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REDUCING DEATHS AND INJURIES IN CRASHES INVOLVING HEAVY TRUCKS: TEN STRATEGIES[1]

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Heavy trucks are disproportionately involved in serious motor vehicle crashes. For many years this fact has been obscured by combining all trucks - heavy and light - when analyzing their experience, or by comparing heavy trucks with other vehicles in terms of crashes "per million miles of travel." While on the surface the latter type of comparison may appear resonable, it ignores the fact that much heavy truck travel is on highways (such as interstates) that have relatively low accident rates per vehicle mile of travel. Analysis by Mela (1), however, shows that on 5 U.S. toll roads the accident rates per 100 million vehicle miles were about twice as high for heavy trucks (mainly tractor trailers) as for cars. There are similar findings for non-toll roads: Brown and Owens (2) studied 17 highway segments in Alabama - two on interstates, three on four-lane highways, 12 on two-lane highways. On 15 of the 17 segments, accident rates were higher for tractor trailers than for cars.

In addition, trucks have high accident rates per registered vehicle. Tractor trailers and other truck combinations make up

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less than 1 percent of all registered vehicles, but about 2½ percent of all vehicles involved in accidents (3). When you look at fatal crashes, the statistics get even worse: a heavy truck is ten times as likely as a car to be involved in a fatal crash during a given period of time.* This means that it is especially important to modify heavy trucks in ways that will reduce their extra-high likelihood of involvement in crashes, as well as the likelihood that the crashes will result in injury or death.

The crashes are especially likely to be fatal for occupants of other vehicles that collide with heavy trucks. In Maryland, for example, fatal collisions between cars and tractor trailers resulted in death rates that were nine times as high in the cars as in the tractor trailers (4). Truck drivers themselves are also at high risk, however, partly because their total amount of driving is so great, and partly because of problems especially pertinent to heavy trucks (5).

A variety of countermeasures can and should be utilized to reduce the number of deaths and injuries from crashes involving heavy trucks. They can be categorized using ten basic strategies

*In 1974, 0.8% of all registered vehicles were tractor trailers or other truck combinations, of which 4,200 were involved in fatal crashes; 77.5% of all registered vehicles were passenger cars, of which 40,700 were involved in fatal crashes (3): (4,200/0.8) ÷ (40,700/77.5) = 10.

for minimizing the damage from dissipation of the kinetic energy in crashes (6, 7). While some of the examples given below might not appear to be feasible if applied in their more extreme forms, their consideration can lead to development or viable and effective countermeasures.

1. Prevent the initial generation of the kinetic energy or
2. Reduce the amount of energy marshalled.

Replacing all truck transport with other modes such as rail, air, water, or pipeline is unlikely, but the strategy is applicable to many instances where a choice of safer transport modes exists or can be created. In 1972, the National Transportation Safety Board estimated that deregulation of freight rates, by diverting one-fourth of the intercity truck traffic to rail, could produce a net safety benefit of 775 lives per year and more than 10,000 injuries (8).

The amount of energy can also be reduced by decreasing the weight of shipments (since kinetic energy increases with mass) - for example, by shipping less goods or using lighter-weight materials for the goods shipped, the packing substances, or the trucks themselves. Another way is to reduce the distance that goods must be transported - e.g., manufacture them closer to their destination. Practices that increase the distances that must be traveled by trucks, except for safety, economic, or environmental reasons, should be avoided.

Reducing the speeds at which vehicles travel is especially important because crash forces (which influence the probability of injury or death) vary with the square of the velocity change. Thus, crashing into a barrier at 65 mph involves forces about forty percent greater than at 55 mph. The importance of speed as a determinant of injury should be reflected in both highway speed limits and vehicle designs (for both cars and trucks) that limit top speeds.

3. Prevent the damaging release of energy.

This strategy includes measures often categorized as "accident prevention." Some truck crashes could be prevented by modifications to the highway environment such as adding passing lanes on hills, reducing the steepness of grades, increasing the radius of curvature of expressway ramps, and improving coefficients of skid resistance of road surfaces.

Changes in trucks that could reduce the probability of crashes include reduced ratios of gross weight to net horsepower, improved braking capability, antiskid devices, and lower centers of gravity. Also important are designs and practices that prevent load shifts or imbalances, and maintenance checks to reduce the likelihood of vehicle failure (4).

Truck length and width can influence crash probability by affecting maneuverability of the truck, the ease with which other vehicles can pass, and the ability of other drivers to see. In view of the crucial role of visibility and the lack of evidence

that trucks can be made wider with impunity, proposed increases in permitted truck widths from 96 to 102" (9) should await the results of both research on the effect of forthcoming increases in bus widths and field tests of wider trailers.

The truck driver's ability to avoid a crash is affected not only by the environment and by characteristics of his own and other vehicles, but by his knowledge, capabilities, motivation, and training. In addition, temporary states such as fatigue and intoxication in truck drivers has especially grave consequences for the public because of the magnitude of forces in crashes involving heavy trucks. In addition, an alcohol problem threatens not only the life but the job security of the truck driver, whose fear of being unemployable as a driver may cause him to postpone seeking treatment. (Out of 17 tractor trailer drivers killed in crashes for which they appeared to be responsible, 8 had illegal blood alcohol concentrations of 0.10% or more (10).)

4. Modify the rate or spatial distribution of the release of the kinetic energy.

The use of seat belts, which decelerate a person more gradually than if he were unrestrained, exemplifies this strategy. The Bureau of Motor Carrier Safety (BMCS) estimates that available safety belts were worn by 93% of drivers in BMCS-inspected vehicles and by 85%

of drivers in accidents reported to the BMCS (11). These figures probably overestimate usage, however, since drivers concerned about sanctions may "buckle up" at weighing or inspection stations and over-report usage when a crash is being investigated. At present there appears to be no basis for belief that a majority of professional drivers are actually protected by safety belts, especially since many companies are not covered by BMCS regulations and don't require their use.

5. Separate the kinetic energy being released and the hazardous materials being shipped from the people or structures likely to be damaged.

Hazardous materials such as explosives should be shipped at times and along routes where a crash would endanger as few people as possible. Similarly, separate roads or special hours could be designated for use by heavy trucks, to prevent collisions with more vulnerable vehicles.

Traffic lights and overpasses are two types of separation (temporal and spatial) for reducing intersection crashes. Road designs that allow vehicles to intersect the paths of fast-moving, heavily laden, hard-to-stop tractor trailers are analogous to intersections where roads cross train tracks. Yet while many rail-highway intersections are being eliminated because drivers cannot always correctly perceive and react to fast-approaching trains, similar solutions are too rarely applied to the analogous highway situation.

6. Separate with material barriers that attenuate the decelerative energy transfer.

For the truck driver, this should mean a protective cab. Increasingly, however, truck cabs are made of light weight materials

and with "cab-over-engine" (COE) designs lacking front-end crash-attenuating structures. The change to COE's was encouraged by regulations that include the tractor in maximum length limits for tractor trailers, making it possible to increase the legal payload by sacrificing driver protection. Revision of the regulations to exclude the cab from specifications for maximum truck length could encourage adoption of designs that provide adequate decelerative distance forward of the driver (4).

Another type of separation is provided by guardrails. Although they are intended to separate vehicles from opposing traffic streams, steep inclines, and unyielding roadside structures, guardrails generally are not adequate to control heavy trucks. Guardrail designs effective for both large and small vehicles have been developed but are rarely used.

7. Modify the surfaces and basic structures likely to be impacted.

This strategy includes making essential roadside structures such as lightpoles and signposts of "breakaway" designs that yield gently when struck, minimizing the damage to vehicles and occupants. Within the truck cab, edges should be rounded, structures that occupants can hit in a crash should be padded, and steering columns should be of energy absorbing designs. Unfortunately, federal motor vehicle safety standards for these and other types of occupant crash protection have been delayed, weakened, or not applied in the case of trucks (4,5).

Injury to other highway users could be reduced by designing truck exteriors so the forces are spread over as large an area as possible. When cars underride trucks, the initial collision forces are applied not to the bumper and adjacent structures but to portions of the car such as the windshield that are much closer to the occupants and not designed to absorb crash forces. Some form of truck "bumpers" are therefore needed at likely contact points, including the sides of trucks. We would scarcely condone the use of one mile - much less five thousand miles - of guardrail that could be underridden by cars. Yet five thousand miles is a very conservative estimated of the aggregate length of truck trailer sides which American motorists drive past every day, and which cars can and do underride in a wide variety of collision configurations.

8. Increase resistance to damage.

Application of this strategy is especially important with regard to preventing post-crash fires. In a series of 150 fatal crashes involving tractor trailers, 12, or eight percent, resulted in post-crash fires - compared to an estimated two percent for other fatal crashes in Maryland (4). Neither tank trailers containing flammable materials nor the fuel systems of any vehicles should rupture in crashes occurring at speeds that vehicles are designed to attain (7).

9. Move rapidly to detect damage and counter its continuation and extension.

Citizen-band radios offer an improvement in ability to report crashes, summon help, and receive instructions for management of the injured. In addition, professional drivers who travel extensively in rural areas where medical resources are scarce should be encouraged to acquire and maintain skills in important life-saving procedures such as airway maintenance, control of hemorrhage, and cardiopulmonary resuscitation.

10. Repair the damage and rehabilitate the injured.

The costs of medical care and rehabilitation of the injured are extremely high, whether measured in terms of dollars, scarce resources, or human suffering. In view of the disproportionate involvement of heavy trucks in serious crashes, we should ask whether an appropriate share of the associated cost is borne by the trucking industry - or whether much of the cost is absorbed by the public through their medical, insurance, and other societal costs. Surely shipping costs for <u>all</u> modes of transport should reflect the cost of the associated human and property damage.

In closing, I would like to emphasize that every year, about one tractor trailer or truck combination out of 250 is involved in a fatal crash, compared with one car out of 2,500. Two out of every three have some sort of reported crash, compared with one car out of five. While their crashes may represent a small proportion of all crashes, heavy trucks have such high involvement and fatality rates compared to most other vehicles that society would benefit substantially from modifications to the trucks themselves, as well as improvement of their drivers and the environment in which they travel.

The recent study of commercial vehicle goals postulates that commercial vehicle fatality rates per 100 million miles will stay fairly constant from 1975 to 1990 and that commercial vehicle mileage will increase by about 50 percent between 1973 and 1990 (9). This would mean an increase of several thousand in the absolute number of deaths every year. In view of the far lower death and injury rates, per ton-mile, for other transportation modes (8) either dramatic progress in heavy truck safety or a shift in emphasis to other modes would seem to be indicated. Hopefully the future of truck transport will be shaped in relation to other modes of freight transport, with emphasis on the conservation of lives as well as other limited resources.

References

1. Mela, D. NHTSA Update of Information on Heavy Truck Accidents. Report to National Highway Safety Advisory Committee, Dec. 8, 1975. Washington: Dept. of Transportation.

2. Brown, D.B. and Owens, J. Heavy Truck Study (Update - I) Report 300-76-002-001-028. Montgomery, Alabama: Alabama Office of Highway and Traffic Safety, 1975.

3. National Safety Council. Accident Facts, 1975 Edition, Chicago, 1975.

4. Baker, S.P., Wong, J., and Masemore, W.C. Fatal Tractor Trailer Crashes: Considerations in Setting Relevant Standards. Proceedings of the Fourth International Congress on Automotive Safety. Washington, D.C., U.S. Dept. of Transportation, NHTSA, 1975.

5. Baker, S.P., Wong, J., and Baron, R.D. Professional Drivers: Protection Needed for a High-Risk Occupation. Amer. J. Public Health, in press, June, 1976.

6. Haddon, W., Jr.: Energy Damage and the Ten Countermeasure Strategies. J. Trauma 15:99-115, 1975.

7. Haddon, W., Jr.: Reducing the Damage of Motor Vehicle Use. Technology Review 77:8:53-59, 1976.

8. National Transportation Safety Board. Safety Recommendation I-72-1. Washington: National Transportation Safety Board. May 26, 1972.

9. U.S. Government Interagency Commercial Vehicle Post-1980 Goals Study (Draft). Washington: Department of Transportation. May, 1976.

10. Baker, S.P. Alcohol in Fatal Tractor Trailer Crashes. Proceedings of the 19th Annual Meeting of the American Association for Automotive Medicine. Lake Bluff, Ill., 1975.

11. Tiemann, N.T. Required Safety Belts for Drivers in Interstate Commerce. Proceedings of National Safety Belt Usage Conference. Washington, D.C.: U.S. Dept. of Transportation, 1973.