But we have a lot of small ones, up to 1,000, 1,500 units a year.
Q And I guess I'm just really trying to narrow it down to those who manufacture box van type trailers.
A Yeah. That is -- that is not more than six, then.
Q Okay. And as far as you know, Krone has been the only company that has ever tried to develop a guard sufficient to keep a vehicle from underriding, correct?
A Correct, sir.
Q Sir, isn't it true, also, though, that the guards that are out there and on the European trailers, that there has -- they have had some effect on keeping automobiles from underriding?
A No. They have to fulfill -- they have to fulfill all the EC approval. That is, a special approval number, and you have to make the test runs. So that means that looks maybe decide a little bit different, but it is always the same strength you can maximum put into the side protection. That's for all of

us, of all trailer manufacturers, the same.
Q I understand that, but I guess my question is -- and I'm talking about real world applicability here.
In the real world, isn't it true that Krone has become aware of side guards that have been out there on the market that have actually kept cars from underriding a trailer?
A Correct. We know that.
Q Okay. So of all of these guards that are also out there who are to keep bicyclists, and pedestrians, and motorcycles from underriding their trailers, some of those guards, at least in the real world, have kept automobiles from underriding and intruding the passenger compartment. Isn't that true?
A No. That is only -- let's say up to bicycles. Not more. Even motorbikes are -- from my understanding, a motorbike has around about between 200, 220 kilos, metric kilos, plus the driver on top means around about 300 kilos, metric kilos. That means automatically that is already about the side protection -- that means the force you can feed into the side protection, I mean.
Q Right. And I guess you're -- you're speaking in technical terms, as far as what they're built for, but in the real word, haven't those guards actually kept

a vehicle from underriding and preventing passenger compartment intrusion?
A No.
Q Not that you know of?
A Not that I'm knowing of.
Q Okay. You've never experienced that, in the 20 something years that you've worked with -- with -- in the trailer manufacturing industry?
A No, sir.
Q I guess at some point, when the entire Safe Liner fleet was returned or accepted back by Krone, were there any attempts at all for any type of research and development to re-engineer a side guard, and perhaps not in the Safe Liner line, but a side guard for an open box van trailer --
A No.
Q -- to sufficiently --
A Yeah.
Q -- strong enough to keep an automobile from underriding?
A No. No intention.
Q Okay. I guess before I was talking to you a little bit about your relationship with Glen Darbyshire and Wabash, and I guess one of my questions is: You had indicated that Wabash, I guess, no longer markets or

manufacturers trailers for the European market, correct -- currently, correct?
A Correct.
Q And my question to you is: Back when they were working with the European market, what were the type of products or trailers that were being manufactured by Wabash in the European market?
A That was reefer trailers and dry liners, but the interesting item was only the box, because we came -- all the trailers came over by one American axle, and one American axle only, and we feed it underneath the European axle system, braking system, lightning system. So it was only half, and we returned, then, 19 axles back to Fayette in a sea container. In a 44 foot sea container. So that was a revolving system only because we were losing RoRo ships from Baltimore into Bremerhaven. So that was better these roll on roll off system for us.
Q So these dry liner trailers, they were never used for the open road?
A Only after -- after fitting -- after fitting the -- let's say European axle system underneath the trailers.
Q All right. And once you fitted the European axle system under the trailers, were you also required

to fit them with the regulated side guards?
A Yes. Not with side guards, because all the dry ones, normally in Europe, have specially reefer trailers, nearly 100 percent, has so-called pallet boxes underneath.
I mentioned that earlier today, 30 to 32 pallet -- European pallets have to be packed. So that was eliminating, in this moment, then, this underride thing.
Q So the actual trailer had some type of apparatus for pallets to be able to be stored underneath the box van trailer, correct?
A Yes, but these were very heavy -- if I say "heavy," around about 360 kilos, such an empty -- empty box, steel box.
Q All right. And what was the dimension of those boxes off the ground? How many inches or how many feet?
A Of ground clearance, you mean?
Q Yes.
A I would guess around about 30 to 35 centimeters. That means more than 1 feet -- 1 foot.
Q Okay. About a foot of ground clearance?
A Sorry?
Q About one -- 12 inches or 1 foot of ground clearance?

A At least -- a little bit above 1 foot ground clearance.
Q Okay. And these trailers were used throughout the European market for purposes of transporting goods, and there were -- is that true?
A That is true, because, let's say, if you drive on boxes today, normally, all the packaging is done on European pallets and that is an exchange. So if you are coming with a full load, you are taking automatically back -- all the drivers getting automatically back the empty pallets.
Q And it is also true, isn't it, Mr. Sanders, that the 1 foot ground clearance never provided a -- or produced a problem for the trailer's utility in your -- in your market, correct?
A No, because these were only road -- road vehicles. So they have to have no further intentions, or they could not go on -- later on boats, even if they came over by RoRo vessels, or on no Huckepack versions.
Q Okay. So let's --
A So piggyback.
Q -- limit it to road -- let's limit it just to road worthy vehicles -- I mean road use trailers.
These dry liners, that had these container open -- or containers for storage, which were just --

had a foot ground clearance, they didn't produce any type of a problem with its utility over the roadways. Is that a true statement.
A No. Not on roadways, no.
Q Okay. So going back to the question of Wabash manufacturing trailers for the European market, those are the same trailers that were retrofitted with these boxes or storage areas where these pallets would be stored. Is that true?
A No, that is not completely so. Don't forget we have three axle worshans, and we have had -- let's say six is assistant frame underneath. So that was even painted and then placed underneath these boxes.
So that was not -- let's say only the small running gear part that was a longer frame, also with two major beams. So that means we have had possibilities to fix there something to these main beams.
Q Well, I guess that's a little difficult for me to understand since I'm not there with you and I --
A Yeah.
Q I apologize for that.
A Let's say we have -- sorry. We have three axle worshans. That means three axles in line are covering much more space than two axle worshan. You are with me?

Q Yes.
A So due to the fact that the three axle worshan is longer, the entire boogy, the entire running gear is longer, we prepared, in Germany already, a complete -- yeah, if you want, chassis frame without the kingpin area. That area was not touched. So we have had then the possibility, on these longitudinal beams, to fix also more items; toolboxes, pallet boxes, or even a spare wheel holder, double spare wheel holder, or whatever was requested.
Q Okay. And again, that type of construction is different than the way they would come over from the United States, right?
A Correct. So that was an adaptation, maybe, that is better understandable. That was an adaptation to the existing finish box in the United States.
Q All right. Would you agree that the -- that the open box van trailer, here in the United States, is constructed differently than the ones that are utilized by Krone in the European market, correct?
A Yes, correct.
Q All right. And just -- just because Krone has failed, as -- as you say, didn't work out, it was unsuccessful in developing a safe side guard, that doesn't mean that a safe and technologically and

economically feasible guard can be developed in the United States, is it?
A That's -- that's possible, maybe. I cannot give any -- any kind of statement here.
Q Okay.
A I don't --
Q And that's because you are not familiar with any type of studies, or testing, or development of side guards in the United States, correct?
A Correct.
Q Okay.
MR. GOMEZ: I think I'll pass the witness at this point.
(Time: 1:38.)
EXAMINATION
BY MR. BOOK:
Q Okay. I'm going to try to be real brief, hopefully.
What's your engineering degree in?
A Engineering for transport. So machine transport, in fact.
Q Did you get your degree there in Germany?
A I got the degree on the high school in Munster in Westphalia. A very old city.
Q This deal about -- Mr. Gomez was talking to you

about taking the Safe Liner design and bringing it to America. With the problems that y'all had with the Safe Liner design, would you advise anybody to bring that to America?
A No. Never. Was not even thought about such a thing.
Q And this deal about the -- this low back trailer, you remember the --
A Yes.
Q -- 1992 Wabash low back trailer that Mr. Coco showed you?
A Uh-huh.
Q He showed you that on -- pulled it up on the internet?
A Uh-huh.
Q That type of trailer, is there any way, in Krone's business, that you could say, "Okay, we're going to make nothing but low back trailers and we can stay in business?
MR. COCO: Object to the form, leading.
A No.
Q (BY MR. BOOK) You kept telling Mr. Coco something about a niche -- it's niche product. Can you explain what that meant by that?
A A niche product means that is specialized

product for special transport, because in Europe, you wouldn't need because we have a height limitation as well of 4 meters. That means you need a traction unit with a very low 5th wheel plate. These are existing, but these trucks are costing around about $10,000 more per unit, and then you have a trailer which has small tire diameters. That means also smaller drums or smaller diameters in disk brakes. So that means you have more wear and tear on these animals as well, so everybody is trying to eliminate that as far as possible, only in the automotive industry. They have very high volume goods and very high goods, let's say dashboards and such, which are upright packed. So they need the full volume, as we call it, around about 10 foot inside of a trailer. Then we are going for low backs, but low backs, again, cannot be transported on railways, have difficulties to go on to boats, ferry boats, so that it's also only a small item. That you cannot use them in wintertimes because the truck has not such a clearance that you cannot snow chains put on to the rear axle of a truck. So that is also limited -- limited variation of these kind of trailers.

Q Of the 30,000 units that Krone makes a year, how many of them are these low back type trailers?

A Of the low back, maybe 10 percent.

Q Okay. And these box trailers -- Krone makes box trailers don't they?

A Yes.

Q Why -- why is it that these box trailers are -- have high floors in them?

A A complete floor, you mean, or half floor?

Q Yeah. The floor.

A Yeah.

Q Why is it that they have the floor high up off the ground, the bottom floor?

A The bottom floor is very simple, because normal trucks have a 5th wheel plate height of a little bit more than one meter that is existing from the Cedars MAN sconia Volvo, whatever you take. It's -- the 5th wheel plate, on an average in Europe, is 1.15 meters today, divided by 33, gives you the feet measurement.

Q Is that why these docks that you see are built to that height?

A Yes, yes, because all the ramps in Europe have, let's say, a general height of around about 1.2 meters if they have not hydraulic ramps, but the old storage facilities have no ramps at all, so that was a standard item of 1.2 meters ramp height.

Q So these box trailers, even that you see going down the road in America, they have got that height for a reason?

A Uh-huh.

MR. COCO: Object to the form.

Q (BY MR. BOOK) Is it that true?

A That's true.

MR. COCO: Object to the form.

Q (BY MR. BOOK) Okay. So Mr. Gomez wants to talk to you a little bit about this bicycle guard?

A Uh-huh.

Q Do you know of -- that you know of, do you know of any data that says that the -- first off, let me back up.

The guard under the European Union guidelines, you didn't have to put the guard on until Britain came into the EU. Is that correct?

A That is correct.

Q So when Britain came into the EU, this bicycle/pedestrian guard that -- to withstand 200 kilos?

A Kilos, yes. Metric kilos.

Q Went into effect. Is that correct?

A That is correct.

Q And from there forward, everyone was required to put the bicycle guard on. Is that true?

A Correct.

Q Okay. But in Mr. Gomez's questioning, do you

build the guard to the specific 200 kilo specifications? Is that correct?

A That is correct.

Q And do you know of anyone that's building such a guard, in Europe, that you're aware of, your competitors, or Krone, or anyone else, that's going to withstand an automobile?

A No. No. There's nobody known to me, and I know the industry quite well, who has a different guard compared to ours or to our main competition.

Q If anyone were to point to the Krone design that we've been talking about here for hours, and say this design, this Krone design, is a safe alternative to -- and it's technologically and economically feasible to protect against side underride by automobile vehicles, what would you tell them?

MR. COCO: Object to the form.

Q (BY MR. BOOK) If they were to say that. Is that true or not true?

MR. COCO: Object to the form.

A That is true. If we would have a facility, we would do that, but for the time being, we have no intention because we have to look here where we are price-wise.

Q (BY MR. BOOK) I don't think you understood my

question.
A Yeah.
Q Let me go back on it. Here's what I'm saying. If someone were to go back and take your '99 design --
A Uh-huh.
Q -- that you've had all these problems with --
A With, yeah.
Q -- and come in before a jury and say that design, that you had these cracks and everything with, that design is a design that should be used for side guard underride protection and it's technologically feasible, would you say that's true or not true?
MR. COCO: Object to the form.
MR. GOMEZ: Objection, form.
A No. That is true.
Q (BY MR. BOOK) Well, that it can be used?
A No. No. Sorry. No, no. I -- I'm with you now. No, no. No. Definitely not.
Q You took it off the market?
A Yes.
Q Why did you take it off the market?
MR. COCO: Object to the form.
A Due to economical and technical reasons, that's all.

Q It wouldn't work. Is that true?
A It is not working.
Q Okay.
A It is not working.
Q So that the record is perfectly clear, the design that Krone put out in the market, Krone withdrew it because it -- why did Krone withdraw it?
A Because we failed technically-wise. We failed completely that we have to withdraw that because if we would have continued, we would have lost our reputation in the market.
Q Okay. Technologically, it didn't work?
A Didn't work.
Q Okay. All right.
MR. BOOK: I don't have anything further.
MR. COCO: I don't have anything.
(Time: 1:48.)
EXAMINATION
BY MR. GOMEZ:
Q Sir, let me ask you a question. Just because you believe that Krone failed in the development of that guard, the Safe Liner, that doesn't mean that you couldn't fix it, Krone just decided not to fix it, correct?
A That is correct, because we have

investigated -- as I said in the beginning, we have investigated, after the first problems were arising, what to do, and we did also something on the design side, but the major fault is the construction as such.
Q That's -- I understand that, but at the same time, Krone could have gone back to the drawing board, so to speak, and tried to correct those small cracks that were being experienced by these customers, but Krone just choose not to do that and go on to something else. Isn't that true?
MR. BOOK: Objection, form.
A That's true.
MR. BOOK: Small.
Q (BY MR. GOMEZ) All right. Sir, you were asked the type of degree you had. In what year did you obtain your engineering degree?
A Yeah. That is difficult to say because I don't know the equivalent here in United States. We call that diplo engineer. Diploma engineer.
Q What year was it that you received that?
A Sorry?
Q What year was it that you received your diploma engineer?
A Where it was?
MR. COCO: What year.

MR. BOOK: What year.
A What year? Oh, my goodness. I'm 59 years old. I have to calculate now backwards. It was in the -- in 1974. Yes.
Q (BY MR. BOOK) In 1974 you received your --
A My --
Q -- engineering degree, is that --
A My -- my engineering degree, yes.
Q And did you -- in 1982, when you worked -- began to work with Krone --
A Yes.
Q -- you weren't hired on as a design engineer, were you?
A No. No. I -- I was -- but that is now a little bit curriculum vitae. I went straight -- my professor gave me an address and I started my career in the textile machinery business. That was, in fact, twisting machines, two for one twisting machines. So I moved over to Krone after that, around about six -- or was it eight years? Eight years in the textile machinery business, I moved over to Krone trailers.
Q And when you worked with -- when moved over to Krone trailers, since 1982, your job has principally been in the sales department?
A I created all the export sales because Krone

was not heavily involved on the trailer side in exports at that time. They were national producer. So I started, then, market after market to export these units into the different countries all over.

Q And it's true, also, that you had no engineering design into the Safe Liner trailer, correct?

A No, that is correct, because I am not starting -- as I said, I'm bringing ideas into the system and then we have the engineers to -- to integrate that and to fulfill it. That is the normal obligation, because I'm talking to customers nearly every day. So if I see, if I hear, that there is a change or a move over, then we try to feed that in. That is maybe why we are so successful.

MR. GOMEZ: Objection to the responsiveness after the "that's correct" -- the words "that's correct."

A Uh-huh. Sorry.

MR. GOMEZ: Mr. Sanders, I pass the witness.

(Time: 1:52.)

EXAMINATION

BY MR. COCO:

Q I have a couple of questions. You agree that

the airbags are -- were a good addition to automobiles, don't you?

A The airbags in general, yes. Not only for the automobile, even for the road surface much better if you are driving suspension with airbags only.

Q Okay. I mean, airbags were a good technological development?

A Yes, definitely, because you can also, under full load, but now we are going too far into techniques, maybe. Under full load, you keep always the same level of a trailer.

Q Well, now -- but with regards to automobiles, those -- those airbags being present in cars currently, give passengers better opportunity to survive accidents, correct?

A Oh, you mean airbags as -- sorry. Yes.

Q In vehicles?

A I was just on the suspension side.

Q Airbags in vehicles --

A Yeah.

Q -- give passengers a better chance to survive accidents, correct?

A Correct.

Q Okay. And you agree that was a good technological development?

A Absolutely.

Q Okay. And you are aware that the early incarnations of airbags had severe technical problems, correct?

A Correct.

Q In fact, some of the early incarnations of airbags were killing -- would have killed people had they been in the vehicles, correct?

A I know that, yes.

Q Okay. And so people studied it over the years, they worked with it, and they developed it, and then they came up with technologically and economically feasible solutions to the problem, which is the current airbags we have working today, correct?

A Correct.

Q And it took time, correct?

A Yes.

Q And it took effort, correct?

A Also correct.

Q And so if a manufacturer was to not study, and work, and develop on something like that, it doesn't get done, does it?

A That is correct, but that means, of course, now you are touching the legislation and the regulation again.

As a single manufacturer, you cannot afford to continue, let's say, for 15 years or whatever to bring such a construction maybe into a reasonable shape that this can get what you want --

Q Well --

A -- or can do what you want in future. That is financial-wise, let's say, killing that manufacturer.

The airbags you are talking, too, were done by component suppliers at that time. So that was with sensors with the explosion all of a sudden. That was not the car industry as such, these were the component people who were -- who we're dealing with.

Q Sir, is it your testimony that the U.S. automakers were not working on airbags prior to the time that the government finally said that they needed to be standard equipment in vehicles? Is that what you're telling me?

A No. No, no. That is -- that is, let's say, we have airbags now. If the -- if the state is coming to -- to certain statements saying we need, from that day onward, such and such an item, then it is equalized for everybody of the manufacturers who have to step in.

Q Sir, in the United States, surely you are aware that automobile manufacturers researched, tested, and implemented frontal airbags in our vehicles in this

country --
A Uh-huh.
Q -- well before the government said that they were mandatory, correct? You know that?
A I know that.
Q Okay. And for instance, here today, side impact airbags in passenger automobiles, are not mandatory by the government, correct? Do you know that?
A No. In Europe -- I say I don't know. In Europe, it is necessary.
Q Okay. Well, I'm going to represent to you that in the United States, side curtain airbags are not mandatory by the government.
A Okay. Okay.
Q But you do know that U.S. automakers have researched, developed, and implemented side curtain airbags in passenger automobiles in the United States, even though the government said they didn't have to, correct?
A Correct.
Q Okay. And had those automakers, with the frontal airbags, and the side curtain airbags, not undertaken the activities to innovate and perfect these safety devices, they wouldn't be there, would they?
A No, they would not be in there.

Q Okay.
MR. COCO: That's all I have. Thank you, sir.
MR. BOOK: Oscar?
MR. GOMEZ: I have nothing further. Thank you very much, Mr. Sanders.
MR. BOOK: No questions.
THE WITNESS: No problem, sir.
THE VIDEOGRAPHER: Off the record at 1:57.

CAUSE NO. 2004-320

MICHAEL JOSEPH FALCON, * IN THE DISTRICT COURT OF
TERRENCE BAKER, *
Guardian of the Person *
and Estate of KELLEIGH *
TERRAN FALCON, and as *
Next Friend for KIERRA *
FALCON and KELESE *
FALCON, Minor Children *
*
JAMES WALKER, *
Individually and as *
Representative of the *
Estate of VIRGINIA *
MARIA WALKER, *
*
Plaintiffs *
*
VS. *
*
*
LUFKIN INDUSTRIES, *
INC. *
*
Defendant * PANOLA COUNTY, TEXAS

REPORTER'S CERTIFICATE
VIDEOTAPED DEPOSITION OF YORG SANDERS
OCTOBER 21, 2006

I, Lee Richards, Certified Shorthand Reporter in and for the State of Texas, hereby certify to the following:
That the witness, YORG SANDERS, was duly sworn by the officer and that the transcript of the oral deposition is a true record of the testimony given by the witness;
That $ _____ is the deposition officer's original charges to _____ for preparing the

original deposition transcript and any copies of exhibits;
That the signature of the witness is waived;
That the amount of time used by each party at the deposition is as follows:
MR. BOOK: -- 1 hour 35 minutes
MR. COCO: -- 2 hours 6 minutes
MR. GOMEZ: -- 31 minutes
That pursuant to information given to the deposition officer at the time said testimony was taken, the following includes counsel for all parties of record:

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I further certify that I am neither counsel for, related to, nor employed by any of the parties or attorneys in the action in which this proceeding was taken, and further that I am not financially or otherwise interested in the outcome of the action.

Further certification requirements pursuant to Rule 203 of TRCP will be certified after they have occurred.

Certified to by me this _____ day of _____, 2006.

_____
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Cert No. 886
Cert Expires: 12/31/07

FURTHER CERTIFICATION UNDER RULE 203 TRCP

The original deposition was____ was not_____ returned to the deposition officer;

If returned, the attached Changes and Signature page contains any changes and the reasons therefor;

If returned, the original deposition was delivered to Mr. William Book, Custodial Attorney;

That $ _____is the deposition officer's original charges to Defendant for preparing the original deposition transcript and any copies of exhibits;

That the deposition was delivered in accordance with Rule 203.3, and that a copy of this certificate was served on all parties shown herein and filed with the Clerk.

Certified to by me this _____ day of _____, 2006.

_____
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TTMA Exhibit D


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