Human Factors: The Necessity of a User-Centred Approach for Automated Vehicles

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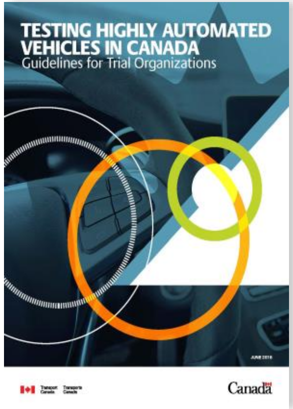
Canada

Overview

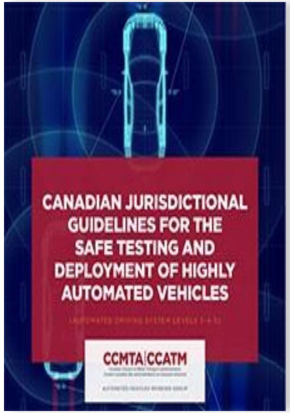
1. Canadian guidance documents to support Testing & Safety Assessments
2. HF Expert Assessment L2 testing program
3. Low Speed Automated Shuttles: Scenario Development & Standardization Initiatives
4. Low Speed Automated Shuttles: Human Factors Assessment
5. Final remarks

Guidance for the Safe Testing and Deployment for ADS

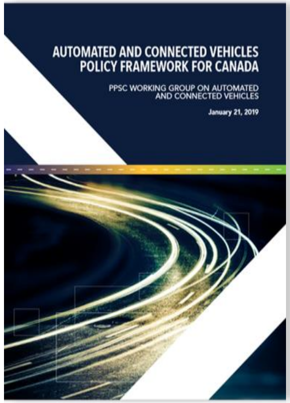
Amendments to Motor Vehicle Safety Act March 2018



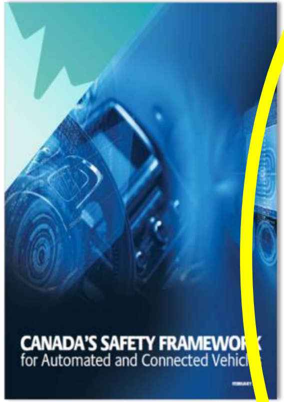
National Testing Guidelines June 2018



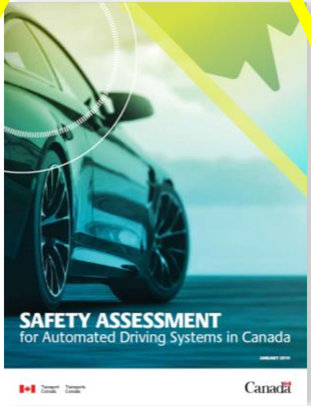
Jurisdictional Guidelines October 2018



National Policy Framework January 2019



Transport Canada Safety Framework January 2019

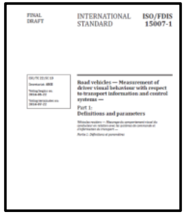


Safety Assessment for Automated Driving Systems February 2019

Documents available at: www.canada.ca/automatedvehicles

Human Factors Concerns

Design Process Requirements


FINAL DRAFT

INTERNATIONAL STANDARD

ISO/FDIS 15007-1

Road vehicles — Measurement of driver visual behaviour with respect to transport information and control systems —

Part 1:
Definitions and parameters

Assessment Procedures

Usability
Inattention, overload
Training

Expert Audit

Mode Confusion
Human Fallback
Miscalibrated trust

Lab Testing

Driver Monitoring
External HMI
Remote operation

On Road Trials

Human Factors Assessment of Interaction & Safety of L2 Vehicles

Transport Canada has been testing components of ADAS systems for ~ 20 years (Forward Collision Warning, ACC, AEB etc) conducted on test tracks

Human Factors Assessments

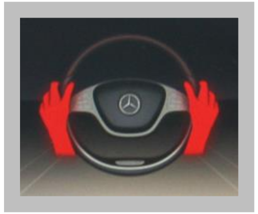
- Driver interactions with currently available L2 systems
- In a single drive, a driver may experience several different driving experiences from home to work
- Must consider driver/vehicle/environment for each of these
- How is this experienced from the user's perspective?

Human Factors L2 Assessments

Goal: Support the development of assessment & testing methods

Areas of Assessment:

- HMI
- Driver understanding & use of system functions
- Transitions: driver & system initiated
- Potential for misuse/mischief



On road assessments with HF experts

Multi-methods approach:

- Video & audio recordings for additional analyses, coding procedures
- Error analyses, check lists….

Work is ongoing

Low Speed Automated Driving Systems (LSAD) Testing in Ottawa

Develop and assess test procedures to evaluate the safe operation of LSAD around pedestrians and cyclists

Build on ADAS test procedures and targets

Capitalize on partners that have a vehicle and city-like test bed

PROCEDURES

- Share results with LSAD standard ISO 22737
- Euro NCAP – AEB VRU Systems
- Low speed urban interaction between vehicles and cyclists/pedestrians

SCENARIOS

- 7 Collision path
- 2 False positive

TARGETS

- 50^{th} percentile male dummy – 5 km/h
- 50^{th} percentile male cyclist – 15 km/h
- 7 year old child dummy – 5 km/h
- Shuttle on a straight line – 7.2 km/h
- Shuttle turning manoeuver – 3.2 km/h

Test Environment Intersection Set Up

Equipment

- Child
- Adult
- Cyclist

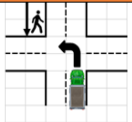
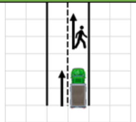
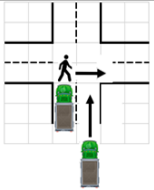
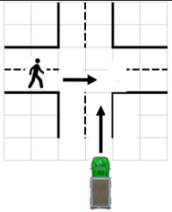
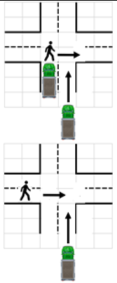
- Euro NCAP Pedestrian Targets paired with the Soft PedestrianTarget (SPT-20) system from ABD

The test vehicles where instrumented with **RT4002 Inertial GPS Navigation Systems and RT-Range from OxTS** to measure the vehicle:

- position and heading,
- vehicle speed and angular velocities (yaw, roll, and pitch rate),
- linear acceleration (longitudinal, lateral and vertical),
- distance to target and relative velocity.

- The accuracy of the GPS was augmented through the use of a portable GPS Base Station.

Example Dynamic Scenarios

VRU Scenario #1		VRU Scenario #2*	
	$V_{shuttle}$ = 3.6 km/h V_{ped} = 5 km/h **Impact zone** = 50% front of shuttle		$V_{shuttle}$ = 3.6 km/h V_{ped} = 5 km/h **Impact zone** = 75% front of shuttle (left corner)
VRU Scenario #3*		**VRU Scenario #4****	
	$V_{shuttle}$ = 3.6 km/h V_{ped} = 5 km/h **Impact zone** = 75% front of shuttle (right front)		$V_{shuttle}$ = 7.2 km/h V_{ped} = 5 km/h **Impact zone** = 25% front of truck
VRU Scenario #5a* (obstructed) child**		**VRU Scenario #5b*** (unobstructed)**	
	$V_{shuttle}$ = 7.2 km/h V_{ped} = 5 km/h **Impact zone** = 75% front of truck, obstructed child		$V_{shuttle}$ = 15 km/h V_{ped} = 5 km/h **Impact zone** = 75% front of truck
VRU Scenario #5a & 5b - cyclist		**VRU Scenario 6**	
	$V_{shuttle}$ = 7.2 km/h V_{ped} = 5 km/h **Impact zone** = 50% front of truck, obstructed/unobstructed cyclist		$V_{shuttle}$ = 3.6km/h $V_{cyclist}$ = 15 km/h **Impact zone** = Front right wheel

Collision Data

Based on vulnerable road user collision data (pedestrian and cyclists)

EuroNCAP CPTA,

turning walking adult. European New Car Assessment Program Test protocol AEB VRU system version 3.0.1

ISO Low Speed Automated Driving 22737

European New Car Assessment Program Test Protocol AEB VRU systems version 2.0.4 February 2019.

EuroNCAP CPLA-50 scenario, longitudinal walking adult.

EuroNCAP CPNC-50 scenario, running child from nearside from obstruction vehicles.

Non-occluded/occluded Hazardous situation (LSADr11.2).

This scenario can be scaled for the cyclist hazardous situation as well.

Preliminary Observations: LSAD work

- Variety of testing scenarios is valuable:
  - Important to use turning scenarios and occlusion of the pedestrians (behind a vehicle) to provide realistic challenges.
- Technical Challenges:
  - Sensors (LIDAR) had issues during rain, which emphasizes the need to test under different weather conditions.
  - Front of vehicle may need added protection to avoid damaging sensors (i.e., expect collisions).

NEXT STEPS:

- Analysis of test repeatability and stopping distances
- Report expected in early 2020.

Test Scenario Development Activities

- TC204 / WG14 Vehicle/roadway warning and control systems
- TC22 / SC33 / WG9 Test scenario of autonomous driving vehicle
- ISO/TC 22 /SC 33/WG 16 Active Safety test equipment
- WP.29 / GRVA / VMAD / Subgroup 1a) Traffic scenario
- SAE On-Road Automated Driving (ORAD)
- UL 4600
- A Framework for Automated Driving System Testable Cases and Scenarios
- Quality criteria, tools, methods, scenarios and situations for highly-automated driving functions
- OpenX format standards: OpenDRIVE / OpenCRG / OpenSCENARIO
- Driving Automation
- Bibliothèque de scenario de validation du véhicule autonome
- Scenario-based Safety Validation of Connected and Automated Driving
- MUSICC - Multi-User Scenario Catalogue for CAVs
- SAKURA - Safety Assurance KUdos for Reliable Autonomous vehicles
- SIP-adus - Strategic Innovation Promotion Program (SIP) Automated Driving for Universal Services
- autonomous driving test guideline
- Autonomous Driving Vehicle Test Scenarios Standards
- University of Waterloo - Wise Lab
- L3 Pilot
- Intereact
- Virginia tech
- UMTRI
- Autonomous Vehicle Computing Consortium
- Tatcham Research
- RCAR
- AAA
- Euro NCAP
- Open Autonomous Safety (Voyage)

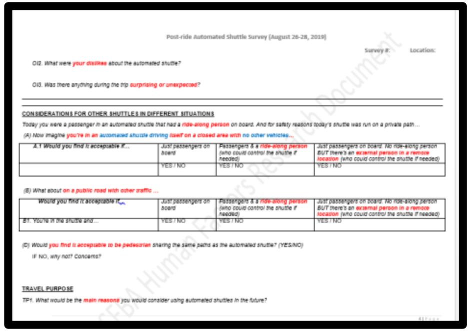
Low Speed Automated Shuttles: Human Factors Considerations

- **User needs & expectations**
  - Comfort, **Safety,** Performance

- **Assistance/control in (un)expected situations**
  - Object in the road, operation failure…
  - **Role of Remote Supervisor/ operator**

- **The larger traffic environment**
  - Interactions with other vehicles & humans

- 76 participants, closed route



Post-ride Automated Shuttle Survey (August 26-28, 2019)

Survey #: Location:

OI2. What were your dislikes about the automated shuttle?

OI3. Was there anything during the trip surprising or unexpected?

CONSIDERATIONS FOR OTHER SHUTTLES IN DIFFERENT SITUATIONS

Today you were a passenger in an automated shuttle that had a ride-along person on board. And for safety reasons today's shuttle was run on a private path…

(A) Now imagine you're in an automated shuttle driving itself on a closed area with no other vehicles…

A.1 Would you find it acceptable if…	Just passengers on board	Passengers & a ride-along person (who could control the shuttle if needed)	Just passengers on board. No ride-along person BUT there's an external person in a remote location (who could control the shuttle if needed)
	YES / NO	YES / NO	YES / NO

(B) What about on a public road with other traffic …

Would you find it acceptable if…	Just passengers on board	Passengers & a ride-along person (who could control the shuttle if needed)	Just passengers on board. No ride-along person BUT there's an external person in a remote location (who could control the shuttle if needed)
B1. You're in the shuttle and…	YES / NO	YES / NO	YES / NO

(D) Would you find it acceptable to be pedestrian sharing the same paths as the automated shuttle? (YES/NO)

IF NO, why not? Concerns?

TRAVEL PURPOSE

TP1. What would be the main reasons you would consider using automated shuttles in the future?

Responses for Safety Items

What safety equipment did you notice on board?

- ✓Seatbelts (.92; wanted 3 point)
- Red emergency button (.30)
- Door handles (.25)

What safety measures would you like to see on board?

- Obvious signage
- Emergency stop button, personal security alarm
- Emergency exit, windows that open
- Communication system during emergencies

Would it be acceptable to have passengers only?

- Yes, on a closed course (.80)
- But on Public roads wanted Remote or On-Board operator (.70)

Human Factors: Shuttle Evaluation

User needs & expectations:

- Safety is a primary concern
- Many needs previously met by the role of a bus driver; how will these needs be met on shuttles?

- Desire for assistance/ control possibly with a Remote Operator
  - Human Factors considerations for remote monitoring & operation
- User concerns impact trust, acceptance & willingness to use

Next Steps:

- Continue with analyses
- HF evaluations of other shuttles

Final Remarks…

- With automated vehicles, the focus is often on the new & exciting technologies
- These new technologies and their functions are, of course, very important. They are changing the relationship between the human and the vehicle
- But we must not neglect the human users in this new relationship
  - Are these systems designed for human interaction?
  - Are they working as intended from a human user’s perspective?
  - Are they meeting users’ needs?
- These are essential requirements for safety and acceptance
- There are tremendous benefits to be gained through coordinated efforts in research and the development of assessment methods to address these human factors needs

Thank you for your attention

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