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ROAD SAFETY AND MOTOR VEHICLE REGULATIONS



Evaluation of Pedestrian and Cyclist Warning Systems for Trucks

Peter Burns, peter.burns@tc.gc.ca

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Outline

- Background
- VRU Safety Task Force
- Track testing of VRU warning systems
- Field operational test (FOT) of warning systems
- CMVSS 111: Mirrors and Rear Visibility Systems
- Long-term study of backing aids
- Crash Avoidance: Automatic Emergency Braking

VRU Task Force

- VRUs are at significant risk when they are involved in collisions with large commercial vehicles.
- Pressures to mandate side guards.
- In Sept 2016, the Minister of Transport, announced a new task force to discuss safety measures to reduce injuries and fatalities involving cyclists, pedestrians and heavy trucks.
- The task force, established through the Canadian Council of Motor Transport Administrators, will explore cameras, sensor systems, side guards, as well as educational safety and awareness programs.
- Transport Canada would also examine the benefits of sensors to reduce collisions between VRU's and heavy trucks.





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DRAFT Report on VRU Safety Countermeasures & Public Consultations

- In 2015, there were 42 VRU fatalities (33 pedestrians and 9 cyclists) represented approximately 11% of all truck involved fatalities.
- A steering committee, co-chaired by Alberta and TC is conducting public consultations on a report that discusses countermeasures to keep pedestrians and cyclists safe around heavy vehicles.
- Interactive website where you can read the report, participate in a discussion forum and/or complete a survey.

<https://letstalktransportation.ca/VRU>

Investigations of Heavy Vehicle Collisions with VRU since 2005

The data from the in-depth collision investigations highlight a number of common characteristics and issues:

- A wide variety of vehicle-types, with both cab-forward and conventional cab designs, were involved;
- Every vehicle, with few exceptions, had mirrors systems that exceeded those required by CMVSS 111, however blind spots still exist;
- The incidents typically involved a low speed turning manoeuvre;
- The majority of collisions occurred in daylight at urban intersections during clear weather conditions;
- The VRU was frequently located in, or near, a crosswalk, or was at an unmarked crosswalk.



Data Summary: Observations

- The first point of contact with the VRU was commonly the front or right side of the vehicle;
- The VRU was almost always run over and fatally injured;
- Low side ground clearance and closed-in sides does not guarantee the safety of VRUs, especially in the common, right-turn collision configurations;
- Drivers were not aware that their vehicle had struck a VRU until after the incident when drivers noticed something unusual or were alerted by other motorists or VRUs;
- A number of VRUs displayed a lack of situational awareness and/or inattention.

The above suggests that commercial vehicle drivers need assistance in detecting VRUs in close proximity to the vehicle. Countermeasures should be examined to improve both direct and indirect visibility in combination with detection systems that alert drivers to VRUs.



Directions

- Effectiveness of side guards has not been sufficiently demonstrated in the Canadian environment
- A regulation mandating side guards would be neither cost effective nor address the majority of the cases
- Collision investigations suggest that drivers need assistance in detecting VRUs in close proximity to the vehicle

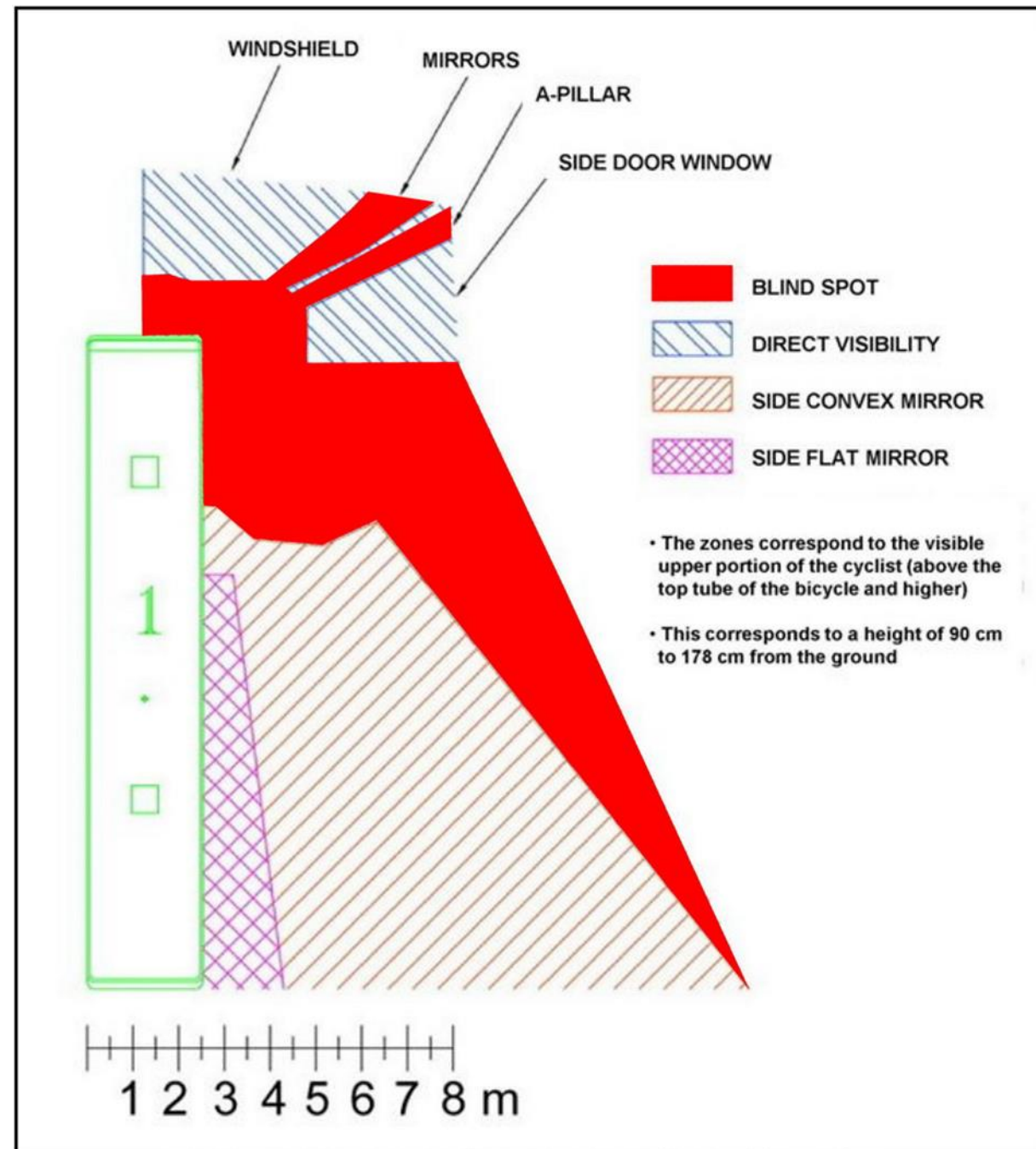


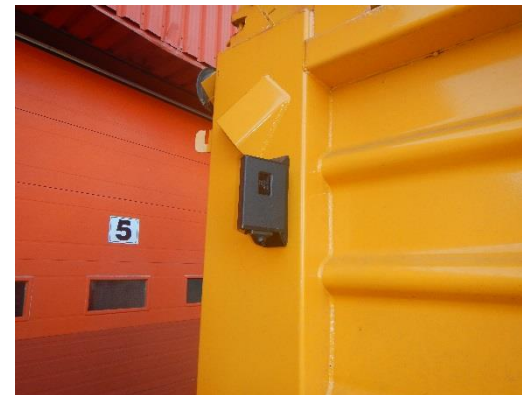
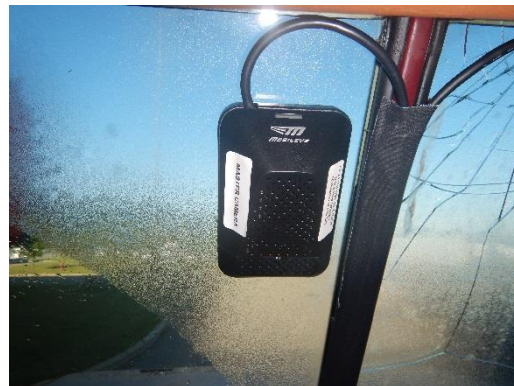
Figure 3: Field of View for 2008 Prevost X3-45 Coach Bus

Part 1: Track Testing

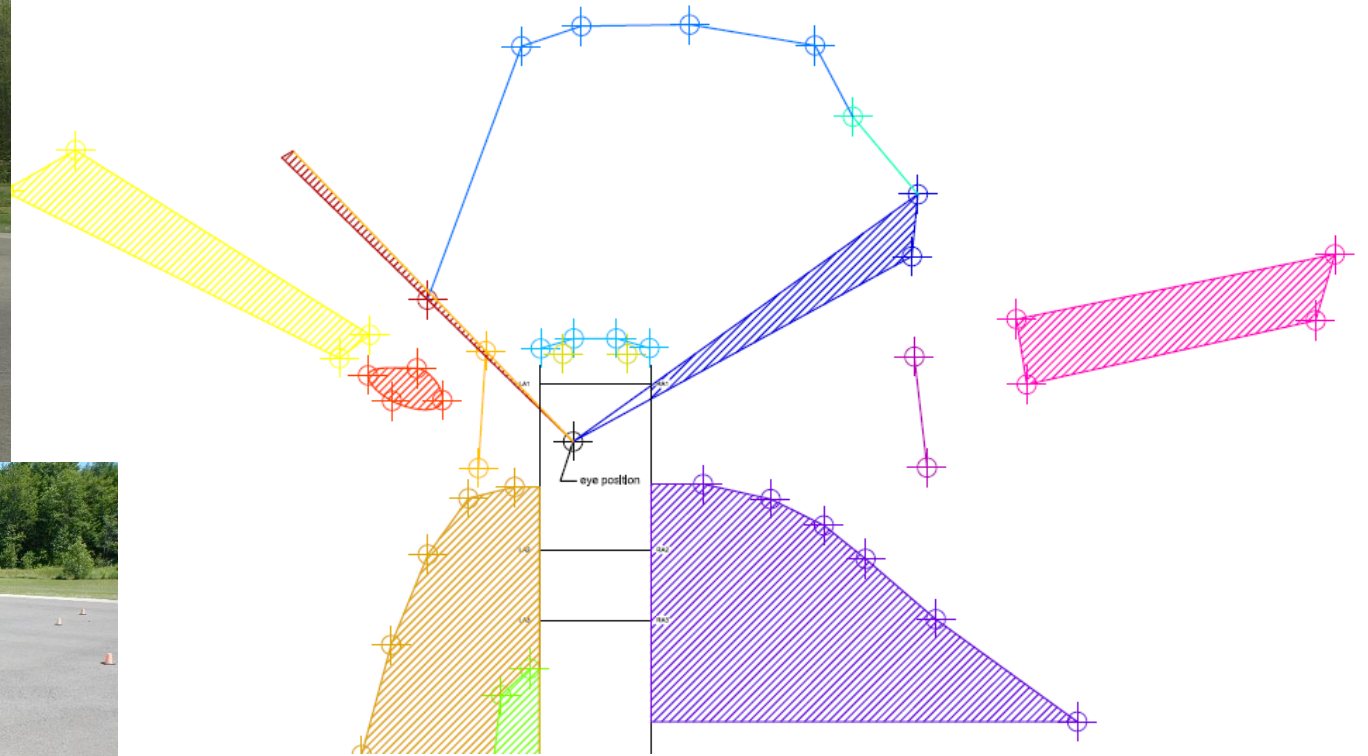
- Evaluated available sensor technologies to address blind spot risks on heavy vehicles (10 scenarios with 350 total tests).
- 3D scan of test truck to measure and visualize blind spots

Sensors/ Systems tested


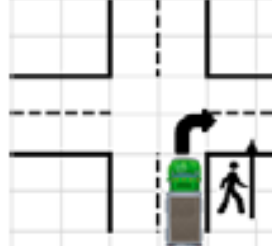

- Image recognition (vehicles and VRUs)
- Image recognition (cyclist detection only)
- Camera 360 degree
- Radar & Camera (activated by turn signal)
- Ultrasonic proximity sensors

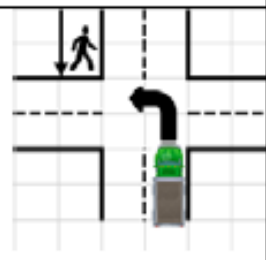

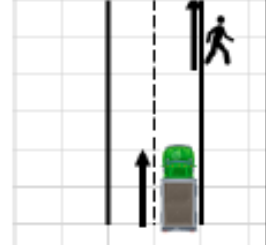
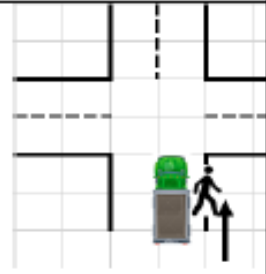


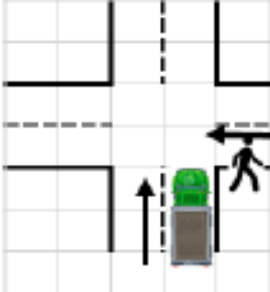
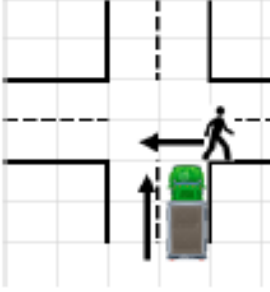
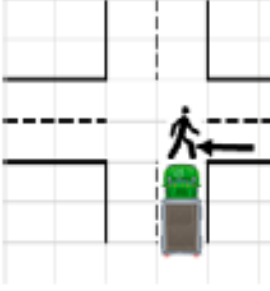
Test Targets



Collision Scenarios

Scenario	Schematic	Kinematics	
#1 EPTa EPTc EBT		$V_{truck} = 10 \text{ km/h}$ $V_{ped} = 5 \text{ km/h}$ Impact zone = 50% front of truck	Determine whether the warning system will warn the driver of a pedestrian crossing the street during a right turn. For this scenario, the dummy is standing on the corner and the point of contact would be 50% of the front of the right turning vehicle. The dummy is travelling north starting at the south east corner at walking speed. The vehicle is coming from the south and turning right (east) at 10 km/h
#2 EPTa EPTc EBT		$V_{truck} = 10 \text{ km/h}$ $V_{ped} = 5 \text{ km/h}$ Impact zone = right side of truck, behind front wheel	Determine whether the warning system will warn the driver of a pedestrian crossing the street during a right turn. For this scenario, the dummy is standing on the corner and the point of contact will be behind the front wheel of the right turning vehicle. The dummy is travelling north starting at the south east corner at walking speed. The vehicle is coming from the south and turning right (east) at 10 km/h.
#3 EPTa		$V_{truck} = 10 \text{ km/h}$ $V_{ped} = 5 \text{ km/h}$ Impact zone = 25% front of truck (left corner)	Determine whether the warning system will warn the driver of a pedestrian crossing across the street during a right turn. For this scenario, the dummy is standing on the corner and the point of contact will be the first 25% of the front of the vehicle. The dummy is travelling south starting on the north east corner at walking speed. The vehicle is coming from the south and turning right (east) at 10 km/h.

#4		<p>$V_{truck} = 10 \text{ km/h}$ $V_{ped} = 5 \text{ km/h}$ Impact zone = 25% front of truck (right front)</p>	<p>Determine whether the warning system will warn the driver of a pedestrian crossing across the street during a left turn. For this scenario, the dummy is standing on the corner and the point of contact will be the first 25% of the front of the vehicle. The dummy is travelling south starting on the North West corner at walking speed. The vehicle is coming from the south and turning left (west) at 10 km/h.</p>
#5		<p>$V_{truck} = 20 \text{ km/h}$ $V_{ped} = 5 \text{ km/h}$ Impact zone = 25% front of truck</p>	<p>Determine whether the warning system will warn the driver of a pedestrian in front of the vehicle, travelling in the same direction. For this scenario the dummy is travelling north at walking speed and the vehicle is coming behind at 20 km/h. The anticipated point of contact is at 25% of the front of the vehicle (right corner).</p>
#6		<p>$V_{truck} = 20 \text{ km/h}$ $V_{ped} = 5 \text{ km/h}$ Impact zone = 0% front of truck, 1 meter distance between truck and pedestrian</p>	<p>Determine whether the warning system will unnecessarily warn the driver of a pedestrian in front of the vehicle, travelling in the same direction but not in the same path. For this scenario the dummy is travelling north at walking speed and the vehicle is coming behind at 20 km/h. 1 meter should be calculated between the vehicle and the dummy.</p>
#7		<p>$V_{truck} = 0 \text{ km/h}$ $V_{ped} = 8 \text{ km/h}$ Impact zone = none, pedestrian between curb and truck, 1 meter zone</p>	<p>Determine whether the warning system will warn the driver that a pedestrian has arrived in its blind spot. Both are travelling in the same direction. The vehicle is stopped (at a red light for example) and the dummy just squeezed in between the curb and the vehicle at an upcoming speed of 20 km/h. The dummy stops at the right front corner of the vehicle. The behavior of the warning system is documented.</p>

<p>#8</p> <p>EPTa</p> <p>EBT</p>		<p>$V_{truck} = 20 \text{ km/h}$ $V_{ped} = 5 \text{ km/h}$ Impact zone = none, stops at edge of curb</p>	<p>Determine whether the warning system will unnecessarily warn the driver of a pedestrian that looks like it will cross the street. The pedestrian stands on the south east corner and heading west. The dummy is approaching the sidewalk edge as the vehicle is travelling north 20 km/h. The anticipated point of impact is 0% of the front of the truck.</p>
<p>#9</p> <p>EPTa</p> <p>EPTc</p> <p>EBT</p>		<p>$V_{truck} = 20 \text{ km/h}$ $V_{ped} = 5 \text{ km/h}$ Impact zone = 50% front of truck</p>	<p>Determine whether the warning system will warn the driver of a pedestrian that crosses the street. The pedestrian stands on the south east corner and heading west. The dummy is crossing at walking speed as the vehicle is travelling north. The anticipated point of impact is 50% of the front of the truck.</p>
<p>#10</p> <p>EPTa</p>		<p>$V_{truck} = 0 \text{ km/h}$ $V_{ped} = 5 \text{ km/h}$ Impact zone = none, pedestrian walks in front of truck, 2 meters away from bumper.</p>	<p>Determine whether the warning system will warn the driver of a pedestrian that crosses in front of the vehicle while the vehicle is about to take off. The pedestrian is travelling west in front of a stopped vehicle. As the pedestrian approaches the middle of the vehicle, the truck starts to move forward toward the pedestrian. The distance between the vehicle and the pedestrian is 2 meter.</p>

Preliminary Results

Warning Timing

- Key benefit of Shield+ system was the 2-staged warning gave drivers more opportunity to respond –
 1. preliminary yellow visual information, escalates to a
 2. crash imminent red visual/ auditory warning.
- The radar and ultrasonic system alerts were later (similar to Shield+ crash imminent alerts).

False Positives

- Shield+ issued fewer false alerts than other systems. For example, for pedestrian walking in front of stopped vehicle, no warning was issued until the vehicle moves. This reduced both annoyance alerts and false positives compared to the other systems that would warn at every crossing.
- Another false positive was driving by a VRU walking in the same direction on the sidewalk. Shield+ would issue amber alert (no audio) while the other system warned the driver.

Analysis continues...

Part 2: Field Operational Testing (FOT)

- FOT starting in 5 cities across Canada collecting data for 1-year (Hamilton, Toronto, Ottawa, Montreal and Edmonton)
- Different common urban heavy vehicles (14 in total)
- Measuring system performance under real world operation (weather, maintenance)
- Evaluation of driver acceptance (usage, workload, annoyance, false alarms, etc).
- Systems are currently being installed
- Data collection will run from April 2018 to April 2019



Past Research - extended use of backing aids

- Participants
 - 42 parent-aged participants (25-60 years)
- Conditions
 - Dashboard mounted video (visual system only) n=15
 - Rearview mirror mounted video (visual system only) n=12
 - Sonar (audio system only) n=15
- 3 Manoeuvres (parallel, perpendicular, extended backing) before and after 2 months of use
 - Parking accuracy, (distance deviation from “perfect”, time to park, # of boxes hit)
 - Visual scans (glances to side and rearview mirrors)
 - Device checks (glances and stares to backing aid devices, responses to warning)
 - Qualitative ratings
- Manoeuvring performance improved.
- Systems did not prevent collision with unexpected obstacle (80 – 93 percent).
- Drivers tended to use mirrors less and made fewer glances to areas around the vehicle after extensive use of sensor-or camera-based backing aids (*Rudin-Brown, Burns, Hagen, Roberts, & Scipione, 2012*).

UNECE Guidelines for High-Priority Warnings HMI

1. Warnings should be noticeable in the driving environment
2. Warnings should be distinguishable from other messages in the vehicle
3. Warnings should provide spatial cues to the hazard location
4. Warnings should inform the driver of the hazard
5. Warnings should elicit timely responses or decisions
6. Multiple warnings should be prioritized
7. False/ nuisance warning rates should be low
8. Non-operational system status should be displayed

CMVSS 111: Mirrors and Rear Visibility Systems

- Nov 15, 2017, Transport Canada amended CMVSS 111 mandating that all new light duty vehicles with a gross vehicle weight of less than 4 536 kg (10 000 lb) be equipped with rear visibility systems.
- Applies to new light duty vehicles with a gross vehicle weight of less than 4 536 kg (10 000 lb), including passenger cars, trucks, three-wheeled vehicles, multi-purpose passenger vehicles (e.g. SUVs), small buses (e.g. passenger van), and low-speed vehicles.
- The requirement takes effect on May 1, 2018.
- Manufacturers of multi-stage vehicles will be given one additional year to comply with these requirements.
- Rear visibility requirements are aligned with US FMVSS 111.

<http://www.gazette.gc.ca/rp-pr/p2/2017/2017-11-15/html/sor-dors231-eng.html>

Crash Avoidance: Automatic Emergency Braking

- Ongoing testing program to collect accurate and reliable data on the performance of AEB for different scenarios.
 - Vehicles are tested using the NHTSA procedure for Car AEB, European procedures for Car AEB and Pedestrian.
 - Over 2000-2500 tests are conducted each year from spring to the first snow fall.
 - This work is to:
 - Monitor new vehicle technologies
 - Assess foundational systems for higher levels of vehicle automation
 - Identify risks and limitations of available systems on the market to the Canadian public
 - Support the development of test targets and procedures
 - Guide future safety regulations.
 - A subsample of tests have also been conducted on various winter surfaces.