Evaluation of Ontario's Speed Limiter Program for Large Trucks

A study of safety outcomes and compliance post 2009 legislation

FINAL REPORT

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EXECUTIVE SUMMARY

Introduction

Collisions involving large trucks (LT), defined here as vehicles with a Gross Vehicle Weight Rating (GVWR) above 11,793kg, tend to be more severe than those involving other vehicles. On January 1, 2009 the Province of Ontario introduced legislation mandating the use of speed-limiting technology to restrict large truck speed to 105 km/h (65 mph). A literature review indicated that only one pre-existing study used crash data to assess the effectiveness of large truck speed limiters (SLs) in reducing collisions (Hickman, et al.).

Objectives

This evaluation aimed to determine whether Ontario's speed limiter program has been effective in reducing large truck collisions on high-speed highways. Specifically, the following research questions guided our analyses: 1) what has been the effect on the frequency of collisions involving speeding large trucks on 100 km/h roads; 2) has the legislation inadvertently caused an increase in other collisions involving large trucks; and 3) are large truck drivers compliant with the legislation?

Methods – Research Questions 1&2

The analysis compared police-reported collision data from a three year pre-implementation period (2006-2008) to a three year post-implementation period (2010-2012). The study group included drivers of large trucks (GVWR>11,793kg); while the comparison group included drivers of all other vehicles. Collision data were obtained from Ontario Ministry of Transportation's (MTO) Accident Data System. The outcome measure was defined as the proportion of large truck drivers who were at-fault due to speeding (relative to all at-fault driver actions), in a collision on a 100 km/h highway. Poisson regression was used to investigate whether speed limiter implementation was associated with a pre/post change in outcome for large truck drivers that differed from any change in outcome observed for drivers of other vehicles. This outcome measure and estimation technique was used for both research questions 1 and 2, with the first research question restricted to 100 km/h roads and the second restricted to 80 km/h roads. The motivation for the second research question was to investigate whether drivers compensated for the restriction of speed on 100 km/h roads. As well, a pre/post comparison of the proportion of large trucks struck in the rear was used to investigate claims that these collisions are a consequence of speed limiter legislation.

Methods – Research Question 3

The analysis assessed data resulting from a one-year LiDAR pilot that began in August 2014. The study group included Ontario and Quebec large trucks stopped for speeding by MTO Enforcement Officers using LiDAR speed guns on 400 series highways in Ontario. Data was provided to the study by the Carrier Safety and Enforcement Branch of the Ontario Ministry of Transportation. A descriptive analysis was conducted. The outcome measure was taken as the proportion of drivers stopped for speeding above 105 km/h who were found to have an engine speed setting of 105 km/h.

Results

For Objective 1, a decrease of 72.7 percent in speeding at-fault proportion on 100 km/h roads was found for large truck drivers in the post-implementation period, which was greater than a 29.7 percent decrease found for other drivers in the post-implementation period ($p < .005$). For Objective 2, regarding large truck drivers in collisions on 80 km/h roads a similar effect was found to that of 100 km/h roads ($p = .051$). As well, no change pre/post was found in the proportion of large trucks struck in the rear (pre: 10.03, post: 10.47). For Objective 3, data collected from speeding Ontario and Quebec large truck drivers stopped during the LiDAR pilot indicated that 48.2 percent drivers had set their engine speed to match the required speed setting of 105km/h.

Conclusions

Our analysis indicates that Ontario legislation limiting large truck speed was associated with a decrease in the proportion of large truck drivers found at-fault for speeding in a collision. In addition, there is no evidence that the legislation has contributed to an increase in large truck drivers involved in other collisions. At the same time, there is room for improvement as data captured in a one-year LiDAR pilot indicates that a segment of the large truck driver population are adjusting their speed limiters to artificially indicate a speed compliant with the legislation. The collision analysis was limited by low collision outcome numbers that prevented the use of a control group more similar to large truck drivers e.g. other commercial vehicles not requiring a speed limiter. As well, the analysis of LiDAR data was limited by the lack of a comparison group.

1. BACKGROUND

1.1 Introduction

Large trucks are essential to Ontario's economy. For instance, in 2016, of the $673 billion in trade between Canada and the United States, 62 percent was transported by road (MTO, 2018). At the same time, when a large truck is involved in a collision, the outcome tends to be notable for its severity when compared to the average motor vehicle collision. Although in a fatal crash, large truck drivers are considerably less likely to have been at-fault[1] as compared to other drivers involved in the same crash, on average, approximately one in five Ontario traffic fatalities result from a collision involving a large truck[2]. Large trucks can weigh 20 to 30 times as much as passenger vehicles; have greater ground clearance, allowing for smaller vehicles to be trapped underneath; and have slower braking capability (IIHS, 2017). As well, large trucks require a much greater stopping distance than do light vehicles; a fully loaded truck traveling under normal conditions on a highway requires almost two football fields of distance in order to stop (FMCSA, 2017). For reasons such as these, a collision involving a large truck is more likely to result in fatalities, particularly for the occupant of a passenger vehicle.

Driver behaviour can compound the already hazardous nature of car-truck interactions. Driving in excess of the speed limit is an established contributor to fatal collisions. The risk is compounded when the collision involves a speeding large truck, possibly

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[1] According to Ontario's most recent data (2014), large truck drivers were coded as "driving properly" 66% of the time as compared to other drivers in the same crash, who were coded as "driving properly" only 34% of the time.

[2] According to Ontario's most recent data (2014), 21.1% of all fatalities in collisions on Ontario roads involved a large truck.

weighing up to 36,000 kg. Restricting vehicle speed by requiring speed limiters on large trucks offers a solution that reduces the potential for harm on the road, especially given their need for extra stopping distance.

A speed limiter is a setting on a truck's engine control module[3] (ECM) that limits fuel injection when the truck reaches a pre-set speed, thereby limiting the engine's top speed. These settings have been standard features in electronically controlled truck engines since the early 1990s.

1.2 Jurisdictions that mandate speed limiters on large vehicles

The concept of a speed limiter for heavy vehicles is not new. Ontario is currently one of only two jurisdictions in North America (Quebec being the other) that have mandated large truck speed limiters. Key jurisdictions that require speed limiters on heavy vehicles include the European Union and Australia. Details differ in each jurisdiction with regards to implementation. At this time no individual state in the U.S. mandates speed limiters for heavy vehicles; a Notice of Proposed Rulemaking has been released for a national law requiring the device. Of note, many large fleets were limiting their vehicle speed prior to 2009.

1.2 A Canada: Ontario and Quebec

On January 1, 2009 Ontario and Quebec implemented concurrent legislation requiring speed limiters on most large trucks (GVWR > 11,793 kg) to be set at 105 km/h. A scan of the remaining provinces and territories identified no other jurisdictions that require speed limiters on large trucks.

1.2 B European Union

A 1992 European Union (EU) Directive (92/6/ECC) (Transportation & Mobility Leuven, 2013) mandated buses over 10 tonnes and trucks over 12 tonnes to be equipped with speed limiters set to 100km/h and 90km/h respectively[4] (Transport Canada, 2008). In

[3] An embedded system that controls one or more of the electrical systems or subsystems in a transport vehicle. (https://en.wikipedia.org/wiki/Electronic_control_unit)

[4] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32004L0011

2002, the EU expanded their speed limiter legislation to include medium-duty vehicles under Directive 2002/85/EC, to include buses under 10 tonnes (with eight or more passenger seats), and weighing more than 3.5 tonnes. Some member states have taken steps beyond the directive. The United Kingdom, for example, requires that new vehicles install tamper-proof devices and that all regulated trucks and buses cannot use outside lanes of highways.

1.2C Australia

In 1990, Australia began requiring speed limiters on new heavy vehicles (as of 1990) (Australian Design Rule 65[5]). All heavy trucks with a gross vehicle mass of 12 tonnes and all buses over five tonnes must be fitted with a speed limiter set to no more than 100 km/h (Transport Canada, 2008).

1.2D United States

No individual states require large vehicle speed limiters. A survey sent to all 50 states and the District of Columbia (D.C.) in December 2015, using a contact list provided by the Commercial Vehicle Safety Alliance (CVSA)[6], resulted in responses from 33 states; responses were received from a further ten jurisdictions contacted through Department of Transportation websites. All states confirmed that they did not require large truck speed limiters. No responses were provided by D.C., Georgia, Hawaii, Idaho, Louisiana, Utah, Virginia and Washington, but there is no evidence that these states require speed limiters.

At the federal level, the United States Department of Transportation's National Highway Traffic Safety Administration (NHTSA) released a Notice of Proposed Rulemaking in August 2016 proposing regulations that would require vehicles with a GVWR greater than 11,793 kg to be set at or below a maximum speed to be specified in a Final Rule[7].

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[5] https://www.legislation.gov.au/Details/F2006L02297

[6] http://www.cvsa.org/contactus/lead_agency_contacts.php

[7] https://www.fmcsa.dot.gov/regulations/usdot-speed-limiting-devices-nprm

Efforts toward speed limiter legislation in the U.S. began in 2006 with a petition submitted by the American Trucking Association to NHTSA.[8,9]

1.3 Speed Limiters in Ontario

The Province of Ontario began mandating the use of speed limiters in large trucks on January 1, 2009. The legislation requires large trucks built after December 31st, 1994 with a Gross Vehicle Weight Rating[10] (GVWR) of 11,794 kilograms or more, licensed or operating in Ontario and equipped with electronic engine control, to use an electronic speed limiter that limits their maximum speed to 105 kilometres per hour (km/h)[11,12]. Ontario's choice of a maximum speed setting of 105 km/h was supported by a 2009 traffic simulation model study (Saccomanno, et al., 2009) that found that large truck speed limiters set at 105 km/h increased safety in uncongested regions of traffic flow.

In addition, speed limiters are intended to reduce fuel consumption and contribute to a cleaner environment. Ontario's Climate Change Update 2014[13], describes a wide range of initiatives implemented in Ontario to reduce greenhouse gas[14] (GHG) emissions.

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[8] https://www.federalregister.gov/documents/2011/01/03/2010-33057/federal-motor-vehicle-safety-standard-engine-control-module-speed-limiter-device

[9] https://www.federalregister.gov/uploads/2011/01/the_rulemaking_process.pdf

[10] The GVWR refers to the maximum operating weight/mass of a vehicle as specified by the manufacturer.

[11] Ontario HTA section 68.1:https://www.ontario.ca/laws/statute/90h08?search=speed+limiting
https://www.ontario.ca/laws/regulation/900587

[12] Commercial vehicles that are exempted from speed limiter legislation include: Bus, mobile crane, motor home, vehicle manufactured before 1995, vehicle with GVWR under 11,794 kg, ambulances, cardiac arrest emergency vehicle, fire apparatus.

[13] The current report provides an update of Ontario's progress towards targets defined in the 2007 Climate Change Action Plan.

[14] Transportation: Source of GHG emissions is the combustion of fossil fuels such as diesel, gasoline and propane.

The combined effect of transportation initiatives, which includes speed limiter regulation, is expected to produce a GHG emission reduction of 4.6 Mt by 2020[15].

Contravening Ontario's *Highway Traffic Act* requiring speed limiters on large trucks can result in fines ranging from $250 to $20,000 (Canadian). Most commonly, the driver and/or operator of the vehicle is fined $390. Charges are laid for having a maximum road speed setting of greater than 105 km/h on the vehicle's electronic control module; for indication of tampering with the speed limiting device; for driver refusal to allow an Officer access to their electronic control module; and for driver speed recorded at/above 115 km/h[16]. Driving at/above 115 km/h results in a charge under a "deeming provision" that allows Police and MTO Enforcement Officers to legally assume that a vehicle moving at that speed does not have a speed limiter set. The provision acknowledges the potential for an accurately limited commercial vehicle to reach speeds above 105 km/h under certain conditions (e.g. a grade), but no higher than 115 km/h.

Currently the road speed setting on a truck's electronic control module is scanned by an Officer using an EZ-Tap read-only device. This plug-in device reads and displays engine parameter settings that are required to be set at specific points in order to limit the vehicle speed to 105 km/h. Drivers may use many different techniques to tamper with their devices; a sample of methods used follows:

- EZ-Tap ECM reader technology currently used reads and displays a limited number of engine parameter settings. Drivers can change the setting within the engine for unmonitored parameters such as the rolling radius of tires or the gear ratio to their benefit. For example, a larger tire size setting will register a speed that is slower than actual speed.
- Abuses of the electronic driver reward feature which allows a vehicle owner to permit a higher speed limit for drivers with, for instance, good fuel economy

[15] Ontario Ministry of Environment and Climate Change (2014).*Ontario's Climate Change Update 2014.* Retrieved from: https://dr6j45jk9xcmk.cloudfront.net/documents/3618/climate-change-report-2014.pdf. See Table 4.

[16] Ontario HTA section 68.1: https://www.ontario.ca/laws/statute/90h08?search=speed+limiting https://www.ontario.ca/laws/regulation/900587

habits. For example, rewarding the driver for not idling for 24 hours a day, can allow the driver to override the speed limit.

- The Bully Dog timer which can reprogram the engine computer to improve the engine's efficiency may allow for speed limiter adjustments allowing the driver to change their top speed and cruise control speed setting.

1.4 Literature Review

1.4A Speed and Collision Risk

Speed limiters are supported by literature that establishes a strong relationship between speed and road safety. This finding is true for analyses that examine collisions involving a mix of vehicles on the road as well as those that focus specifically on the crash risk related to large trucks in speed collisions.

In a meta-analysis of 97 studies by Elvik et al (2004) a relationship was found between speed and the number and severity of crashes; in fact speed was found to be the primary determinant in the frequency of crashes. Another source of multiple studies on the relationship between speed and crashes are those that examine the effect on road fatalities associated with the 1995 repeal of the National Maximum Speed Limit in the United States. One such study by Friedman et al (2009) found a 3.2% increase in the number of road fatalities related to raised speed limits on all road types. Addressing the negative consequences of speeding, a 1997 case-control study (Kloeden, et al.) concluded that even a small reduction in traveling speed could lead to large potential safety benefits, finding that the risk of involvement in a fatal or injury crash doubled with every 5 km/h increase in free traveling speed over 60 km/h.

For large truck crashes specifically, in their examination of differential speed limits, Korkut et al (2010) found that the rate of collisions increased when trucks violated their speed limit. Specifically, in a report to congress, the Federal Motor Carrier Safety Administration's (FMCSA) Large Truck Crash Causation Study estimated that 22.9 percent of all large truck crashes and 10.4 percent of large truck/passenger car crashes could be coded as "traveling too fast for conditions" (FMCSA, 2006).

1.4B Speed differentials and collision risk

Respondents in the survey (ATRI, 2007) who were not utilizing speed limiters were asked to elaborate on the reasons for their choice. Forty-one percent of large truck drivers and carriers surveyed believed that large truck speed limiters compromise safety. The potential for a car-truck speed differential caused by large trucks limited to a lower speed than the general flow of traffic was a primary concern; seen as increasing the potential of being struck in the rear.

Multiple studies have found that different speed limits for trucks and cars did not impact collision risk. A 2008 University of Waterloo traffic simulation model study mentioned earlier found that large truck speed limiters set at 105 km/h increased safety in uncongested regions of traffic flow. When maximum speed was set at 110 km/h the safety gains of mandating speed limiters were negligible (Saccomanno, et al., 2009).

Studies that utilize data from U.S. States with differential posted speed limits for cars and trucks can be used to assess the safety impact of differential speed flow. Results of a 2002 study comparing the safety effects of a uniform speed limit for all vehicles to that of differential speed limits for cars and heavy trucks over a ten-year period found no consistent safety effects for states that employed a uniform speed limit (Sun & Garber). A 2009 study using 15 years of state-level data found that higher speed limits for cars and trucks contributed to higher fatality rates, but differential speed limits between the two vehicle types had no significant impact (Neeley & Richardson).

1.4C Research on Speed Limiters

At the same time, a search for studies that use crash data to assess the effectiveness of large truck speed limiters in reducing collisions generated only one article. Hickman et al (2012), compared crash results for large truck fleets that require speed limiters to those that do not, and found that trucks that did not use speed limiters were significantly more likely to be involved in a speed limiter-relevant crash (1.94 times greater than trucks with speed limiters). As this study was conducted in the U.S., carriers included in this study chose to limit the speed of their trucks, whereas in Ontario, speed limiters are required for large trucks. This difference may limit the study's relevancy to Ontario, as it is possible that the overall safety culture of a (U.S.) company that self-imposes speed limiters may contribute to better collision outcomes, (as noted by the authors). In other words, Ontario's experience would be quite different from that of the study population.

A number of surveys have been conducted drawing on the experiences of U.S. carriers and drivers who use speed limiters on their large trucks. While not empirical in their approach, they nonetheless speak to the perceptions of speed limiter effectiveness and associated behaviours. Bishop et al (2008) conducted a survey of 103 fleet safety managers in a convenience sample and found that 64 percent indicated that speed limiters were either successful or very successful in reducing crashes. Even so, 88 percent of respondents believed that their drivers were likely speeding when on lower limit roads to "make up time". Lack of compliance was at the heart of the question on speed limiter tampering, addressed to 148 carriers and drivers (across the trucking industry) in an American Transportation Research Institute (ATRI, 2007) survey in which 30.2 percent of respondents believed driver tampering was an issue.

1.5 Constitutional Challenge

The argument that the speed differential between large trucks and buses would cause rear-end collisions was the basis of an ultimately unsuccessful constitutional challenge to Ontario's large truck speed limiter legislation.

Gene Michaud, an Ontario commercial truck driver was charged with contravening speed limiter legislation in 2009 for having his speed limiter set to 109.4 km/h. In 2012, backed by the U.S. Owner-Operator Independent Drivers Association, Mr. Michaud challenged the legislation in court arguing that the law was unsafe and violated his charter rights. The Justice of the Peace acquitted Mr. Michaud on the basis that legislation infringed his right to security of person and thereby violated s.7 of the Canadian Charter of Rights and Freedoms. In 2013, on appeal the Ontario Court of Justice admitted fresh evidence that found no Charter violation and reversed the earlier decision. Of note, the 2012 Hickman article mentioned earlier was included as fresh evidence. The Ontario Court of Appeal upheld the legislation in 2015 after an appeal by the Michaud family. On May 5, 2016, the Supreme Court of Canada denied the Michaud family's application for leave of appeal, thus ending the challenge. The 2015

Court of Appeal ruling would stand; the law requiring the use of speed limiters in large trucks in Ontario is not unconstitutional[17].

1.6 Initial Evaluation 2010

A preliminary evaluation of the safety effect of large truck speed limiters was conducted in 2010 comparing collision data from 2009 (Education period - January to June, Enforcement period – July to December) to the average from the same six month periods in 2005 to 2008. Overall findings suggested improvements in road safety during that time. MTO committed to a formal evaluation of the program once three years of data post legislation was available; the current evaluation fulfills this commitment.

2. OBJECTIVES

Given Ontario's implementation of speed limiter legislation, the supporting evidence and the availability of data, the current evaluation was conducted to examine the effect of this legislation on large truck safety on Ontario's highways. The primary focus was on quantifying changes in collision frequency following the introduction of large truck speed limiter legislation in 2009. In addition, a secondary focus on large truck driver behaviour related to the new requirement (e.g., compensatory speeding and usage compliance) was examined.

In terms of road safety, speed limiter legislation was intended to limit truck driver operating speeds on 100km/h roads to 105km/h in an effort to reduce collisions. Therefore our first research question asks:

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[17] For more:

- https://www.canlii.org/en/on/onca/doc/2015/2015onca585/2015onca585.html?searchUrlHash=AAAAAQANc3BlZWQgbGltaXRlcgAAAAAB&resultIndex=4
- https://www.canlii.org/en/on/onca/doc/2015/2015onca585/2015onca585.html?searchUrlHash=AAAAAQAIaGFtaWx0b24AAAAAAQ&resultIndex=2

- Has mandatory requirement to limit large truck speed had an effect on the number of large truck drivers found at-fault for speeding in collisions on roads with a maximum speed limit of 100 km/h?

Yet by limiting operating speeds, the legislation may have inadvertently increased other collision types. For example, drivers burdened with restricted operating speeds may compensate by driving too fast on lower limit roads. As well, the potential for a rear-end collision may have increased as a consequence of the speed differential created between the large truck and the general flow of traffic. Therefore our second research question asks:

- Has large truck speed limiter legislation had an effect on the number of large truck drivers found at-fault for speeding in collisions on lower limit highways; or on the number of trucks struck in the rear in collisions occurring on 100 km/h roads?

Driver actions that increase collision risk, such as the above-mentioned attempt to compensate for the speed restriction, are one form of non-compliance with the legislation. Another form of non-compliance, and the focus for our third research question, relates specifically to driver usage of the speed limiter setting. A large truck driver who has an ECM speed setting above 105 km/h for whatever reason is clearly non-compliant. To assess driver compliance with the legislation, we investigate drivers who consciously defy the legislation; setting their ECM to indicate a speed setting of 105 km/h while continuing to drive above 105 km/h. Tampering with the speed-limiting setting to mask actual speed is easily done, and has the potential to weaken the effect of the speed limiter legislation. We focus on this non-compliant driver as their intention is unambiguous. Therefore our third research question asks:

- What is the relationship between the observed speed and the recorded Electronic Control Module (ECM) speed setting for large truck drivers stopped for speeding in the one-year LiDAR pilot?

3a. METHODS: Research Questions 1&2

Summary of objectives:

- What has been the effect on the frequency of collisions involving speeding large trucks on 100 km/h roads; and
- Has the legislation inadvertently caused an increase in other collisions involving large trucks?

3a.1 Data Source

Police reporting of collisions in Ontario on an annual basis is recorded in the Accident Data System (ADS)[18]. Information extracted from the ADS included: Vehicle type, speed limit on the road where the collision occurred, severity of collision (fatal, injury, property damage), vehicle licence plate numbers, indication of self-reported collision, vehicle manoeuvers/actions, driver actions, initial impact type, impact sequence, make of vehicles and body styles. For each vehicle involved in a collision, the following were extracted from the CVINA[19] database and merged with ADS data: Weight (GVWR), vehicle type, number of axles and vehicle make, series and body type.

3a.2 Data Preparation

For each of the six years of the study (2006-2008, 2010-2012), a merged dataset combining the ADS variables and VIN data of interest was extracted. Drivers in police-reported collisions were divided into two categories based on their vehicle GVWR: "Large trucks" (GVWR>11,793kg) and "other vehicles" (all GVWR<=11,793kg, large buses GVWR>11,793kg). Vehicles in each GVWR category were then assessed manually for consistency with ADS data[20] in terms of weight and vehicle description. To ensure the independence of each category, the sample only included vehicles that could be identified clearly as large trucks or "not" large trucks. Where ambiguity

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[18] The Ministry of Transportation collision database captures every *Highway Traffic Act* (HTA) reportable motor vehicle collision (any collision resulting in a fatality, personal injury or property damage in excess of $1,000.00) occurring on public roads in the province. The Safety Policy and Education Branch, Ministry of Transportation are users of the ADS collision database. Note that as of September 2015 property damage collisions are reportable at $2,000.

[19] Vehicle Identification Number Analysis tool by Polk

[20] For example, Tractor-trailer (ADS vehicle type), GVWR >11,793kg (CVINA). See appendix for all ADS vehicle types.

existed, cases were eliminated from the dataset. In the case of discrepancy, or where ADS vehicle type and description were known but the GVWR was not, variables that describe the vehicle in both datasets were used to assess inclusion as a “large truck” or “other vehicle”; if determination was unclear, the case was eliminated. Where neither ADS vehicle type nor GVWR were available the case was eliminated. A final total of 189,830 vehicles were included in the primary analysis.

3a.3 Study Design

Our main interest was to see whether speed limiters were associated with a change in the number of collisions where the large truck driver was at-fault for speeding. Specifically, the primary outcome for this study was the number of large truck drivers found to be at-fault in a collision due to speeding as a proportion of all large truck drivers at-fault. A measure of exposure was necessary as well to account for any changes in exposure i.e. travel time on the road, which may have occurred over the course of the two phases of the study. We chose to assess drivers in collisions who were at-fault for all driver actions as our measure of exposure in our analysis of speeding large truck drivers in collisions. To isolate the effect of the speed limiter, drivers at-fault for speed were assessed relative to all at-fault driver actions.

With any change in exposure we would expect a similar change in all at-fault driver actions; identifying a different pattern for drivers at-fault for a specific driver action, in this case speeding, would indicate that the frequency of that driver action in collisions had changed as compared to frequency of all driver actions.

At-fault determination was based on police coding of driver action in a collision, as recorded in ADS[21]. A driver is deemed at-fault for any action that may contribute to a collision. This coding does not determine overall fault, as police assign a driver action to every driver in the collision. For this study drivers coded as “speed too fast” were

[21] The full-list of at-fault driver actions is as follows: Following too close, speed too fast, speed too fast for conditions, speed too slow, improper turn, disobey traffic controls, fail to yield, improper passing, lost control, wrong way on a one way road, improper lane change and “other” (e.g. hit and run, driving on the wrong side of the road).

compared to drivers coded with any of the other at-fault actions. Note that drivers coded as “driving properly” or as driver action “unknown” were excluded from the analysis.

Drivers involved in a police-reported collision on high speed Ontario highways (80-100 km/h) between 2006 and 2012 comprised the study population. Collision outcomes were compared between the pre (2006-2008) and post (2010-2012) legislation phases. Although our outcome measure is correlated for exposure changes, simply comparing the two phases would not fully account for background trends in collision rates caused by other external factors, such as a climate event or an economic recession, which might affect the collision outcome. Therefore a control group of “other vehicles” was introduced:

Drivers of trucks with a Gross Vehicle Weight Rating (GVWR) greater than 11,793 kg at the time of collision were compared to drivers of all other vehicles. Although drivers of commercial motor vehicles that do not require a speed limiter (GVWR<11,794kg / large buses / large trucks with a GVWR>11,794 but built before 1995) offer the best comparison group, they could not be used in the final analysis as collision outcomes for these groups were too small to produce meaningful results.

Note that collision data for 2009 was excluded, as large truck speed limiters were phased in over the course of 2009, commencing with a six-month education period during which no charges were laid. As a result, collisions that occurred in 2009 may not reflect the effect of speed limiters in the same way as those that occurred post legislation.

Counts for the primary outcome were modelled using a Poisson regression, in which independent variables included time period (pre-mandatory SL, post-implementation), group membership (large truck, other vehicles), and their interaction. The number of drivers at-fault for all reasons in a collision was incorporated into the model as an offset (exposure).

The secondary outcome was the number of rear-end collisions in which a driver of another vehicle struck a large truck. Counts for the secondary outcome were measured relative to the number of all collisions involving a large truck for both the pre and post phase.

3b. METHODS: Research Question 3

Summary of objective:

- To what extent are large truck drivers compliant with the legislation?

3b.1 Data Source

MTO Enforcement Officers on Provincial highways identify speeding drivers using a LiDAR[22] speed gun; EZ-Tap ECM technology readers are used to scan and display a number of the engine parameters that must be set to specific targets to limit the engine speed to 105 km/h. Drivers stopped by Enforcement Officers for speeding (observed using a LiDAR speed gun) are subject to a test of their engine speed settings (scanned using an EZ-Tap ECM reader and recorded). This analysis used the observed speeds (LiDAR speed gun) and recorded engine speed settings (EZ-Tap ECM reader) of speeding large truck drivers collected by MTO Enforcement Officers during the one-year LiDAR pilot [23](August 2014-August 2015).

3b.2 Data Preparation

A dataset of speeding licensed Ontario and Quebec large truck drivers travelling in Ontario was extracted from data collected during the LiDAR pilot. As Quebec and Ontario are the only two North American jurisdictions that require a speed limiter for large trucks, it is presumed that all of these drivers were aware of the requirement. Speeding drivers (observed at speeds above 105 km/h) were divided into four categories based on their recorded ECM engine speed setting: Set above 105 km/h, set at 105 km/h, no reading available, and driver refusal i.e. drivers who refused to have their engine speed scanned. Drivers with ECM settings of 105 km/h observed travelling at speeds just below the deeming provision of 115 km/h, were noted in the analysis.

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[22] LiDAR speed guns: Advanced speed enforcement gun using laser that can pinpoint individual vehicles in multi-lane traffic

[23] Data from Carrier Safety and Enforcement Branch, Ministry of Transportation

3b.3 Study Design

Ontario and Quebec large truck drivers stopped by MTO Enforcement Officers for speeding on 100 km/h Ontario highways, during a one-year period (August 2014-August 2015), comprised the study population. Speeds observed by a LiDAR speed gun were compared with the recorded speed setting as displayed by the EZ-Tap reader. A descriptive analysis was used to compare percentages of speeding drivers in each of four categories of recorded ECM engine speed settings cited above. The outcome measure was taken as the proportion of drivers stopped for speeding above 105 km/h who were found to have an engine speed setting of 105 km/h. These drivers were further divided by the frequency of observed speeds for each 1 km/h change, for speeds between 107 km/h and 136 km/h (the top speed observed). Drivers observed at speeds of 106 km/h were excluded from the analysis to allow for slight differences in device calibration.

4. RESULTS

Research Question 1

The first research question asks whether requiring large trucks to have speed limiters has had an effect on collisions involving speeding drivers on 100 km/h roads. An initial descriptive analysis of collision outcomes for the sample population, i.e. the study (large trucks: GVWR 11,794 kg+) and comparison (other vehicles) group, indicated an 11.2 percent decrease for large truck drivers in police reported collisions post the 2009 large truck speed limiter legislation, from 9,485 (2006-2008) to 8,427 (2010-2012) collisions. By comparison, drivers of other vehicles experienced an increase of 6.8 percent in collisions, from 83,103 (2006-2008) to 88,815 (2010-2012). This initial analysis did not control for confounding factors (Figure 1).

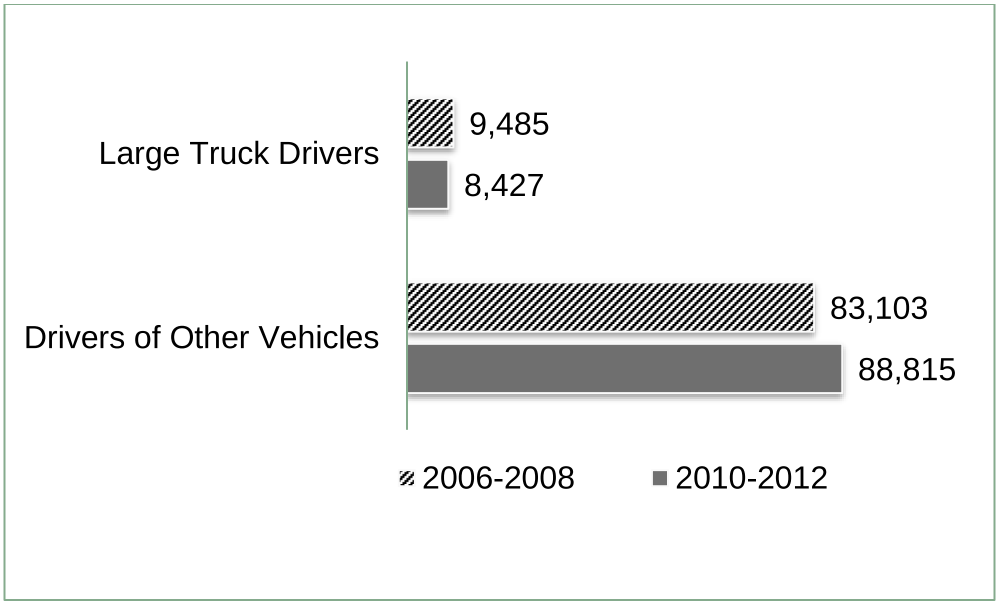

Figure 1: Drivers in collisions on 100 km/h highways

A further examination was conducted in which large truck drivers at-fault for speed on 100 km/h roads were assessed relative to all large truck drivers at-fault for any reason in collisions. For this analysis, drivers of "other vehicles" were used as a control group. The percent of large truck drivers at-fault due to speeding, relative to all at-fault driver actions decreased 72.73 percent post implementation of speed limiter legislation (from 1.1% to 0.3%). In comparison, drivers of all other vehicles indicated a decrease of 29.73 percent (from 3.7% to 2.6% post 2009) (Figure 2, Table 1). Comparatively, the reduction in the number of speeding large truck drivers in collisions was 2.4 times that of the reduction for all other speeding drivers in collisions.

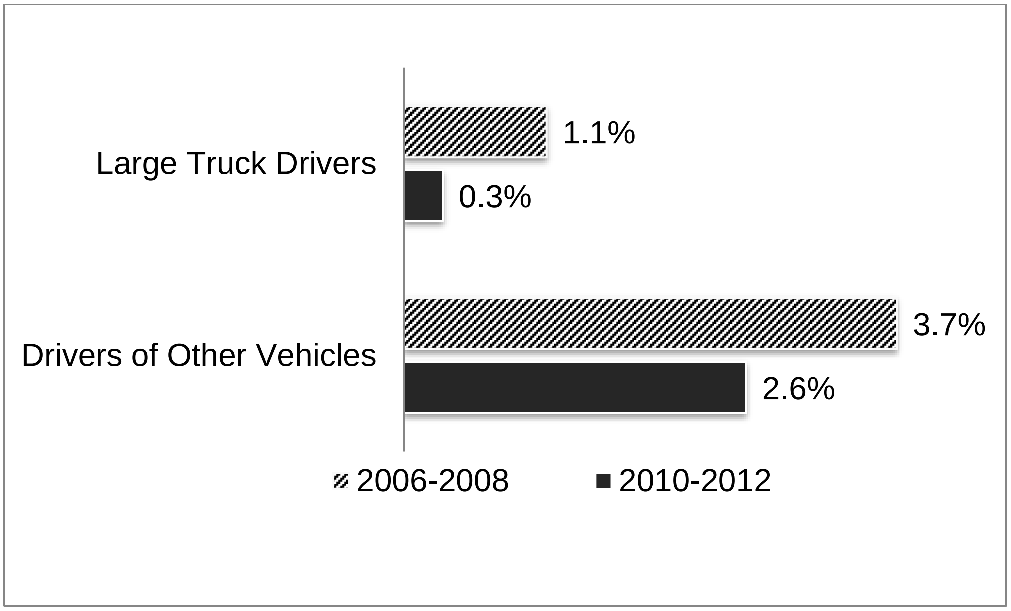

Figure 2: Drivers in speed collisions on 100 km/h highways

	2006-2008			2010-2012		
	Speed At-Fault	Total At-Fault	% of Total	Speed At-Fault	Total At-Fault	% of Total
Large Truck Drivers	46	4,320	1.1	11	3,817	0.3
Drivers of Other Vehicles	1,544	41,928	3.7	1,117	43,694	2.6

Table 1: Drivers in speed collisions on 100 km/h highways

Results of a Poisson regression indicate a significant overall decrease in the primary outcome measure for both drivers of large trucks and other vehicles of 31% ($\exp(\beta) = 0.694, p < 0.000$) from pre to post periods. However, a significant interaction effect shows that this decrease in the number of drivers being at-fault due to speeding (relative to being at-fault for any reason) was a further 61% for large truck drivers ($\exp(\beta) = 0.390, p < 0.005$), possibly due to speed limiter implementation.

Research Question 2

The second research question asked whether requiring large trucks to have speed limiters has inadvertently created secondary effects. As above, drivers of “other vehicles" were used as a control group in the analysis of large truck speed collisions. The results of two analyses undertaken follow:

An examination of large truck drivers in collisions on 80 km/h roads, where drivers could potentially speed up to 25 km/h above the speed limit, was conducted. As above, large truck drivers at-fault in a collision due to speeding on 80 km/h roads were assessed relative to all large truck drivers at-fault in collisions on these roads. Results indicated a decrease from 1.37 to 0.56 percent post implementation of speed limiter legislation for drivers at-fault due to speeding relative to all at-fault driver actions. By comparison drivers of other vehicles noted a decrease from 2.73 to 2.37 over the same time period (Table 2).

	2006-2008			**2010-2012**		
	Speed At-Fault	Total At-Fault	% of Total	Speed At-Fault	Total At-Fault	% of Total
Large Truck Drivers	29	2,118	1.37	9	1,599	0.56
Drivers of Other Vehicles	1,564	57,273	2.73	1,137	47,949	2.37

Table 2: Drivers in speed collisions on 80 km/h highways

Results of a Poisson regression indicate a significant overall decrease in the outcome measure for both drivers of large trucks and other vehicles of 13% $(\exp(\beta) = 0.870, p < 0.000)$ from pre to post periods. A marginal interaction effect shows a possible decrease in the number of drivers being at-fault due to speeding (relative to being at-fault for any reason) that was a further 53% for large truck drivers $(\exp(\beta) = 0.473, p = 0.051)$.

An analysis of lead large truck drivers hit in the rear by following vehicles, relative to all large truck drivers in collisions, indicated no substantial change in proportions from the pre to post 2009 phase of the study (Table 3). Of all large truck drivers involved in collisions, 10.03 percent were struck in the rear pre 2009, and 10.47 percent were struck in the rear post 2009. A small increase was indicated for "other drivers" post 2009 with an increase from 18.61 pre to 21.32 percent post-legislation. No testing for significance was undertaken as the similarity of the outcome measure for large trucks in the two study phases was clear.

	2006-2008			**2010-2012**		
	Rear-Ended	Total	% of Total	Rear-Ended	Total	% of Total
Large Truck Drivers	951	9,485	10.03	882	8,427	10.47
Drivers of Other Vehicles	15,464	83,103	18.61	18,939	88,815	21.32

Table 3: Lead drivers rear-ended, of total drivers in collisions, on 100 km/h highways

Research Question 3

The third research question asks whether large truck drivers are compliant with the legislation requiring them to have an electronic speed limiter set at 105 km/h. Data from the one-year LiDAR pilot (August 2014 – August 2015) suggested that some speeding drivers were altering their speed settings. Although these drivers were observed with LiDAR speed guns to be speeding on 100 km/h highways, when their Electronic Control Module (ECM) was scanned by an MTO Enforcement Officer, a speed setting of 105 km/h was displayed by the reader.

Data collected from speeding Ontario and Quebec large truck drivers stopped during the LiDAR pilot indicated that 48.19 percent (239) drivers had deliberately set their engine speed to match the required speed setting of 105km/h. Displayed engine speeds for the remaining large trucks were as follows: Engine speed settings above 105 km/h were displayed for 22.78 percent (113), no reading was available for 27.82 percent (138), and 1.21 percent (6) drivers refused to comply with officers (Figure 3).

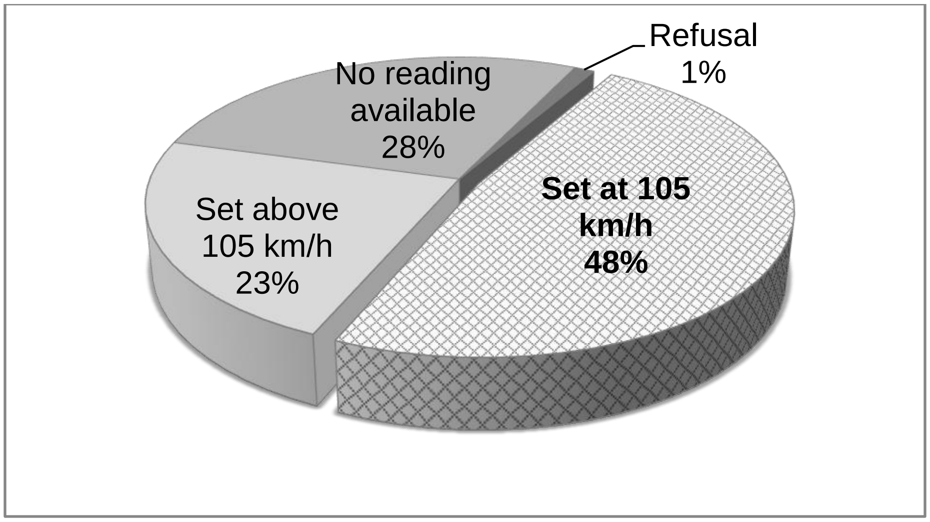

Figure 3 LiDAR Pilot: Total Ontario and Quebec large truck drivers stopped for speeding on 100 km/h Ontario highways, n=496

Of the 48 percent of speeding large truck drivers with engine speed setting of 105 km/h, more than half (55.2%, 132) were observed traveling between 110-114 km/h; thirteen percent were traveling at/above 115 km/h (Figure 4).

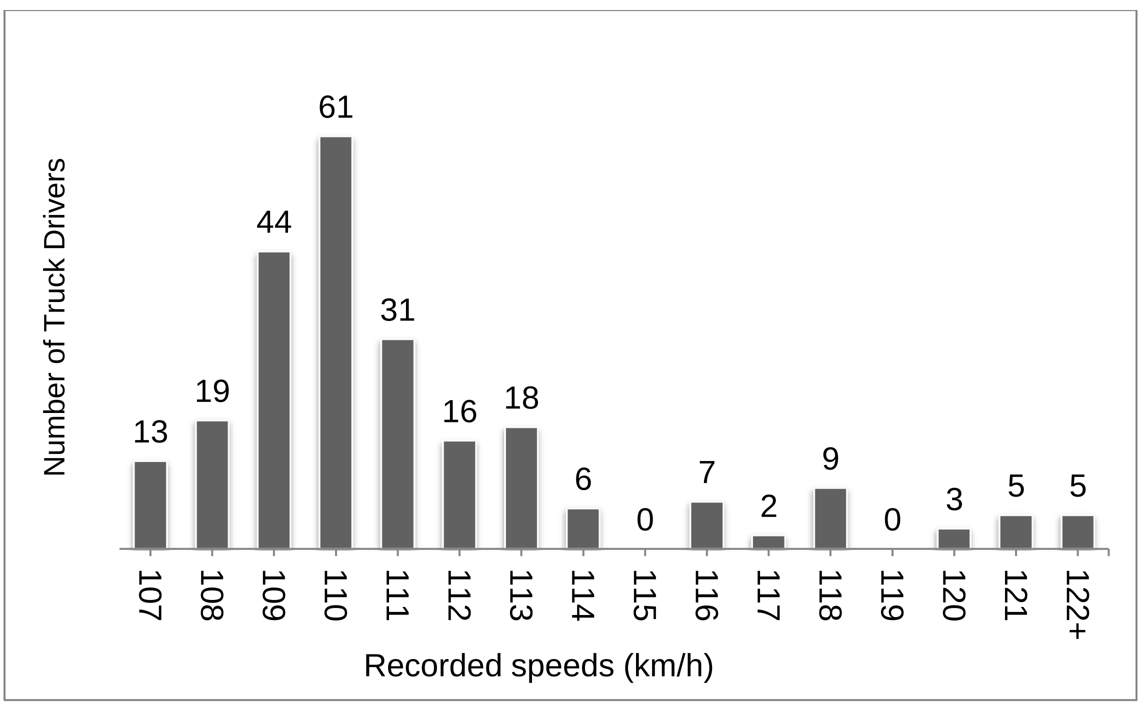

Figure 4 LiDAR Pilot: Ontario and Quebec large truck drivers stopped for speeding on 100 km/h Ontario highways with engine speeds set at 105 km/h, n=239

As mentioned earlier, speed limiter legislation in Ontario includes a deeming provision which allows charges to be laid against the driver and/or operator when a large truck is observed traveling at/above 115 km/h regardless of the ECM speed setting.

5. DISCUSSION

Our main purpose in conducting the current analysis was to evaluate whether legislation requiring large trucks to electronically limit their speed to 105 km/h has had an effect on road safety. If indeed limiting large truck speed has been a success as intended, then we would expect the effect to be manifested as a decrease in large truck collisions post legislation, in particular those involving speed.

A preliminary descriptive analysis of large truck drivers in collisions indicated a drop of 11.2 percent in collisions post 2009 as compared to an increase of 6.8 percent for drivers of other vehicles. Analysis did not account for other factors, including changes in exposure and background trends, which may have played a role in describing the decrease in collisions.

A comprehensive analysis with a focus on speeding, found that large truck drivers were significantly less involved in speeding collisions (coded as "speed too fast" in the police report) than the comparison group of drivers of other vehicles post implementation of speed limiter legislation. A significant decrease in drivers at-fault for speed relative to all at-fault driver actions was noted post 2009 for both large truck drivers and drivers of other vehicles. The significant interaction between pre/post and vehicle type variables confirmed that for large truck drivers the decrease in at-fault due to speed collision involvement was significantly larger than for drivers of other vehicles. As a speed limiter specifically targets speeding drivers, we can infer that this positive finding reflects the beneficial effect of the speed limiter requirement.

We wondered as well whether there had been secondary consequences to the requirement for large truck drivers to limit their speed on 100 km/h highways. Did large truck drivers attempt to compensate in other ways for their perceived time lost on 100 km/h highways post 2009? We chose to evaluate this possibility by assessing their likelihood to speed when no longer on 100 km/h roads but still traveling on roads that offer the potential to travel well above the speed limit, i.e. Ontario highways with a maximum allowable speed limit of 80 km/h. Found mostly in rural areas, these types of roads are the most common high speed highways in Ontario after those with a maximum allowable speed of 100 km/h[24], and offer the highest potential for crash migration as cross-continent drivers exit the 100 km/h highway onto lower speed roads.

Although drivers of both vehicle types at-fault in a collision demonstrated a significant decrease in the proportion of those collisions that involved speeding, analysis of the interaction between drivers and phases of the study indicated that for large truck drivers the decrease was marginally larger than that of other vehicles in collisions. In other words, there was no obvious increase or decrease in these collisions after the implementation of speed limiter legislation. We can conclude that large truck drivers did not increase their speed on high speed highways with a maximum speed limit of 80 km/h in an attempt to compensate for lost time. This finding can likely be extended to other high speed roads with maximum speed limits below 100 km/h, such as 90/95 km/h, considerably less common in Ontario than 80 km/h roads, and for which collision outcome numbers were too low for meaningful analysis.

A further assessment of the potential for secondary consequences to the legislation explores the interface between other drivers and large truck drivers on 100 km/h roads. Detractors of Ontario's speed limiter legislation cite the speed differential created between large trucks and the general flow of traffic as increasing the potential for collisions in which a large truck driver is struck in the rear. They argue that limiting driver speed to 105 km/h does not allow large truck drivers the flexibility to increase their speed to avoid a collision. Again, in this scenario, no evidence of a change in the

[24] Freeways have a maximum speed limit of 100 km/h (62 mph); Trans-Canada routes have a maximum speed of 90 km/h (56 mph); most other rural highways and country roads have a speed limit of 80 km/h (50 mph).
https://www.ontariotravel.net/en/plan/tools-and-tips/rules-of-the-road

proportion of large trucks rear-ended post 2009 (of all collisions) on 100 km/h roads was indicated, suggesting that large trucks post 2009 are not at an increased risk of being “rear-ended”.

Results of collision analysis support Ontario’s large truck speed limiter legislation; speed limiters have contributed to fewer speed collisions on our high speed highways. At the same time an investigation of large truck driver usage compliance suggested that non-compliance is an issue. A compliant driver will have their speed limiter set to 105 km/h and will allow the device to govern their speed. A non-compliant driver will have tampered with their speed setting such that when scanned by an Officer using an EZ-Tap device their speed setting does not reflect their actual speed potential.

This analysis looked only at drivers who were observed speeding on 100 km/h highways, and is not meant to reflect the overall behaviour of large truck drivers in Ontario. Analysis of large truck drivers who were observed speeding by MTO Enforcement Officers using LiDAR speed guns indicated that 48 percent of them had an ECM speed setting of 105 km/h; and that greater than half (55.2%) of these drivers were traveling between 110 – 114 km/h when they were stopped.

For the purposes of this study, the group of speeding large truck drivers (>105 km/h) we were most interested in was the 48 percent of speeding drivers stopped during the LiDAR pilot who had engine speed settings of 105 km/h. This group of speeding drivers can be seen as consciously defying the legislation, as a scanning of their speed setting by an Officer would indicate incorrectly that their speed was limited to 105 km/h (in compliance with legislation). Note that more than half of these drivers with speed limiters set at 105 km/h were observed traveling between 110-114 km/h, thereby avoiding the penalty of the deeming provision (at 115 km/h) that would result in a speed limiter charge when stopped. As well, a scan of engine speed settings in an inspection station would result in no charge to the driver/operator, as there would be no indication of their actual driving speed.

Although the speed setting results of other speeding drivers stopped may also indicate tampering, the connection is not as clear. A scan of the engine speed setting of the 23 percent of drivers with speed limiter settings above 105 km/h would result in a charge being laid. We can speculate that some drivers may not have changed the factory pre-setting perhaps because the bulk of their driving takes place outside of Ontario and Quebec; or others may want a slight advantage when passing, even though they would be charged with a violation if their engine speed setting was scanned. In terms of the 28 percent of drivers whose ECM's indicated no reading when scanned, it has been suggested that many of these drivers are tampering with their devices to block a reading. In these cases, no charge can be laid if the driver speed is below 115 km/h. The final one percent of drivers refused to allow a scan of their engine speed leading directly to a charge for non-compliance with speed limiter legislation.

As mentioned, the analysis described refers to the behaviour of drivers who had been stopped for speeding over the course of the one year pilot. It does not reflect the overall actions of large truck drivers on Ontario roads. A speed survey conducted by MTO Enforcement Officers that captured the observed speeds (using LiDAR speed guns) of large trucks and large buses over a six-week period on 400-series highways suggests that the great majority of large truck drivers are compliant with the requirement to have their speed limited. The speed of 1,139 large trucks observed on ten occasions (December 6, 2015 to January 19th, 2016) found that only 20.5 percent of large truck drivers were traveling above 105 km/h (Figure 4). The most common speed driven was 105 km/h. Although this convenience sample cannot be seen as representative of all truck drivers in Ontario, it likely does reflect an accurate trend. The message that emerges from the LiDAR analyses is that most large truck drivers are compliant with the legislation but tampering remains an issue that requires monitoring.

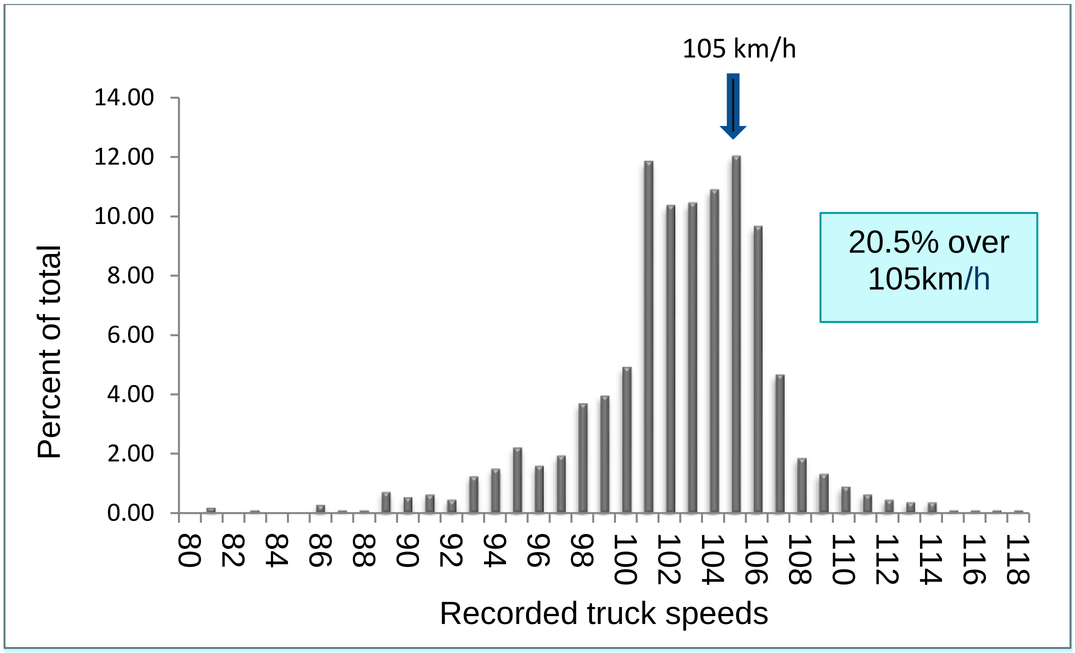

Figure 4 LiDAR survey: Large truck speeds (% of total) observed December 6, 2015 – January 19, 2016 on 400-series Ontario highways, n=1,139

6. SNAPSHOT: LARGE BUSES

Results of the LiDAR survey of large vehicles on 100 km/h highways can be used to preliminarily compare trends in speed between large vehicles that require a speed limiter (large trucks) and those that do currently do not (large buses). As noted above 80 percent of large trucks were found to be traveling at or below 105 km/h. In comparison, 92 percent of large buses observed were travelling above 105 km/h (see Appendix 1). The most common speed was 112 km/h. This convenience sample cannot be seen as representative of the entire population.

As large buses do not require speed limiters, they are an ideal choice for a control group. Collision analysis indicated that similar to all other vehicles there was a drop in large bus driver involvement in collisions on 100 km/h roads post 2009 (17%), but large bus collision outcomes were too few for in-depth analysis. This reality also precluded an analysis that would support extending the speed limiter legislation to large buses, as is currently the law in the European Union. At the same time, it can be argued that large buses carry precious cargo, i.e. bus passengers, and therefore collisions have the potential for increased crash severity.

7. LIMITATIONS

The study was limited by its choice of "drivers of other vehicles" as a comparison group, in that large truck driving patterns and their vehicle populations differ greatly from that of other drivers on the road. Specifically, large truck drivers travel for extensive hours and kilometres on a regular basis through all weather and light conditions; because of their greater exposure to the road they are at a higher risk of collision than drivers of "other vehicles". The more comparable choice would be commercial vehicles that do not require a speed limiter, but low collision outcomes prevented their use as a comparison group. The decision to use "other vehicles" as the comparison group was made after a careful assessment of collision outcomes for the following commercial vehicles that do not require a speed limiter: Trucks with GVWR<11,794 kg; large buses with GVWR>11.793 kg; large trucks built before 1995 with a GVWR>11,794 kg.

It is worth noting that commercial vehicles that do not require a speed limiter were part of the control group, although to much lower extent than passenger vehicles. Approximately 13 percent of all vehicles registered in Ontario are commercial vehicles that do not require speed limiters[25].

Low collision frequencies required, as well, the analysis of all collision types (fatal, injury and property damage). Whereas an analysis of fatal injury collisions is seen as the "gold-standard", (as they are investigated more thoroughly than other collision types), in this case, total collisions presented the most robust picture. To compensate, self-reported property-damage-only collisions were excluded from this study, as the determination of fault in these collisions cannot be considered objective.

[25] Ontario licensed driver data

As well, the potential for indirect negative effects of speed limiters could not be investigated in this report. For instance, speed limited trucks may slow traffic when overtaking each other. In anticipation of this scenario do other vehicles on the highway engage in risky driving behaviour to pass the trucks i.e. by speeding, thereby increasing their potential for collision?

In providing compliance data on large truck drivers who were observed speeding, the LiDAR pilot data offers an informative view of the practical consequences of the legislation. At the same time, because the primary purpose of the pilot was to increase the ability of Enforcement Officers to identify non-compliant drivers, the resulting data cannot inform the bigger-picture question: "What percent of all large truck drivers are using speed limiters as designed?" Enforcement Officers conducted a survey of truck speeds based on a convenience sample of large trucks observed speeding over a six week period which suggested overall compliance (79.5%) with speed limits, but a more representative analysis is suggested.

7. CONCLUSIONS

The current analysis indicates that Ontario's experience with limiting large truck speed has been positive. A decrease of 72.73 percent in speeding at-fault proportion on 100 km/h roads was indicated for large truck drivers as compared to a decrease of 29.73 for drivers of other vehicles; the decrease for large truck drivers was found to be significantly larger than that of drivers of other vehicles. In addition, there is no evidence that the legislation has contributed to an increase in large truck drivers involved in other types of collisions: no increased speeding on 80 km/h roads; no increase in drivers rear-ended unable to avoid other speeding vehicles.

Our findings indicate good news, but there is room for improvement. Of speeding large truck drivers stopped by MTO Enforcement Officers during a one-year LiDAR pilot, close to half (48%) were found to have adjusted their engine speed to artificially indicate a speed of 105 km/h. Engine speed readings of other drivers stopped in the pilot study period may also indicate tampering, but the connection is not as clear.

Insights from this evaluation will help MTO to continue to meet its mandate of evidence based research to support policy development and to guide education and marketing programs. Specifically, the study findings support enforcement of Ontario's large truck speed limiter program and future related policy changes; contribute to large truck research being conducted internally as well as to the overall body of evidence on large truck speed limiter effectiveness; and offer current information to engaged stakeholders.

A sub-section of this report was submitted as conference proceedings at the 2017 Canadian Association of Road Safety Professionals conference, and was awarded Best Research and Evaluation Paper from among more than 100 research submissions[26].

[26] Dr. Charles H. Miller Award for Best Research and Evaluation Paper, CARSP 2017

8. APPENDIX

Appendix 1: LiDAR Survey – Large Buses

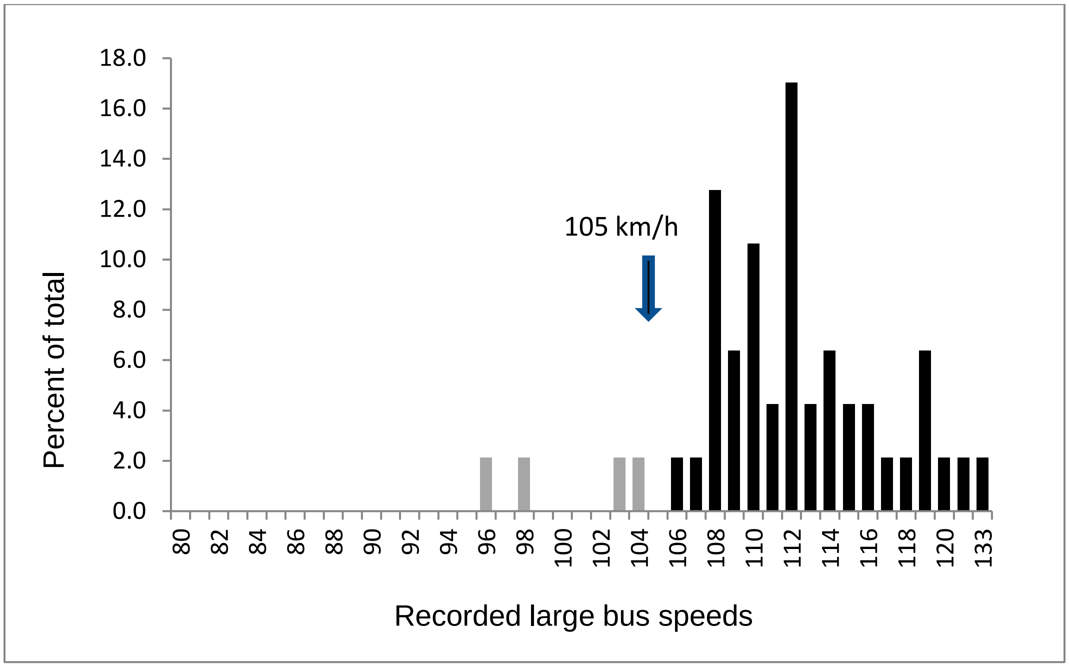

Figure 5 LiDAR survey: Large bus speeds (% of total) observed December 6, 2015 - January 19, 2016 on 400-series Ontario highways, n=47

Appendix 2: Data Sources and Variables Used

Collision Data

Source: Accident Data System, Safety Policy and Education Branch, MTO

- Vehicle type (D29)
- Maximum speed (B47)
- Classification of accident (B13)
- Permit number (D25)
- Self-reporting centre form indicator (B66)
- Vehicle manoeuver/action (D36)
- Driver action (D15)
- Vehicle number D/V (D01)

- Initial impact type (B16)
- Make of vehicle (D20)
- Body style (D24)
- Time of accident (B19)
- County (B26),
- Municipality (B27)
- Model year (D21)
- eCollision (ECOL)

Vehicle Identification Number Decoder Data

Source: Polk VINtelligence (CVINA)

- GVW (V16/GWV)
- Make name (V8/VMAKE)
- Series name (V9/VSERIES)
- Body type (V10/VBODY)
- Wheels/driving wheels (V11/WDW)
- Model year (V6/MYEAR)
- Vehicle type (V7/VTYPE)

LiDAR Speed Gun and EZ-Tap ECM Reader Data

Source: Carrier Safety and Evaluation Branch, MTO

- Highway
- Recorded Lidar Speed (km/h)
- Speed Limiter Setting (mph)
- Charge Laid
- Plate Jurisdiction
- Inspection Report #
- District

Appendix 3: Accident Data System (ADS) D29 Vehicle Type

0	Unknown
1	Passenger Car
2	Motorcycle
3	Moped
4	Passenger Van
5	Pick-up Truck
6	Delivery Van
7	Tow Truck
8	Truck - Open
9	Truck - Closed
10	Truck - Tank
11	Truck - Dump
12	Truck - Car Carrier
13	Truck - Tractor
14	Municipal Transit Bus
15	Intercity Bus
16	Bus (Other)
17	School Bus
18	School Van
19	Other School Vehicle
20	Motor Home
21	Off-Road 2 Wheels
22	Off-Road 3 Wheels
23	Off-Road 4 Wheels
24	Off-Road Other
25	Motorized Snow Vehicle
26	Farm Tractor
27	Other Farm Tractor
28	Construction Equipment

29 Railway Train

30 Street Car

31 Snow Plow

32 Ambulance

33 Fire Vehicle

34 Police Vehicle

35 Other Emergency Vehicle

36 Bicycle

97 Other (Motor Vehicle)

98 Other (Truck)

99 Other (Non Motor)

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