

Winter Track Testing of Collision Avoidance Systems: What Have We Learnt?

CARSP/PRI 2021 Conference
August 22-25, 2021



Winter Conditions



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Menu

- **What was the problem?**
 - Methods
 - Performance in winter

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- **What was the plan?**
 - Winterize equipment and methods
 - Test same vehicle in summer and winter

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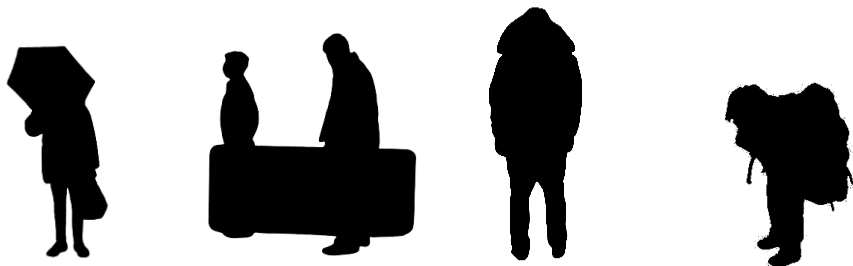
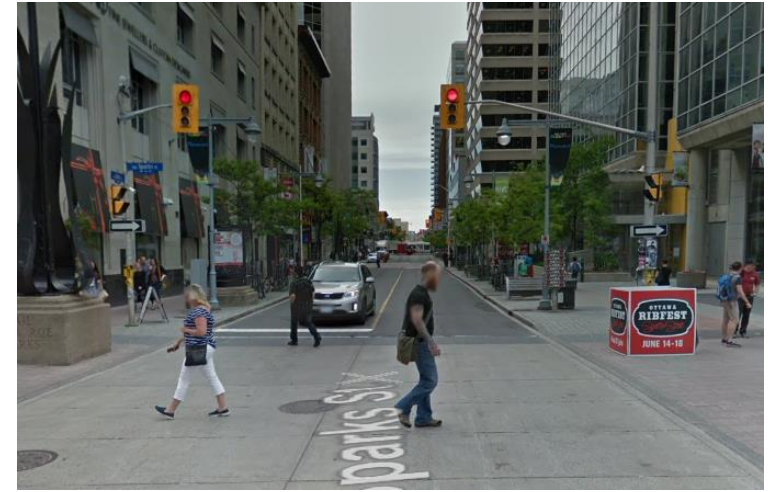
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 - Test same vehicle in summer and winter
- **What was the testing?**
 - Use snow and ice
 - Dress up dummies

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- **What was the problem?**
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 - Winterize equipment and methods
 - Test same vehicle in summer and winter
- **What was the testing?**
 - Use snow and ice
 - Dress up dummies
- **What was the conclusion?**
 - Designed relevant scenarios
 - Not all systems are affected the same way

What was the problem?

- Winter conditions are typically present for over 3 months of the year
- Potential reduction in the benefits associated with the assistance and safety features provided by ADAS
- Equipment designed to operate in ideal summer conditions
- Focus on detection capability



What was the plan?

- **Modify equipment**
 - Pedestrian propulsion system
 - Use snow cannon
 - Vehicles equipped with w tires



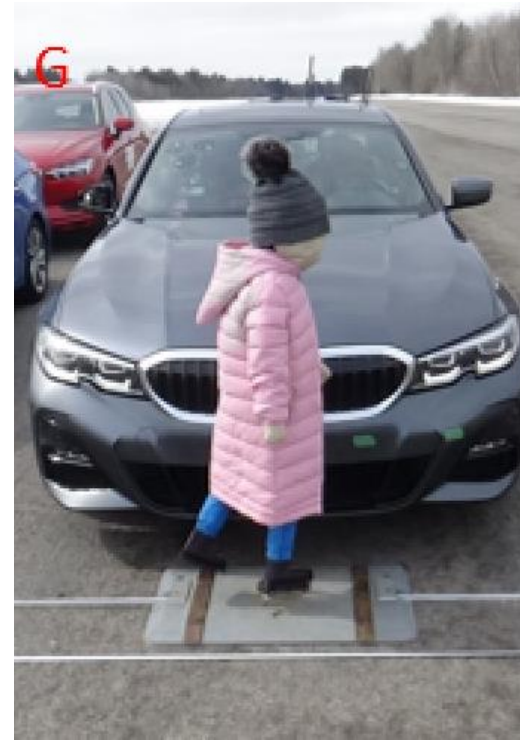
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- **Modify methodology**
 - Clear pathway, keep traction, reduce impact
 - Keep white background



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- **Modify appearance**
 - Dress dummy with long jackets, hats, backpack and umbrellas
 - Cover targets with ice or snow
 - Cover the test vehicles with ice



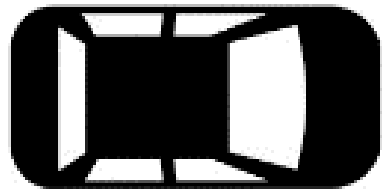
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- **Modify equipment**
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- **Modify appearance**
 - Dress dummy with long jackets, hats, backpack and umbrellas
 - Cover targets with ice or snow
 - Cover the test vehicles with ice
- **Use a sample of vehicles available in Canada**
 - 5 vehicles for vehicle target detection
 - 4 vehicles for Adult and Child AEB detection and avoidance



What was the testing?

- Effect of snow and ice on vehicle's sensors and vehicle target






20, 42 and 60 km/h



Vehicle Sensors covered with ice in Static Test






Test Matrix – Snow/Ice on Vehicle, Snow on Target

Test Vehicle	Speed (km/h)	EVT				SSV		GVT	
									
		Dry	Snow	Ice on Car	Snow on Car	Dry	Snow	Dry	Snow
VEH-A	20, 42, 60	X	X	X	X	X	X	X	X
VEH-B	20, 42, 60	X	X	X	X	X	X	X	X
VEH-C	20, 42, 60	X	X	X	X	X	X	X	X*
VEH-D	20, 42, 60	X	X	X	X	X	X	X	X
VEH-E	20, 42, 60	X	X	X	X	X	X	X	X

*42 km/h only




Conclusion – Snow/Ice on Vehicle, Snow on Target

Test Vehicle	Speed (km/h)	EVT				SSV		GVT	
									
		Dry	Snow	Ice on Car	Snow on Car	Dry	Snow	Dry	Snow
VEH-A	20, 42, 60	X	X	X	X	X	X	X	X
VEH-B	20, 42, 60	X	X	X	X	X	X	X	X
VEH-C	20, 42, 60	X	X	X	X	X	X	X	X*
VEH-D	20, 42, 60	X	X	X	X	X	X	X	X
VEH-E	20, 42, 60	X	X	X	X	X	X	X	X

*42 km/h only

3/5 vehicles – No FCW to the driver when covered in Ice




Conclusion – Snow/Ice on Vehicle, Snow on Target

Test Vehicle	Speed (km/h)	EVT				SSV		GVT	
									
		Dry	Snow	Ice on Car	Snow on Car	Dry	Snow	Dry	Snow
VEH-A	20, 42, 60	X	X	X	X	X	X	X	X
VEH-B	20, 42, 60	X	X	X	X	X	X	X	X
VEH-C	20, 42, 60	X	X	X	X	X	X	X	X*
VEH-D	20, 42, 60	X	X	X	X	X	X	X	X
VEH-E	20, 42, 60	X	X	X	X	X	X	X	X

*42 km/h only

Of those 3 vehicles, 1 displayed a message about sensor obstruction




Conclusion – Snow/Ice on Vehicle, Snow on Target

Test Vehicle	Speed (km/h)	EVT				SSV		GVT	
									
		Dry	Snow	Ice on Car	Snow on Car	Dry	Snow	Dry	Snow
VEH-A	20, 42, 60	X	X	X	X	X	X	X	X
VEH-B	20, 42, 60	X	X	X	X	X	X	X	X
VEH-C	20, 42, 60	X	X	X	X	X	X	X	X*
VEH-D	20, 42, 60	X	X	X	X	X	X	X	X
VEH-E	20, 42, 60	X	X	X	X	X	X	X	X

*42 km/h only

1 vehicle was not affected by snow and ice

Conclusion – Snow/Ice on Vehicle, Snow on Target

Test Vehicle	Speed (km/h)	EVT				SSV		GVT	
									
		Dry	Snow	Ice on Car	Snow on Car	Dry	Snow	Dry	Snow
VEH-A	20, 42, 60	X	X	X	X	X	X	X	X
VEH-B	20, 42, 60	X	X	X	X	X	X	X	X
VEH-C	20, 42, 60	X	X	X	X	X	X	X	X*
VEH-D	20, 42, 60	X	X	X	X	X	X	X	X
VEH-E	20, 42, 60	X	X	X	X	X	X	X	X




*42 km/h only

1 vehicle FCW was slightly delayed

Snow Covered Vehicle Targets in Static Test



Test Matrix – Snow/Ice on Vehicle, Snow on Target

Test Vehicle	Speed (km/h)	EVT				SSV		GVT	
									
		Dry	Snow	Ice on Car	Snow on Car	Dry	Snow	Dry	Snow
VEH-A	20, 42, 60	X	X	X	X	X	X	X	X
VEH-B	20, 42, 60	X	X	X	X	X	X	X	X
VEH-C	20, 42, 60	X	X	X	X	X	X	X	X*
VEH-D	20, 42, 60	X	X	X	X	X	X	X	X
VEH-E	20, 42, 60	X	X	X	X	X	X	X	X

*42 km/h only

4 vehicles were not able to detect the snow covered targets, EVT and GVT




Test Matrix – Snow/Ice on Vehicle, Snow on Target

Test Vehicle	Speed (km/h)	EVT				SSV		GVT	
		Dry	Snow	Ice on Car	Snow on Car	Dry	Snow	Dry	Snow
VEH-A	20, 42, 60	X	X	X	X	X	X	X	X
VEH-B	20, 42, 60	X	X	X	X	X	X	X	X
VEH-C	20, 42, 60	X	X	X	X	X	X	X	X*
VEH-D	20, 42, 60	X	X	X	X	X	X	X	X
VEH-E	20, 42, 60	X	X	X	X	X	X	X	X

*42 km/h only

Vehicles experienced delays in generating a FCW

Test Matrix – Snow/Ice on Vehicle, Snow on Target

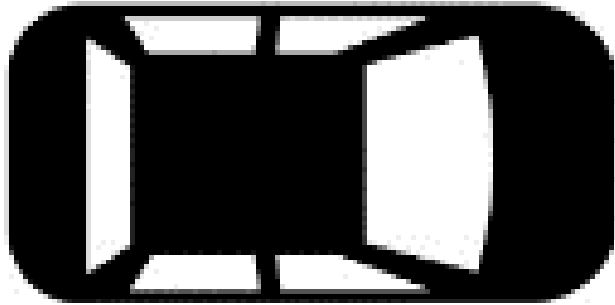
Test Vehicle	Speed (km/h)	EVT				SSV		GVT	
									
		Dry	Snow	Ice on Car	Snow on Car	Dry	Snow	Dry	Snow
VEH-A	20, 42, 60	X	X	X	X	X	X	X	X
VEH-B	20, 42, 60	X	X	X	X	X	X	X	X
VEH-C	20, 42, 60	X	X	X	X	X	X	X	X*
VEH-D	20, 42, 60	X	X	X	X	X	X	X	X
VEH-E	20, 42, 60	X	X	X	X	X	X	X	X

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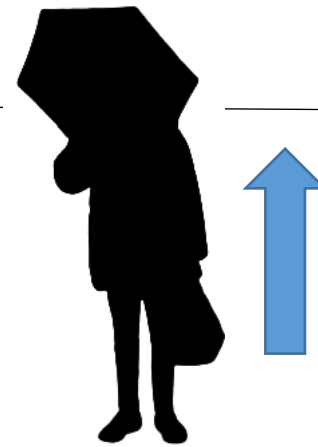
Vehicles experienced improvement in generating a FCW

What was the testing?

- Adult pedestrian avoidance with different clothing iterations (jacket, hat, backpack, umbrella)









20 to 50 km/h




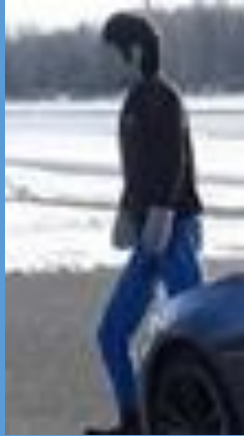




Adult Pedestrian 75%



Test Matrix – Adult Pedestrian


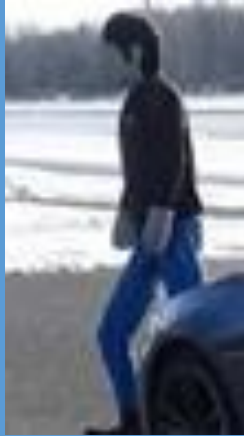




Test Vehicle	Speed (km/h)						
VEH-B	20	1	5	1	1	3	5
	25	5	5	5	5	5	3
VEH-C	45		5	5	2		
VEH-D	45						5
	50	5	5	5	5	5	1
VEH-E	45		5				5
	50	5	1	5	5	5	2

Conclusion – Adult Pedestrian

Test Vehicle	Speed (km/h)						
VEH-B	20	1	5	1	1	3	5
	25	5	5	5	5	5	3
VEH-C	45		5	5	2		
VEH-D	45						5
	50	5	5	5	5	5	1
VEH-E	45		5				5
	50	5	1	5	5	5	2

1 vehicle: was challenged in all winter condition

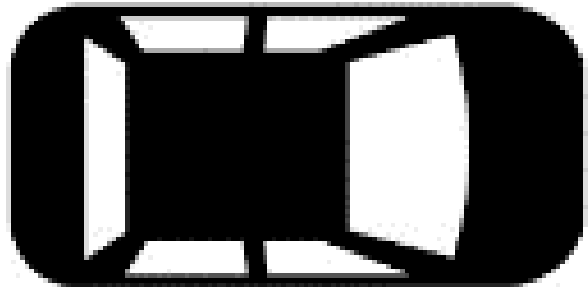
Conclusion – Adult Pedestrian

Test Vehicle	Speed (km/h)						
VEH-B	20	1	5	1	1	3	5
	25	5	5	5	5	5	3
VEH-C	45		5	5	2		
VEH-D	45						5
	50	5	5	5	5	5	1
VEH-E	45		5				5
	50	5	1	5	5	5	2

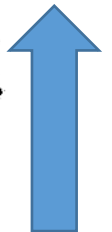
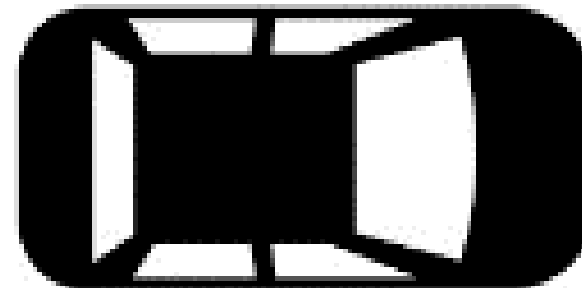
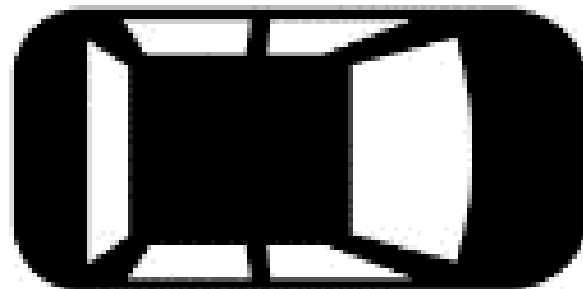
2 vehicles: challenged by the umbrella and bag

What was the testing?

- Child pedestrian avoidance with different clothing iterations (jacket, hat, backpack, umbrella)








20 to 30 km/h








Child Obstructed Scenario?



Test Matrix – Child Pedestrian





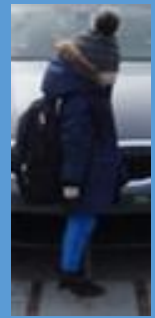
Test Vehicle	Speed (km/h)					
VEH-B	20		1	1		1
VEH-C	30		5	5	5	5
VEH-D	25	5	5			
	30	5	1	5	5	4
VEH-E	25				5	
	30	5	5	5	3	5

Conclusion – Child Pedestrian

Test Vehicle	Speed (km/h)					
VEH-B	20		1	1		1
VEH-C	30		5	5	5	5
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	30	5	1	5	5	4
VEH-E	25				5	
	30	5	5	5	3	5





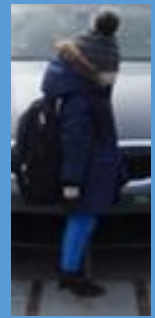
1 vehicle did not avoid impact

Conclusion – Child Pedestrian

Test Vehicle	Speed (km/h)					
VEH-B	20		1	1		1
VEH-C	30		5	5	5	5
VEH-D	25	5	5			
	30	5	1	5	5	4
VEH-E	25				5	
	30	5	5	5	3	5

Backpack increased the frequency of impacts

Conclusion – Child Pedestrian

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VEH-B	20		1	1		1
VEH-C	30		5	5	5	5
VEH-D	25	5	5			
	30	5	1	5	5	4
VEH-E	25				5	
	30	5	5	5	3	5

Some winter conditions did not affect vehicles

Take Home Message

Covering Vehicle with Snow/ice

- Inconsistency in application
- Can't cover camera, only radar

Which Target to use?

- use the Global Vehicle Target due to the large adoption of future international protocol in regular ADAS testing.

Adult Pedestrian Testing

- Challenge vehicles using umbrella and other accessories

Child Pedestrian Testing

- Most challenging test, test other vehicles with backpack

Thank You

Transport Canada

Dominique Charlebois, Shivang Dube & Benoit Anctil, P. Eng



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<https://tc.canada.ca/en/innovation-centre>

PMG Technologies

Annie Saleh, P. Eng & Guillaume Pierre, P. Eng



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