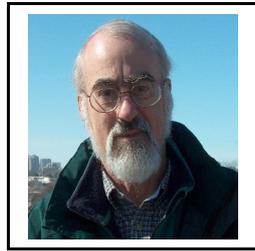


INTRODUCTION OF LONG COMBINATION VEHICLES IN ONTARIO

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Abstract

Various configurations of long combination vehicle (LCV) are now well-established in Québec, three western provinces, and Yukon, where they operate by special permit with a length that may vary from 28 to 40 m (92 to 131 ft). Three further provinces have recently begun LCV pilot programs, and Ontario joined these in 2009. This paper describes the policy development process, the assessment of vehicle dynamic performance, key points of the permit, provides estimates of expected benefits, and gives the current status of the Ontario pilot program.

Keywords: Long Combination Vehicle, LCV, Special Permit, Ontario, Dynamic Performance

1. Introduction

A long combination vehicle (LCV) in Canada is a tractor towing two or three standard length trailers in a combination that is longer than the prevailing overall length limit of 25 m (82 ft), and may be up to 40 m (131 ft) in length. The most common LCVs are a Turnpike Double, with two trailers each from 13.71 to 16.2 m (45 to 53 ft) long; a Rocky Mountain Double, with one long trailer from 13.71 to 16.2 m (45 to 53 ft) long, and a short trailer about 8.53 m (28 ft) long; and a Triple, with three short trailers, each about 8.53 m (28 ft) long.

LCVs were first operated by special permit in Alberta in 1969, and LCV programs are now well-established in Alberta, Saskatchewan, Manitoba, Québec and Yukon. Québec introduced LCVs to support the James Bay development during the late 1970's, and extended their operation by special permit on specified routes in the southern part of the province in 1985 (MTQ, 1986). New Brunswick began an LCV pilot program in 2005, British Columbia in 2007, and Nova Scotia in 2009. 23 U.S. states also have well-established LCV operations.

This paper describes the development of an LCV pilot program that began in Ontario in 2009.

2. Policy Development and Planning

The trucking industry asked the Ontario Commission on Truck Safety in the early 1980's to consider LCV operations in Ontario. It conducted a review of LCV operations, sponsored an on-highway LCV demonstration, and concluded that LCVs should "... NOT be allowed at this time". It cunningly gave no guidance when the time might be right (Uffen, 1983).

Ontario increased its allowable gross weight to 63,500 kg (140,000 lb) in 1970, and there has been virtually no pressure for any increase since. About 50% of all truck trips within Ontario, between Ontario and Québec, and between Ontario and the U.S., are made by tandem axle semitrailers with an average payload around 15,000 kg (33,069 lb), carrying consumer goods, car parts, grocery products, courier and other freight of low and moderate density.

Semitrailer length in Ontario was 13.71 m (45 ft) in the 1960's, became 14 m (46 ft) in 1978, and 14.65 m (48 ft) in 1984. It became an issue in 1989 when Ontario tried to adopt 16.2 m (53 ft) semitrailers, and an overall length of 25 m (82 ft), under the national Memorandum of Understanding on Vehicle Weights and Dimensions (Council of Ministers, 1988). These lengths were finally adopted in 1994. Semitrailer length changes provided useful increases in productivity for freight of low and moderate density, but there is little prospect of another increase. The box length of double trailer combinations was about 17 m (56 ft) in the 1960's, and increased to 20 m (65 ft 7 in) in 1994, in several steps. This also increased productivity for freight of low and moderate density, but was much more beneficial in improving the productivity and stability of double trailer combinations moving heavy payloads. Box length might be increased somewhat, but would be of limited interest as provinces operating LCVs already have much greater productivity. The single largest available gain in truck productivity for Ontario has always been through adoption of LCVs for freight of low and moderate density (Nix and Boucher, 1987, and Billing, 2002), as the prevailing allowable gross weight of 63,500 kg (139,992 lb) allows two semitrailers from the U.S. at a gross weight of 36,287 kg

(80,000 lb) to become an LCV for travel in Ontario, and also allows a tridem semitrailer at its allowable gross weight to tow a lightly loaded semitrailer.

Academic studies identified the benefits of extending Québec LCV operations into Ontario, to address transportation costs (Nix and Boucher, 1987, Nix and Delaquis, 1999, and Woodrooffe, 2001a), and greenhouse gas emissions (Delcan, 2001, and Tardif and Barton, 2006). LCVs could also alleviate concerns like high fuel prices, highway congestion and a developing driver shortage. Ontario Ministry of Transportation (MTO) recognized the LCV option, and began internal policy development and planning in the early 2000's.

Coincidentally, Ontario and Québec were working jointly to remove barriers to trade between the two provinces. Truck weights and dimensions was one of the issues, and several agreements between these provinces resolved regulatory differences. MTO therefore worked with the Ministère des Transports du Québec (MTQ), with extensive consultations with the Ontario Trucking Association (OTA) and its Québec counterpart (ACQ), to develop a program for free movement of LCVs between the two jurisdictions. Discussions were also held with New Brunswick and Nova Scotia, as shippers indicated they needed seamless LCV service within and between the four provinces. An Ontario LCV program had to hold participating carriers, drivers and vehicles to higher standards than in other trucking operations, and to higher standards than LCV operations in Québec and the western provinces, to gain political approval in Ontario. Higher standards were also necessary to ensure Ontario achieved the highway safety benefits seen in other provinces (Woodrooffe, 2001b, and Montufar, 2007), and also for public approval.

3. Dynamic Performance of LCVs

Four distinct studies of the dynamic performance of LCV Turnpike Doubles were sponsored by the OTA to support MTO's policy development and planning. Dynamic performance was evaluated against the RTAC performance standards (CCMTA/RTAC, 1986).

3.1 A-train Turnpike Doubles

MTO initially considered only the A-train Turnpike Double, so the first study addressed the dynamic performance the seven most likely (out of 16 possible) arrangements of tandem and tridem 16.2 and 14.65 m (53 and 48 ft) semitrailers, all using a tandem converter dolly (Billing, 2008a). The shortest semitrailer considered was 14.65 m (48 ft), as previous work had determined that a Turnpike Double with two 12.19 m (40 ft) container chassis was too lively, and carriers who would operate LCVs no longer have 13.71 or 14 m (45 or 46 ft) semitrailers. A twin 16.2 m (53 ft) A-train Turnpike Double is shown in Figure 1.



Introduction of Long Combination Vehicles in Ontario

Figure 1: A-train Turnpike Double

Low-speed offtracking exceeded the performance standard by a wide margin. However, this was addressed by ensuring these vehicles were only approved for routes where they could make all turns required.

The static roll threshold decreased with an increase in payload weight, and with payload height. The tractor and lead semitrailer rolled over first for all configurations and payloads. The static roll threshold was essentially the same as if the tractor and lead semitrailer had not been part of a Turnpike Double.

High-speed offtracking exceeded the performance standard of 0.46 m (18 in) for many semitrailer wheelbases, payload weights, payload heights and speeds. However, this was not an issue, as these vehicles would only operate either on a freeway with a design speed of at least 120 km/h (74.5 mi/h), when it was well within the performance standard even at 110 km/h (68.3 mi/h), or at low speed on streets and ramps (Billing and Patten, 2008).

Any configuration that met the load transfer ratio performance standard also met the transient offtracking performance standard for the same payload weight and payload height. An appropriate combination of restrictions on semitrailer wheelbases, payload weight, payload height, and speed could ensure both performance standards were met.

Saskatchewan and Alberta have an overall length limit of 38 m (124 ft 8 in), which limits the tractor wheelbase to about 4.5 m (177 in), and constrains the converter dolly drawbar to the minimum clearance between trailers, though this may also be desirable for other reasons. Neither tractor nor converter dolly wheelbase appeared to be a strong factor in dynamic performance, so there was no reason to limit these either directly, or artificially through a tight limit on overall length that would make it difficult to configure vehicles.

There appeared no reason why a carrier with an LCV permit should not use a tractor-semitrailer to tow a converter dolly on a route approved for LCVs, even if the overall length of the vehicle would exceed the prevailing overall length of 23 m (75 ft 5 ½ in).

There were modest benefits to dynamic performance if wide single tires replaced dual tires, so there appeared no reason why wide single tires should not be fitted to any axle group in a combination.

A-train Turnpike Doubles met all performance standards with both semitrailers empty, and all except for a few high-speed offtracking points with an empty rear semitrailer. There appeared no reason that a Turnpike Double should not operate with the rear semitrailer, or both semitrailers, empty.

The dynamic performance of an A-train Turnpike Double with a tridem semitrailer was better than if a tandem semitrailer had been used for the same payload weight and payload height. There appeared no reason why a tridem semitrailer should not be used in either position.

As a result of this work, and other considerations, MTO made its initial definition of LCV dimensions, including a 40 m (131 ft) overall length. It also limited the operating speed to 90 km/h (55.9 mi/h), the same as used in Québec (MTQ, 1986).

3.2 B-train Turnpike Doubles

Carriers and shippers identified that the B-train Turnpike Double might have a significant role, particularly to haul containers. This led to a study of the dynamic performance of a van B-train, where either semitrailer was 16.2 or 14.65 m (53 or 48 ft) long, and a B-train container chassis, where each chassis was either of fixed length, or extendable, and might carry a 16.2, 14.65 or 12.19 m (53, 48 or 40 ft) long container (Billing, 2008b). A twin 16.2 m (53 ft) B-train Turnpike Double container chassis is shown in Figure 2.



Figure 2: B-train Turnpike Double

Low-speed offtracking exceeded that of an A-train Turnpike Double. This was addressed by ensuring B-trains were only approved for routes where they could make all turns required. This severely restricts the number of routes available to B-trains.

B-train Turnpike Doubles did not meet the static roll threshold performance standard of 0.40 g when loaded to their allowable gross weight with a payload height over 1.83 m (72 in), or with a moderate payload weight and a payload height of 2.44 m (96 in). However, their static roll threshold was no different than for a B-train carrying payload of the same weight and height at the legal length of 25 m (82 ft). The static roll threshold of a B-train LCV was because it was a B-train, not because it was an LCV.

B-train Turnpike Doubles met the load transfer ratio and transient offtracking performance standards for all vehicle configurations, payload weights, and payload heights.

A van carried a greater payload weight than a container, so the dynamic performance of a B-train van loaded to its allowable gross weight with a high payload was slightly worse than a container. When each carried the same payload, the container chassis was slightly worse, because the chassis and container was heavier than a van. However, in this situation, both vehicles were below their allowable gross weight, so generally met all performance standards.

The rear semitrailer may be either a tandem or tridem. A tridem semitrailer has a slightly better static roll threshold, and slightly better high-speed dynamic performance, as its higher tare weight displaces payload, and the additional axle provides greater roll resistance.

As a result of this work, and other considerations, MTO accepted the B-train Turnpike Double configuration, but with a maximum length of 14.65 m (48 ft) for the lead semitrailer (MTO, 2009). It set other appropriate dimensions, including a 3.6 to 3.7 m (142 to 146 in) spread tridem at 26,000 kg (57,319 lb) on the lead semitrailer, with no increase in gross weight, which slightly improved low-speed offtracking, and improved load distribution.

3.3 A-train Quad-axle Lead Semitrailer

Québec allows a quad-axle lead semitrailer in an A-train Turnpike Double (MTQ, 1986). Carriers, especially from Québec, expressed interest in this configuration for operation into Ontario. This work assessed the dynamic performance of an A-train Turnpike Double with either a 14.65 or 16.2 m (48 or 53 ft) self-steer quad semitrailer, or a 14.65 m (48 ft) quad-axle semitrailer with a rigid liftable axle, as the lead semitrailer, towing a 14.65 or 16.2 m (48 or 53 ft) long tandem semitrailer (Billing, 2008c).

A tandem or tridem semitrailer typically has a sliding bogie that is positioned within the wheelbase limits for proper axle weight distribution. A quad or self-steer quad semitrailer typically has fixed axles. This resulted in a wheelbase less than that proposed by MTO for a lead semitrailer, and a longer hitch offset.

The quad-axle Turnpike Doubles considered here did not meet the static roll threshold performance standard of 0.40 g when loaded close to their allowable gross weight with a payload height over 1.83 m (72 in). The tractor and lead semitrailer rolled over first for all configurations and load cases, and the static roll threshold was essentially the same as if the tractor and lead semitrailer had not been part of a Turnpike Double.

The quad-axle Turnpike Doubles met the load transfer ratio and transient offtracking performance standard for most load cases for each configuration at 90 km/h (55.9 mi/h).

MTO elected not to allow a quad-axle semitrailer lead semitrailer during the pilot program.

3.4 A-train Hitch Offset

Hitch offset has a strong effect on the dynamic performance of an A-train double trailer combination, so it is limited to 1.80 m (71 in) (Council of Ministers, 1988). Other dimensional limits result in almost automatic compliance with the hitch offset requirement for an A-train within an overall length of 23 m (75 ft 5 ½ in). However, an A-train Turnpike

Double has a long lead semitrailer with a sliding bogie that can be positioned over a wide range for load distribution, and may have a hitch offset much greater than 1.80 m (71 in). MTO initially proposed 2.80 m (110 in), but this was not quite achievable for some existing semitrailers with a 3.66 m (144 in) spread tridem, which had a physical restriction on rearward travel of the bogie. This study examined how hitch offset greater than 2.80 m (110 in) affected the dynamic performance of an A-train Turnpike Double with a tridem lead semitrailer (Billing, 2009).

This configuration met the load transfer ratio performance standard for almost all conditions considered with a hitch offset up to 3.66 m (144 in), except when the rear semitrailer payload weight was over 13,608 kg (30,000 lb) and the payload height was over 1.83 m (72 in).

Based on this work, MTO relaxed the hitch offset to 3.4 m (134 in) for a tridem lead semitrailer with a tridem spread from 3.6 to 3.7 m (142 to 146 in).

4. LCV Pilot Program

The Premier of Ontario announced on 2 June 2009, after a joint meeting between the cabinets of Ontario and Québec, that Ontario would proceed with a carefully controlled LCV pilot program (MTO, 2009), compatible with the existing LCV operation in Québec (MTQ, 1986).

The LCV pilot program was led by the OTA and the Private Motor Truck Council of Canada (PMTCC). They were responsible for identifying the LCV primary network and its rest/emergency stops, for undertaking all necessary engineering assessments of routes off provincial highways, and for obtaining road authority consent for travel on those routes.

The OTA and the ACQ were responsible for adapting the Canadian Trucking Alliance LCV driver training program for Ontario/Québec operations. In conjunction with the OTA, carriers were responsible for assessing driver qualifications and experience, training them, and issuing LCV Driver Certificates to those who qualified.

MTO would issue permits to qualifying carriers for operation on the LCV primary network and specified routes to and from approved origin/destination (O/D) locations. A permit was not vehicle-specific, so could be used for any vehicle meeting all LCV specifications.

MTO could suspend one or more of a carrier's permits, revoke its LCV permit, or cancel the LCV program at any time. A carrier's LCV permits automatically become void if its Safety Rating became 'Conditional' or 'Unsatisfactory'.

4.1 Carrier Qualification

Each carrier participating in the pilot program was required to be a member of the OTA; required at least 5 years of prior trucking experience; at least \$5 million public liability insurance coverage; a Carrier Safety Rating under MTO's Commercial Vehicle Operator's

Registration not less than “Satisfactory”; and had to sign a Memorandum of Understanding with MTO signifying that it accepted the responsibilities associated with the program. The carrier was required to maintain specific documentation regarding drivers, equipment and operations, and must provide any of this to MTO upon request.

4.2 Driver Eligibility

An LCV driver must have a

valid Ontario Class A driver’s license with air brake endorsement, or equivalent from another jurisdiction; at least

5 years provable tractor-trailer driving experience; no driving-related criminal code convictions in the previous 36 months, no more than two moving violation convictions of any kind in the previous 12 months, and no more than three moving violation convictions of any kind in the previous 36 months, based on a driver’s abstract dated no more than 30 days prior to issue of an annual LCV Driver Certificate; and must have p

assed the OTA/ACQ LCV Driver Training Program, or be a qualified LCV driver from a western province or Québec.

Qualifications and procedures were specified for a driver to become an LCV driver instructor, and for training and qualifying LCV drivers.

4.3 LCV Routes

The LCV primary network consists of controlled access, multi-lane, divided highways, and ramps connecting such highways. Rest/emergency stops are service centres, truck stops or other suitable locations close to and readily accessible from the LCV primary network, where an LCV may stop safely and/or park in case of inclement weather, road closure, time restrictions, a driver break, etc. All LCV permit holders have access to the LCV primary network and approved rest/emergency stops.

LCV O/D locations are shipper facilities, truck terminals, or LCV assembly/disassembly yards, generally within 2 km (1.2 mi) of the LCV primary network, though more distant locations with suitable access could be approved. Only carriers authorized to access an O/D location may take an LCV on the route to or from that location.

LCVs may only enter or exit the LCV primary network on routes authorized for access to O/D locations, at approved rest/emergency stops, and at Truck Inspection Stations. A-trains may access all routes and O/D locations. B-trains may only access routes and O/D locations approved for B-train access.

The OTA may propose additions to the LCV primary network during the pilot program, providing acceptable rest/emergency stops are available. Any carrier may propose additional O/D locations. Any proposed addition requires an engineering assessment by a consultant pre-qualified by MTO to assess highway design and traffic. The consultant:

- Must acquire plans of the route, posted speeds, and relevant traffic information, and must make a site visit to verify existing conditions;
- Must contact road authorities to determine whether there is proposed construction and/or maintenance work along the proposed LCV route, and must document and evaluate the implications of any changes on LCV operations;
- Must ensure the route can accommodate LCV turning movements without affecting other traffic operations;
- Must provide an operational and traffic safety impact analysis based on turning and weaving movements, storage and lane change space, and traffic signal timing;
-
- Must prepare a standard-form route map for attachment to the in-vehicle permit; and
- May recommend restrictions on LCV operations by time of day for O/D locations where these might alleviate potential traffic issues.

MTO specified A- and B-train LCV design vehicles for evaluation of turns, based on the maximum axle spacings and typical values for steering lock, fifth-wheel and king-pin settings.

Any modification made to the primary network or other route infrastructure to accommodate LCV operation is the responsibility of a shipper or carrier working in conjunction with the appropriate road authority or property owner.

Carriers may cooperate to share costs of an engineering assessment if part of a proposed route will be shared, or has previously been approved for another carrier.

Every authority having jurisdiction over part of a route, other than MTO, including owners or operators of rest/emergency stops, must acknowledge in writing they are aware of the engineering assessment, and do not object to LCV travel over the proposed route.

Applications are reviewed by MTO's LCV Route Committee. The committee may accept or reject a request, may work with an applicant and/or road authority to address issues, or may request further information or assessment. The committee authorizes addition of the route/location to permit attachments when an application is approved.

A list of highways forming the LCV primary network, all rest/emergency stops, and all O/D locations approved for a carrier, must be attached to each of the carrier's LCV permits.

4.4 LCV Weights and Dimensions

An A-Train Turnpike Double consists of a 3-axle tractor, a tandem or tridem lead semitrailer, a tandem converter dolly, and a tandem or tridem rear semitrailer, as shown in Figure 3 (MTO, 2009). The combined weight of the drive axles and the lead semitrailer axles must be greater than the combined weight of the converter dolly axles and the rear semi trailer axles. The combined weight of the lead semitrailer axles and the converter dolly axles depends on the spacing between the axle groups, and is less than the sum of the allowable axle loads of the two axle groups. The hitch offset for a lead semitrailer with a tridem spread from 3.6 to 3.7 m (142 to 146 in) may be up to 3.4 m (134 in).

A B-Train Turnpike Double consists of a 3-axle tractor, a tridem lead semitrailer and a tandem or tridem rear semitrailer, as shown in Figure 4 (MTO, 2009). When the lead semitrailer operates alone, its bogie must retract within the dimensional limits for a semitrailer.

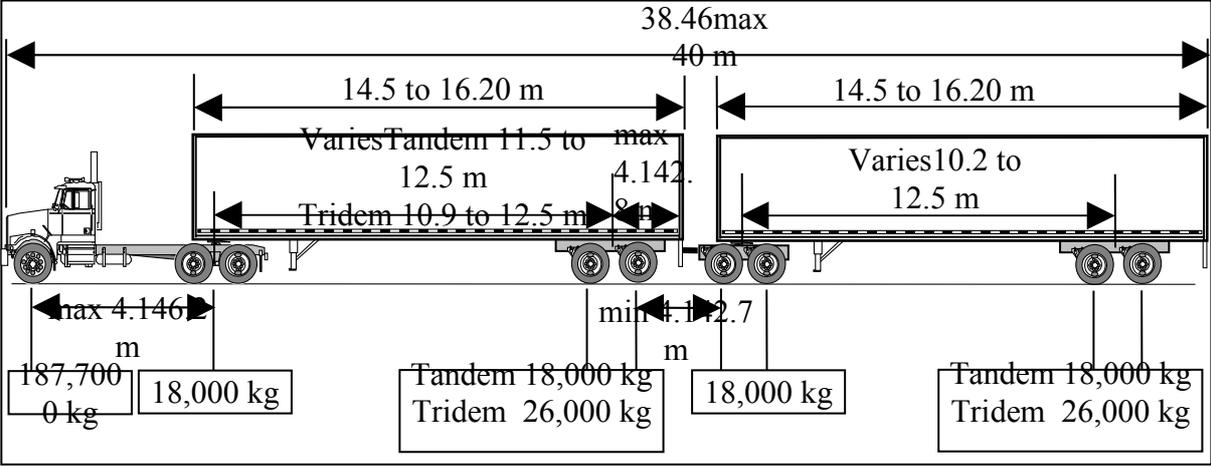


Figure 3:A-train Turnpike Double Dimensions and Weights

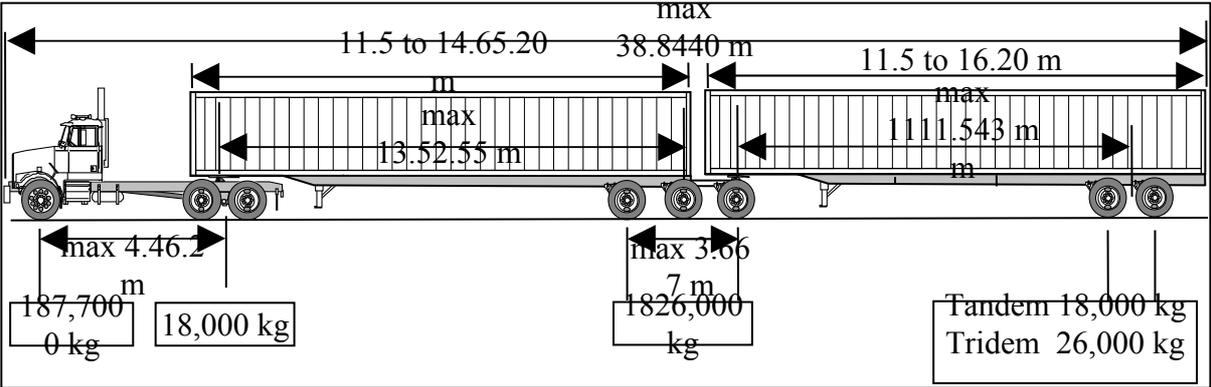


Figure 4:B-train Turnpike Double Dimensions and Weights

The specifications for these two configurations (MTO, 2009) are considerably more detailed than those of Québec (MTQ, 1986), but do not restrict most LCVs that operate in Québec from also operating in Ontario without modification.

For each configuration shown in Figure 3 and Figure 4:

- Only principal controlled dimensions are shown, other dimensions are also controlled;
- The effective rear overhang of the rear semitrailer is 35% of its wheelbase;
- The tandem axle group weight shown requires a spread of 1.2 to 1.8 m (47 to 71 in), and 19,100 kg (42,108 lb) is allowed for a spread from 1.8 to 1.85 m (71 to 73 in);
- The tridem axle group weight shown requires a spread of 3.6 to 3.7 m (142 to 146 in), and is reduced for spreads from 2.4 to 3.6 m (94 to 142 in); and
- The allowable gross weight is 63,500 kg (139,992 lb).

4.5 Equipment Requirements

Each tractor must have at least 425 horsepower; at least 40 deg of steer; an air compressor with at least 465 l/min (16.5 cu ft/min) capacity; sufficient air dryer capacity to prevent moisture accumulation in trailers; a functioning and accurate electronic device that records speed, time and date; and a functioning electronic stability control system.

Each tandem or tridem axle unit must be equipped with anti-sail mud-flaps.

The lead semitrailer of an A-train must be equipped with a no-slack, snubber-type pintle hook equipped with a secondary locking device.

If the lead semitrailer has a functioning independent roll stability system, the system must also automatically apply the brakes to any converter dolly and rear semitrailer.

The tractor, each semitrailer and the converter dolly must be equipped with a functioning anti-lock brake system compliant with CMVSS 121.

The converter dolly, lead semitrailer, and any rear semitrailer set up for towing must be equipped with a control line pilot (speed-up) valve.

The converter dolly must be equipped with a supply line pressure protection valve.

Any semitrailer retrofitted for towing must have its brake timing tested and certified as complying with CMVSS 121.

A converter dolly must have functioning tail lights, brake lights, turn signals and reflectors, and each semitrailer must have functioning side marker lights, in accordance with CMVSS 108.

4.6 Operational Rules

LCVs are restricted to approved routes between O/D locations and the LCV primary network, and approved rest/emergency stops, as specified in permit attachments. A detour off these routes is only allowed for a semitrailer pulling a converter dolly with no rear semitrailer.

An LCV must not exceed 90 km/h (55.9 mi/h), or any lower posted speed limit.

An LCV must not operate:

- In a specified area around Toronto Monday through Friday during specified rush hours;
- At the start and end of a specified long weekend;
- During December, January or February; or
- During specified bad weather conditions.

An LCV must not carry livestock, or any regulated dangerous goods that require a placard.

An LCV driver is expected to travel in the right-most lane of the highway, at least 150m (500 feet) from another LCV traveling on that highway, where practical, and must operate the LCV in a fashion that does not cause damage to highway infrastructure. LCVs must report to Truck Inspection Stations on the same basis as other commercial vehicles.

A yellow-orange sign bearing a black illustration of an LCV and the word “LONG” must be displayed on the rear of the rear semitrailer.

5. LCV Program Benefits

Analysis of truck traffic identified potential for up to 4,100 LCV trips per day in Ontario, and between Ontario and Québec, or 1.5 million trips per year. Each LCV trip replaces about two tractor-semitrailer trips, which resulted in the following estimates:

- Costs to shippers and consumers reduced by up to \$320 million Cdn/year;
- 70 million l/year of fuel saved;
- Greenhouse gas emissions reduced by 200,000 t/year;
- Tractor-semitrailer collisions reduced by around 9%;
- Overall infrastructure stress reduced by around 2%;
- Congestion during rush hours reduced in Toronto and Montreal; and
- A developing driver shortage alleviated.

6. Current Status

Carriers were gradually issued permits during the first months of the pilot program, in a sequence based on criteria and a process developed by a joint MTO/OTA/PMTC selection committee. The first ten carriers each had at least one year of experience in operation of Turnpike Doubles. Each of 50 carriers was limited to two permits, to maximize participation, and to prevent any carrier gaining a competitive advantage, so 100 permits were to be issued.

LCV operations started on 5 August 2009. As of 30 November 2009, when operations shut down for the winter, 26 carriers had each received two permits, allowing two vehicles to operate simultaneously, and collectively they had made over 4,000 trips, amounting to nearly 1.3 million km of travel. There were no incidents of any kind in this period. Little public concern was expressed. Permits have continued to be issued through the winter shut-down, and carriers with permits will start or resume LCV operations from 1 March 2010.

The results of the pilot program will be reviewed in 2010. A fully satisfactory review would be expected to allow gradual expansion of LCV operations.

LCVs can now operate from Windsor, Ontario in the west to Riviere-du-Loup, Québec in the east, a distance of 1,330 km (826 mi), and on north-south links joining the principal east-west

route, including all primary links to the U.S. border. When the divided highway between Québec and New Brunswick is completed, possibly by 2013, LCVs will be able to operate from Windsor to Halifax, Nova Scotia, a distance of 2,141 km (1,330 mi).

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