

Does Driver Error Cause Most Truck Rollovers?

A two-year study undertaken by Battelle Laboratories (Columbus, Ohio) on behalf of the U.S. Department of Transportation's Federal Motor Carrier Safety Administration (FMCSA) found driver error in one form or another was responsible for about three quarters of all cargo tank rollovers. In addition, most rollovers occurred in single-vehicle crashes, and a large majority of the incidents occurred when there were no adverse weather conditions.

In "Cargo Tank Roll Stability Study," FMCSA identified the need to study cargo tanks, from design through operation, to improve their roll stability. To the extent possible, the scope for examination in the report was cargo tank motor vehicles carrying a hazardous material.

The purpose of Battelle's research was to identify and evaluate four broad approaches to decreasing the number of cargo tank rollovers: driver training, electronic stability aids, improvements in design of the vehicle itself, and improvements in highway design. FMCSA said it anticipates that solutions may come from regulations, outreach, operational changes, and deployment of technology.

In compiling the report, statisticians examined four crash databases to identify the conditions and circumstances that were present when cargo tank motor vehicles rolled over. They included the Motor Carrier Management Information System, the Large Crash Causation Study, Trucks Involved in Fatal Accidents, and the General Estimates System.

The collected data, while confirming many expectations, highlighted some factors that were not as strong as might have been expected. The portion of rollovers on freeways, about 15% to 20%, though substantial, was not the largest share. Only about 7% of cargo tank rollovers occurred on entrance or exit ramps. Inattention and distraction accounted for about 15%, and evasive maneuvers were a factor in only 5% to 10% of rollovers. Pavement was dry in 85% to 90% of rollovers. A vehicle-related failure as the primary cause represented less than 10% of cargo tank rollovers.

The "Cargo Tank Roll Stability Study" noted that rollovers occur in more than two-thirds of the serious single-vehicle crashes of cargo tank motor vehicles. While cargo tank trucks accounted for only 15% of all fatal crashes involving heavy trucks, cargo tank rollovers accounted for 31% of the heavy vehicle rollover fatal crashes.

For purposes of the study, trucks were classified as empty if they had cargo from 0% to 20% capacity, partially loaded if they had from 20% to 75% capacity, and as full if they had cargo greater than 75%. As expected, the majority of the rollovers occurred among trucks that had partial to full loads. From 71% to 94% of rollovers referenced in the various databases occurred among trucks with at least partial loads.

Single-vehicle events where trucks ran off the edge of the road preceded more than half of all cargo tank rollovers, and drowsiness, inattention, and speed were commonly implicated. A large number of rollovers occurred either during straight travel, 41.46%, or after the truck negotiated a curve, 31.77%. If they are in a crash, single (straight) trucks and semitrailer trucks both roll at about the same rate, Battelle noted. Truck tractors pulling one trailer, however, accounted for about 60% of all rollovers, while straight trucks accounted for about 30%.

A large percentage of rollovers occurred on non-interstate roads. Only

**ROLLOVER CRASH DRIVER ERRORS AND DISTRACTIONS CATEGORY
RELATIVE FREQUENCY (TIFA)**

Driver Factor	Straight Tank Trucks		Tractor-Semitrailleurs	
	Roll	Percent of All Rollovers	Roll	Percent of All Rollovers
None	26	23.4%	87	23.5%
Physical or Mental Condition				
Inattentive	13	11.7%	39	10.5%
Drowsy, Asleep	3	2.7%	31	8.4%
Other Physical	1	0.9%	8	2.2%
Miscellaneous Driver Errors				
Run Off Road	60	54.1%	203	54.7%
Driving too Fast	25	22.5%	102	27.5%
Erratic/Reckless	8	7.2%	29	7.8%
Over Correcting	17	15.3%	26	7.0%
Failure to Yield or Obey	9	8.1%	14	3.8%
Other Driver Error	7	6.3%	14	3.8%
Other				
Avoiding, Swerving or Sliding	11	9.9%	15	4.0%
Misc. Non-Driver Causes	2	1.8%	9	2.4%
Miscellaneous Violations	4	3.6%	7	1.9%
Possible Distractions (Inside the Vehicle)	2	1.8%	7	1.9%
Vision Obscured	2	1.8%	5	1.4%
Total				
Total	111		371	

(Note that a driver may have been coded with more than one condition, so the numbers add to more than 100%.)

15.5% took place on an interstate. A significant number occurred at or near the interchange on divided highways, but they were by no means the bulk of the problem. In fact, two-thirds of cargo tank rollovers occurred on undivided highways, while fewer than 10% happened on freeway entrance or exit ramps. A large number of rollovers took place in rural areas, representing 53.6% to 83%, depending on the source. It was also noted that a large majority, 92.9%, occurred when there were no adverse weather conditions. "Conceivably," the report said, "driver vigilance improves when the surface is slippery."

The study concluded that the number of rollovers where the driver was impaired or distracted was greater than the number where vision was obscured. "Thus, reducing driver errors due to distractions has more potential to reduce the overall number of rollovers than decreasing the incidence of vision being obscured," the report observed. In 74% of rollovers driver error was cited. While various databases referenced in the report categorize driver errors differently, decision errors were the most common, followed by roughly equal numbers of performance and recognition errors.

Again, in the majority of these cases, the pre-crash event was "a decision error on the part of the truck driver in a single-vehicle accident." In more than 90% of the accidents, rollover was not the first event; there was some other dangerous event that occurred previously. For single-vehicle accidents, the most common first event was the truck running off the road. With driver error being at least a contributing factor in three-quarters of cargo tank rollovers, errors might be a failure to notice a situation in time, a misjudgment, or driving off the road edge, the report noted. As a result, driver training warrants a

Category	Percent of All Rollovers	
	Estimate	95% Confidence Interval
Going Straight	41.46%	(28.0, 56.3)
Decelerating in traffic lane	1.86%	(0.5, 7.3)
Passing or overtaking another vehicle	1.48%	(0.3, 6.1)
Turning right	11.69%	(4.7, 26.3)
Turning left	10.46%	(4.5, 22.6)
Negotiating a curve	31.77%	(18.6, 48.6)
Changing lane	0.9%	(0.2, 5.2)
Merging	0.07%	(0.0, 0.6)
Other	0.31%	(0.0, 2.2)

closer look, with a specific focus on anti-rollover training programs.

The report recommends that researchers also need to gather more detail on dispatcher training, rollover accident reductions and cost savings from training, and turnover rates for tank truck drivers.

Electronic stability aids, devices that slow the truck when a driver enters a curve at too high a rate of speed, are an option identified by the study to provide additional safety. However, the study authors noted that crash statistics and anecdotal accounts from carriers consistently show that the majority of heavy vehicle rollovers are caused by reasons other than excessive speed in a curve.

Analyses conducted by Battelle predicted that 53% of rollovers due to excessive speed in a curve could be prevented by the particular kind of electronic stability aid that was studied. The laboratory estimated the retail cost of the option to be \$619, and that "because the prevention estimate was made with a model of a 2003 system, and vendors are continuously improving their products, the estimate of the economic benefits of the system will be conservative."

Regarding improvements in vehicle

design, the study concluded that lowering the center of gravity (height) of tank trailers is perhaps the most effective way to improve the roll stability of a vehicle. The authors noted that the advantages of a wider tank width were appreciated by many involved in the study, but that the benefits of a lowered tank were not as widely recognized. Although a significantly lowered tank is feasible from an engineering perspective, it is limited by loading rack standards.

The study notes that improvements to highway design may decrease rollover rates in some instances. Battelle undertook a nationwide identification of site-specific elements that may contribute to rollover crashes. The goal was to identify clusters of truck rollover crashes. Roadway curvature, lane width, shoulder construction, elevation, profile, and improper signage may all contribute to rollovers at a specific location, the report said.

Some of the situations noted as causing difficulty for trucks were negotiating the vertical curves along a bridge structure, close to traffic entering and exiting from nearby interchange ramps; an excess grade that deviated from the recommended maximum; and a roadway dip/horizontal curve combination, pavement conditions, and the speed differences between large trucks and light vehicles.

The entire Battelle "Cargo Tank Roll Stability Study" is available for viewing online at www.fmcsa.dot.gov/safety-security/hazmat/cargo-tank-roll-stability-finalreport-april2007.pdf.

—John Needham

Tank Type	No Roll		Roll		Total	
	Number	%	Number	%	Number	%
Gases	67	60.9	43	39.1	110	100.0
Solids	134	73.2	49	26.8	183	100.0
Liquids	636	62.4	383	37.6	1,019	100.0
Total	837	63.8	475	36.2	1,312	100.0