ROAD SAFETY BULLETIN: A QUESTION OF SIZE

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When it comes to road safety in Canada, size matters. Canada is the second largest country in the world with a land mass of 9,984,670 km² (3,855,103 mi²) and a population of 35.1 million people in 2013 (Canada Facts 2015); its road network spans almost 900,000 kilometers (km) (Transport Canada 2015c).

In a country this large, the transportation of goods is essential to Canadians, and trucking is a $65 billion industry that brings significant economic benefits. According to the Canadian Trucking Alliance, it is estimated that more than 90% of all consumer products and perishables are shipped by truck, and data from Transport Canada reveal that the number of large trucks[1] on our roads has grown in the past decade from 740,000 registered large trucks in 2003 to 1,072,000 trucks in 2013 (Transport Canada 2015b). This means that large trucks are increasingly present on our roads along with other types of vehicles including fleet vehicles, service vehicles, passenger vehicles ranging from large SUVs to smaller compact cars, and also motorcycles that represent the most vulnerable group of drivers.

To place the issue of large trucks and road safety in context, this Bulletin provides a summary of some of the latest research about this topic and describes the involvement of large trucks in road crashes, as well as the characteristics of crashes involving large trucks. It also highlights some of the most topical issues of fatigue and distraction and their implications for large truck safety.

While drivers of all types of vehicles share the roads, their driving experiences can be very different depending on the type of vehicle that they drive. In this regard, the experiences of large truck drivers are

substantially different from the experiences of other drivers who are behind the wheel of a passenger vehicle. For instance, drivers of large trucks spend much more time in their vehicle and on the road as compared to other drivers. They often drive for extended periods and their schedule may have them driving during the day or night, during weekdays, weekends and holidays, in all seasons and weather, on all types of roads and in all traffic conditions. In both Canada and the United States, the estimated average annual distance travelled for large trucks is twice the distance for passenger vehicles. In 2012, large trucks were driven an average of almost 28,000 km per year compared to 14,600 km for passenger vehicles. Similarly, in the United States, the average annual distance driven by large trucks was almost 41,000 km, compared to an average of 17,500 km for passenger vehicles. Although passenger vehicles are driven a similar average annual distance in both countries, large trucks are driven approximately 50% further on an annual basis in the United States than in Canada (Transport Canada 2015d; NCSA 2015b). The differences in average annual distance travelled by large trucks in Canada versus the United States may be due to variations in data collection practices as well as differences in terms of the types of industries relying on the transport of goods.

1 Large trucks are typically defined as vehicles that weigh 4,536 kg or more. These vehicles would include heavy unit trucks with or without a trailer, and also tractor trailers (Transport Canada 2015a). Similarly, in the United States, large trucks are defined as vehicles with a gross vehicle weight rating in excess of 10,000 pounds (NCSA 2015) which is equivalent to 4,536 kg.

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Their greater weight and mass also makes the handling and control of large trucks vastly different from that of passenger vehicles. Driving a large truck means that blind spots are much larger in accordance with the sheer length of the truck, and turning corners, particularly on city streets, requires much more space not only in length but in width. The vehicle sits higher on the road, making it more difficult to see vehicles that are smaller and lower to the ground in heavy traffic. In addition, the substantial weight of the vehicle, particularly if it is carrying a full load, means that the distance it needs to speed up as well as stop is exponential to that of a passenger vehicle. As such, climbing steep grades and passing other vehicles poses a different set of challenges, and of greatest importance, the safe following distance that large trucks require ahead of them is considerably larger since it takes more time and more space for these vehicles to stop.

Collectively, these factors mean that drivers of large trucks require different skills and training as compared to drivers of passenger vehicles. To this end, all jurisdictions in Canada have implemented licensing requirements for large truck drivers that are more rigorous than those that are in place for drivers of other vehicles. For example, Alberta has a Road Safety Action Plan which includes a professional driver designation on the driver's licence of those drivers who take the Professional Driver Certificate course at Red Deer Community College and its Partners in Compliance program for carriers with excellent safety performance. Similarly, Manitoba Public Insurance (MPI) offers an Entry Level Professional Truck Driver Training Program which provides driver training and financial support to qualified candidates (100% tuition funding) who want to work in the Manitoba trucking industry, and British Columbia utilizes a road test that is more challenging than elsewhere largely because it requires tractor-trailer combinations to be loaded, which is not the case among road tests that are administered in other provinces and territories. And, the Ontario Ministry of Transportation and training, colleges and universities are working with the Ontario Trucking Association on the introduction of mandatory entry level training for tractor-trailer drivers. Both Ontario and Quebec have also implemented legislation that sets a maximum speed of 105km/h with the support of the Ontario Trucking Association that has mandated the activation of speed limiters on all trucks. Finally, the Canadian Trucking Alliance and Transport Canada are working on a universal mandate requiring all trucks to replace paper log books and be equipped with the use of an Electronic Logging Device.

However, the nature and extent of licensing requirements, and the types of training required are varied with some jurisdictions imposing much more stringent requirements than others. As a consequence, some new truck drivers possess much more practical experience and have logged more hours behind the wheel of a large vehicle, and are better prepared to safely respond to a variable and unpredictable road environment. For these reasons, driver training is one of the priority issues of concern to industry leaders who are working to strengthen standards across the trucking industry.

At the same time, large truck safety is an important issue for the majority of Canadians. In particular, they are concerned about truck drivers who are tired from driving long hours (69.7%); large trucks that do not meet safety standards (87.1%); and large trucks traveling too fast above the speed limit (63.8%; TIRF 2010). To help place these concerns in context, it is important to examine the role of large trucks in fatal and other types of crashes.

How big is the large truck crash problem?

Large trucks accounted for 4% of all registered vehicles in Canada in 2014 and 4% in the United States in 2013 (Statistics Canada 2015; NCSA 2015a), and for the past decade there have been declining numbers of large trucks involved in fatal crashes despite substantial growth in the number of large trucks on the road. In fact, the number of large trucks involved in fatal crashes generally declined between 2000 and 2012. While it fluctuated between 443 and 527 between 2000 and 2008 in Canada, since 2009 the number of large trucks in fatal crashes has declined and ranged from 380 to 393 (Transport Canada 2015a). In the U.S. the number of large trucks involved in fatal crashes fluctuated between 4,000 and 4,100 from 2000 to 2008, dropped to a low of 3,211 in 2009 and increased again to more than 3,800 in 2012 (NSCA 2015a).

It is estimated that in Canada about 15% of highway deaths each year are due to collisions involving large trucks (TIRF 2015). In the United States, 1 out of 10, or 10% of highway deaths occurred in a crash involving a large truck.

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These data show that large trucks are over-represented in highway deaths; they accounted for less than 5% of registered vehicles but about 10% of highway deaths (NCSA 2015a).

However, the reason that persons are more likely to be killed or seriously injured in large truck crashes, particularly passengers of other vehicles, is due to the fact that large trucks weigh significantly more than passenger vehicles, and are designed with greater ground clearance; this can result in passenger vehicles under-riding trucks in crashes. To illustrate, research in Canada and the United States shows that most deaths in large truck crashes involved occupants of passenger vehicles (IIHS 2015; Mayhew et al. 2004). In 2010, in Canada, 351 out of 2,541 persons (or 14% of all fatalities) died in a collision that involved a large truck. Among these 351 fatalities, 54 of these persons (or only 15%) were large truck occupants (Brown et al. 2013). In 2013 in the United States, 71% of fatalities in crashes involving large trucks were occupants of other vehicles, 11% were non-occupants, and 17% were occupants of the large trucks (NCSA 2015a). A similar pattern emerged for people injured in crashes involving large trucks – 72% were occupants of other vehicles, 2% were non-occupants and 25% were occupants of large trucks (NCSA 2015a).

However, it is important to consider the high level of exposure of large trucks in order to place these crashes in context. Comparisons of the involvement of large trucks in fatal crashes between Canada and the United States using measures of exposure include:

1. vehicle registration (number of trucks involved in fatal crashes per 100,000 registered large trucks); and,
2. distance travelled (number of trucks involved in fatal crashes per 100 million large truck kilometres travelled).

Overall, data show that the involvement of large trucks in fatal crashes (based on 100,000 large truck registrations) is similar in Canada and the United States. In Canada, the ratio decreased from 69.9 in 2002 to 36.1 in 2012. This compares with a decrease in the ratio from 57.9 in 2002 to 35.9 in 2012 in the United States. During the same period, the ratio of involvement of non-commercial passenger vehicles (cars, vans, light trucks) in fatal crashes per 100,000 registrations decreased from 18.7 to 10.3 in Canada.

The ratio among non-passenger commercial vehicles also decreased in the United States from 22.9 in 2002 to 14.4 in 2012 (Transport Canada 2015d; NCSA 2015b).

However, if one examines the large truck involvement rate in fatal collisions based on 100 million VKTs in Canada, in 2002, the ratio decreased from 2.8 to 1.3 in 2012. In the United States, large truck involvement in fatal crashes ratio was 1.3 in 2002 and this had declined to 0.9 in 2012. By comparison, an examination of data regarding passenger vehicles revealed that the involvement rate in fatal crashes was 1.1 per 100 million VKT in 2002, and this had decreased to 0.7 in 2012 in Canada, and in the U.S. ratios for non-commercial passenger vehicles involvement in fatal crashes decreased from 1.2 in 2002 to 0.8 in 2012 (Transport Canada 2015d; NCSA 2015b).

What are the characteristics of drivers of large truck involved in crashes?

In Canada and the United States, drivers of large trucks are mostly male. Accordingly, a Canadian study (Jonah et al. 2009) found that drivers of large trucks in injury collisions were mostly male. Male drivers of large trucks had higher crash rates than female drivers of large trucks in most age categories, being more than two times higher (Knipling et al. 2004).

Of concern, young drivers of large trucks are significantly over-represented in crash populations. Fatal involvement rates for drivers of large trucks remain high until approximately age 25 (Campbell 1991; 1988; Duke et al. 2010). More specifically, fatal collision rates for drivers aged 17 to 18 were 4.5 times higher, and drivers aged 19 to 20 were six times higher than drivers of other ages in the large truck sector (Blower 1996).

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Other studies examining fatal collisions as well as collisions of all severity levels (i.e., fatal, injury, and property damage) and insurance collision claims in the United States and elsewhere have also reported an increased risk among young drivers of large trucks (Hakkanen & Summala 2001; Hamelin 1987; Stein & Jones 1988). In this regard, Campbell (1991) reported that the risk of fatal collision involvement for young drivers of large trucks is consistent with the pattern of over-involvement as drivers of passenger vehicles, as compared to adult drivers.

More recently, concerns have been raised about the crash risk of older drivers of large trucks given the chronic shortage of qualified new drivers coming into the industry (e.g., Hildebrand & Morrison et al. 2006). In a recent review of the literature, (Bergoffen et al. 2010) observed that older commercial drivers posed no greater safety risk than younger or middle-aged commercial drivers. However, given that there are functional declines associated with normal aging, the authors underscored that as the number of older persons driving large trucks increases, as will the drivers of passenger vehicles, it is important that crash data continue to be monitored for any trends that differ from their findings.

What are the characteristics of collisions involving large trucks?

Large trucks are more likely than passenger vehicles to be involved in fatal crashes involving multiple-vehicles as opposed to single-vehicles in North America. In Canada, Jonah et al. (2009) found that the majority of heavy truck fatal and injury collisions involved two vehicles. Multiple-vehicle collisions were more likely to be head-on whereas single-vehicle collisions were more likely to result in the vehicle going off road to the left or right. Similarly, in the United States a majority (80%) of fatal crashes involving large trucks were multiple-vehicle, compared with 58% for fatal crashes involving passenger vehicles (NCSA 2015a).

Mechanical fitness of vehicles has improved significantly over past 20 years. In fact, according to ORSAR in 2012 not one of the fatal crashes involving a heavy truck was attributed to mechanical defects. Driver error is the chief cause and in most fatals at least, the truck driver is not at fault.

Canadian drivers of large trucks were much less likely to be considered "at-fault" for fatal crashes (13%) than the drivers of other vehicles (39%) according to a Canadian at-fault analysis (Jonah et al. 2009).

This same study suggested that drivers of large trucks and other drivers were considered to be about equally at-fault (27% and 26%, respectively) in injury collisions. In other words, drivers of large trucks were equally likely to be considered at fault for collisions as the other drivers involved, however, the results of who was at-fault depended on the severity of the collision. In the United States, a large truck crash causation investigation found that the critical reason for the multiple-vehicle crash was assigned to the truck in 44% of the cases. For all crashes (single- and multiple-vehicle), large trucks were assigned the critical reason in 55% of the cases (FMCSA 2007).

What are the key factors that contribute to large truck crashes?

Two of the key factors in large truck crashes include fatigue and distraction (Orris et al. 2005; Bishop et al. 2011), which have also been shown to increase the likelihood that a large truck crash will be fatal (Bunn et al. 2005). Each of these factors is described in more detail below.

Driver fatigue. Driver fatigue has been recognized as a major safety problem in the transportation industry (Lee 2010; Chen & Xie 2014). The Federal Motor Carrier Safety Administration (FMCSA) estimates that 15% of large truck crashes involving death or serious injury are due to driver fatigue (McCartt et al. 2008). Of concern, McCartt et al. (2008) observed that long driving hours (roughly eight to ten hours), are related to drivers falling asleep at the wheel or reporting driver fatigue. According to McCartt, drivers of large trucks

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accumulate "sleep debt" as a result of having limited opportunities to get a full sleep cycle as needed.

Research shows that the causes and effects of sleepiness among drivers are due to the long-distance schedules, since driving is often a "monotonous, repetitive task that requires sustained attention" (McCartt et al. 2000). Tight delivery schedules associated with transporting perishable products and driving alone may be factors that contribute to fatigue among large truck drivers.

Nonetheless, crashes involving large trucks in which fatigue is a factor are under-reported, often since there is little evidence to prove the driver was drowsy, or that they had fallen asleep (McCartt et al. 2000). In other words, there are no witnesses, those involved in the crash are fatally injured, and drivers are unlikely to admit to being fatigued. Generally, drivers of large trucks themselves label fatigue as a serious problem while driving a large truck (McCartt et al. 2000; Vanlaar et. al. 2009). A review of the literature on truck driver fatigue (Orris et al. 2005) reported that:

- Falling asleep at the wheel is a common experience for truck drivers;
- Night driving is associated with poor sleep as well as with more falling asleep incidents;
- Long haul drivers get poor sleep;
- Night driving is associated with poorer driving performance;
- Reduced sleep at night is associated with poorer daytime performance and with inadequate recovery;
- Dangerous events are related to sleep deficit and prolonged driving;
- Driving while fatigued increases the likelihood of close calls;
- Time of day is far more important than hours of driving in terms of predicting observed fatigue;
- Under ideal circumstances, long daytime hours with good sleep are not a problem;
- Night sleep is important for recovery from a single day of driving and from several days of driving;
- Single drivers are more involved in fatigue/drowsy incidents than team driving;
- Insufficient recovery is related to close calls;
- Starting the work week feeling fatigued is a common experience for commercial vehicle drivers;
- Dangerous events are related to a driver's self-perceived health status and;
- Poorer lane tracking and gear shifting related to poorer general fitness.

Distraction appears to be a cause for concern for all commercial drivers and that "eyes-off-road" is more important than the nature of the distraction.

Studies to increase understanding of driver fatigue are important to develop more effective strategies of fatigue management among drivers of large trucks. Driving regulations and driver education related to fatigue can positively affect attitudes and in turn reduce the kinds of risks drivers of large trucks are taking while fatigued. Chen and Xie (2014), for example, found that increasing total rest-break duration and taking more rest breaks can reduce fatigue-related crash risk. In this regard, there is a need to design countermeasures for entry-level drivers of large trucks who continue driving while fatigued including public information and education programs, as well as training and licensing programs. Requiring electronic onboard recorders for all commercial trucks would also improve compliance with hours-of-service rules by automatically recording when a truck is driven. The recorders would replace the easily falsified handwritten logbooks drivers keep to catalog their work hours (IIHS 2015). Most recently, in March 2015, Transport Canada announced that it was, with the support of the Canadian Trucking Alliance, mandating the use of electronic logging devices (ELDs) in commercial vehicles. It was noted that this technology can help ensure that time driving

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is accurately recorded and reduce the likelihood that drivers and companies will drive for longer periods which increases crash risk (CTA 2015).

Driver distraction. Driver distraction has emerged recently as a major safety concern for drivers of all vehicle types, including those operating large trucks. Data from naturalistic studies of large trucks showed that drivers were engaged in non-driving related tasks in 71% of crashes, 46% of near crashes, and 60% of all safety-critical events (Olson et al. 2009). Bishop et al. (2011), in a synthesis of the literature on distracted driving countermeasures for commercial vehicles, concluded that commercial drivers are less prone to be involved in distraction-related crashes as compared to the general public. They also observed, however, that distraction appears to be a cause for concern for all commercial drivers and that "eyes-off-road" is more important than the nature of the distraction. Research they reviewed, for example, showed that texting is very dangerous, hand-held cell phone calls range from potentially dangerous to very dangerous, and the evidence with respect to hands-free phones is inconclusive (Hickman & Hanowski 2012). Bishop et al. (2011) noted that lock-out features, those designed to shut down cell phones or screens when a truck is in motion, are increasingly available to fleets. However, they also observed, many common driver distractions identified in the research that are not technology-based but related to eating, manipulating dials and buttons, and adjusting mirrors.

According to Olson et al. (2009) given that performing highly complex tasks while driving leads to a significant increase in risk, tasks that draw the driver's visual attention away from the forward roadway should be minimized or avoided. A motor carrier survey in Canada revealed that driver distraction is currently being addressed mainly through driver training, education and awareness programs, and cell phone policies (Thiffault 2011). This survey suggests that few carriers report using crash avoidance or other technologies to address the problem arising from driver distraction.

Other crash-related factors. Factors such as alcohol and vehicle defects are less often recorded in relation to large truck crashes. For example, large truck drivers involved in fatal crashes are seldom impaired by alcohol. In Canada in 2010, only 4.7% of fatally injured drivers of large trucks had a BAC of .08 and over, compared to 31% of fatally injured automobile drivers. Similarly, a report on Large Trucks: State of Knowledge in the United States in 2013 reported that only 2% of fatally injured large truck drivers had a BAC of .08 and over, compared to 23% of automobile drivers fatally injured in a crash (Brown et al. 2013; NCSA 2015).

Vehicle defects account for a very small fraction of large truck crashes. According to the Federal Motor Carrier Safety Administration (FMCSA 2012), vehicle-related factors were only coded for 4% of the large trucks involved in fatal crashes and tires were the vehicle-related factor most often coded.

Conclusions

Collisions involving large trucks are a concern due to the deaths and serious injuries resulting from these crashes. Data suggest that trucks are over-represented in highways deaths in light of the fact that these vehicles represent less than 5% of all registered vehicles on our roads but account for about 10% of the highway deaths each year. However, when fatal and serious injury crashes are viewed in light of the much greater distances that are travelled (i.e., exposure) compared to passenger vehicles, their crash involvement is actually much lower. In particular, although the number of large trucks on the road and the distances they travel has increased during the past decade, the number of crashes per VKT has declined.

Regardless, improvements and standardization in driver training is one important tool that can help governments and the trucking industry increase the safety of large truck drivers and other road users, and contribute to further declines in crashes. Other tools including telematic devices (such as electronic on-board recorders), and additional safety features of large vehicles (such as back up cameras and devices that prevent phone use) are also increasingly available and being adopted by some members of the trucking industry.

Distraction and fatigue are two important issues that affect drivers of all vehicles. With regard to large truck drivers, connectivity to managers is important, for example, to ensure goods are delivered as scheduled, changing weather conditions are tracked, or points of delivery are accurate. Research to develop safer practices to achieve these objectives and also minimize distraction is needed. Similarly, research to better address fatigue generally and sleep apnea in particular among large truck drivers is essential to help governments and industry identify these issues earlier and also implement prevention strategies.

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In sum, continued efforts to raise the bar for large truck safety on our roads benefit all Canadians. There are examples of positive change happening among industry and government, but more work is needed. In particular, the collection of data to inform research, and a closer examination of behaviours as well as effective strategies to increase safety are strongly encouraged. Much is known about what works among drivers of passenger vehicles. These important findings must be translated and applied in the field of large trucks.

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