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An Evaluation of Light-Vehicle Automatic Emergency Brake System Responses to 2-Wheeled Road Users

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16. Abstract
The research in this report used lead vehicle stopped, lead vehicle moving, and lead vehicle decelerating test scenarios to evaluate the automatic emergency braking (AEB) performance of four light vehicles (subject vehicles, or SVs) when presented with a test surrogate designed to emulate a 2-wheeled road user as the principal other vehicle (POV). Up to two motorcycle and two bicycle test surrogates, and two lateral overlaps per POV type, were nominally used for each test scenario. Additionally, up to two POV decelerations were used during conduct of the lead vehicle decelerating tests. Time-to-collision values at the onset of the SV's forward collision warning and automatic braking initiated by the AEB systems are presented. Crash avoidance summaries are provided where applicable. For test trials that concluded with the SV contacting the POV, relative impact speeds are indicated. Discussions of how the test surrogate radar cross sections compare to the requirements defined in ISO 19206-4:2020 and ISO 19206-5:2025, and of test surrogate use considerations, are also provided.

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automatic emergency braking, AEB, forward collision warning, FCW, crash avoidance, advanced driver assist systems, ADAS, regenerative braking, road user, motorcyclist, bicyclist	Document is available to the public from the DOT, BTS, National Transportation Library, Repository & Open Science Access Portal, https://rosap.ntl.bts.gov.

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Test Objectives

The National Highway Traffic Safety Administration research in this report used three test scenarios to evaluate the automatic emergency braking (AEB) performance of four light vehicles when presented with a test surrogate designed to emulate a bicyclist or motorcyclist 2-wheeled road user as the principal other vehicle (POV).

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Test Methodology

Test Maneuvers

Although certain test parameters may differ, the rear-end, pre-crash scenarios used for the tests in this report are similar to the lead vehicle test scenarios defined in the May 2024 final rule for Federal Motor Vehicle Safety Standard (FMVSS) No. 127, *Automatic emergency braking systems for light vehicles* (49 CFR Parts 571, 595, and 596, 2024):

- Lead Vehicle Stopped (LVS): The subject vehicle (SV) approaches a stationary lead vehicle in the forward path of the SV. The lead vehicle is also known as the POV.
- Lead Vehicle Moving (LVM): The SV approaches a slower-moving POV traveling at a constant speed in the forward path of the SV.
- Lead Vehicle Decelerating (LVD): After a short period of the SV following a POV in its forward path with a constant speed and headway, the POV is braked to a stop using a constant deceleration.

While the POV used by NHTSA when performing FMVSS No. 127 lead vehicle AEB testing is a vehicle test device representing a passenger car, the POVs used for the work described in the report were motorcycle- or bicycle-based surrogates. Additionally, two within-lane lateral overlaps, subsequently referred to simply as "overlaps," per POV type were used and some POV speed and deceleration parameters varied, where applicable.

Test Speed, POV Lateral Overlaps, SV-to-POV Headway, and POV Deceleration

For each test scenario, the overlaps used when the POV was a bicycle were 25 and 50 percent of the SV width (Figure 1). Similarly, the overlaps used when the POV was a motorcycle were 50 and 75 percent of the SV width (Figure 1). All indicated percentages are based on a coordinate system that uses 0 and 100 percent as the right and left side of the SV.

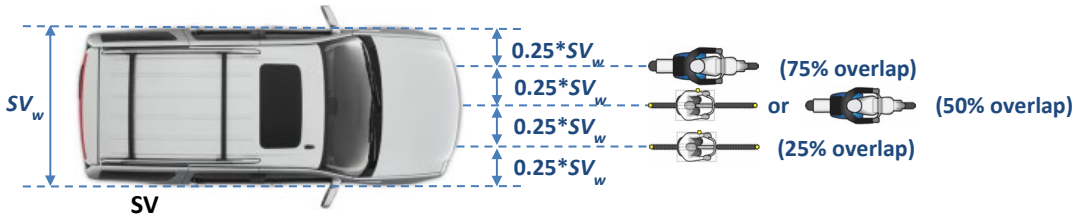

Figure 1. Lateral overlaps used for tests performed with bicycle and motorcycle POVs

Table 1 presents a summary of the nominal SV and POV test speeds, POV lateral overlaps, SV-to-POV headways, and POV decelerations used for each test scenario discussed in this report.

Table 1. NHTSA's 2024-25 Light Vehicle 2-Wheeled Road User AEB Test Matrix

Test Scenario	Test Speeds (km/h)			Headway (m)	POV Decel. (g)	POV Lateral Offset (% of SV width)	SV FCW Setting	SV Regen. Braking Setting
	SV	Bicycle POV	Motorcycle POV					
 LV Stopped, Bicycle (LVS_B)	10, 40 to 80[1]	0	--	--	--	25 and 50	Near[2]	Off (or lowest)
 LV Stopped, Motorcycle (LVS_M)		--	0	--	--	50 and 75		
 LV Moving, Bicycle (LVM_B)	40 to 80[1]	20	--	--	--	25 and 50	Near[2]	Off (or lowest)
 LV Moving, Motorcycle (LVM_M)		--	20	--	--	50 and 75		
 LV Decelerating, Bicycle (LVD_B)	20 and 30	20 and 30 (same as SV)	--	12 and 40	0.3	25 and 50	Near[2]	Off (or lowest)
 LV Decelerating, Motorcycle (LVD_M)	50 and 80	--	50 and 80 (same as SV)	12 and 40	0.3 and 0.5	50 and 75		

[1]Nominally increased in 10 km/h increments.

[2]Except for Cadillac Lyriq tests performed with the bicycle POVs, where the SV forward collision warning (FCW) was set to "far."

Regardless of which POV was used, the LVS test speed was increased from 10 to 80 km/h in 10 km/h increments until the termination conditions described in the "Use of Repeated Trials" section were realized.

During LVM tests, the SV test speed was increased from 40 to 80 km/h in 10 km increments until termination conditions described in the "Use of Repeated Trials" section were realized. The POV speed remained at 20 km/h for each of these tests, regardless of whether the POV was a bicycle or motorcycle test device.

For LVD testing performed with a bicycle or motorcycle test device as the POV,

- SV-to-POV headway was either 12 or 40 m until POV braking was initiated.
- The desired POV deceleration was established within 1.5 seconds of being initiated.
- The average POV deceleration remained at the desired magnitude until a time of 250 ms before stopping.

However, the test speed and POV deceleration used for LVD testing depended on whether the POV was a bicycle or motorcycle test device.

- Tests performed with a bicycle surrogate used SV and POV speeds of 20 and 30 km/h, and the SV and POV were operated at the same speed until POV braking was initiated. The bicycle POV deceleration was nominally 0.3g during these tests.
- Tests performed with a motorcycle surrogate used SV and POV speeds of 50 and 80 km/h, and the SV and POV were operated at the same speed until POV braking was initiated. The motorcycle POV deceleration was nominally 0.3 or 0.5g during these tests.

SV Accelerator Pedal Release Timing

For all tests, the SV accelerator pedal was released within 500 ms from when the FCW's auditory alert was presented.

Manual SV Brake Pedal Applications

The SV brakes were not manually applied during any test described in this report. Any SV speed reductions were only the result of the SV AEB system automatically intervening in response to the crash-imminent driving situation plus the contribution of regenerative braking, where applicable.

Ignition or Start/Stop Switch Cycling (Cycling of the Power System)

The SVs were power cycled via the ignition switch or power button after completion of each test trial.

Use of Repeated Test Trials

For each SV, SV speed was iteratively increased from lowest to highest for each scenario, and each combination of scenario/speed nominally included repeated trials. The number of repeated trials used depended on factors such as whether an SV-to-POV impact occurred for a given test condition, the relative impact speed magnitude observed during the first trial of the test series (if applicable), and where in the test sequence the SV was evaluated.

For the first two SVs tested, the Subaru Crosstrek and Toyota Corolla, a series of five trials per scenario/speed combination were nominally specified. However, the number of actual tests performed for a given test condition depended on whether SV-to-POV contact occurred, as provisions were used to help mitigate the potential for repeated SV-to-POV impacts from damaging the SV, bicycle and motorcycle test devices, and/or other test equipment.

- If an SV-to-POV impact occurred during the first trial of the series, and the SV speed reduction at the time of the impact was less than 50 percent, then no additional trials were performed for that series or test scenario.
- If three impacts were observed during the within-series repeat sequence, then the test series was terminated, and no further trials were performed for the test scenario.
- For tests performed with motorcycle POVs, if either test series termination conditions were realized during an LVD test performed with a POV deceleration of 0.3g, then the otherwise equivalent test series performed with the greater 0.5g POV deceleration was not performed.

For the remaining SVs, two trials per scenario/speed combination were nominally specified. However, the number of trials actually performed also depended on whether SV-to-POV contact occurred.

- If the SV did not contact the POV during either trial, then the SV speed (and/or POV deceleration for LVD tests, where applicable) was iteratively increased.
- If an SV-to-POV impact occurred during the first trial of the series, and the SV speed reduction at the time of the impact was less than 50 percent, then no additional trials were performed for that series or test scenario.
- If an impact was observed during the first or second within-series test trial, and the SV speed reduction at the time of the impact was greater than or equal to 50 percent then an additional trial was performed. If this third trial concluded with an impact, the test series was terminated, and no further trials were performed for the test scenario. If the SV did not contact the POV on the third trial, then the SV speed (and/or POV deceleration for LVD tests, where applicable) was iteratively increased.

Test Validity Criteria

The tests in this report were performed within the ambient conditions described above and the vehicle test parameter tolerances described in Appendix Table A-1.

Test Vehicles

This section includes SV and POV descriptions and/or driver-configurable settings relevant to the AEB evaluations described in this report. Subject vehicle weight ratings and as-tested weights are available in Appendix Table A-2.

Subject Vehicles

The four SVs evaluated for the work described in this report are listed in Table 2. Descriptions of the SV firmware (where applicable), FCW and AEB system names, operational speed ranges (specific to bicycle and/or motorcycle encounters where available), and available settings are also available in Table 2. Where possible, the ability of the SVs to automatically receive over-the-air firmware updates was switched off during the testing timeline.

Table 2. Subject Vehicles and Related FCW/AEB Systems

Vehicle	FCW System			AEB System		
	Name	**Speed Range (km/h)**	**Available Settings**	**Name**	**Speed Range (km/h)**	**Available Settings**
2024 Cadillac Lyriq AWD; EV SUV Firmware: GM V66.19 Forward looking sensors: Mono camera + radar	Forward Collision Alert	"All speeds" [1]	Far, Medium, Near, Off	Automatic Emergency Braking	>4 km/h (2 mph)[2]	On, Off
2024 Subaru Crosstrek AWD 5-dr hatchback Firmware: F71WMM043-670 Forward looking sensors: Stereo cameras + monocular camera	Forward Collision Warning	>1 km/h (1 mph), but <100 km/h (60 mph)[3]	Far, Normal, Near	Pre-Collision System Braking	>1 km/h (1 mph), but <100 km/h (60 mph)[4]	On, Off
2024 Tesla Model 3 AWD; EV sedan Firmware: v12 (2024.32.10) Forward looking sensors: Two cameras	Forward Collision Warning	5 - 200 km/h (3 - 124 mph	Late, Medium, Early, Off	Automatic Emergency Braking	5 - 200 km/h (3 - 124 mph)	On, Off
2023 Toyota Corolla Hybrid XLE FWD sedan[5] Forward looking sensors: Mono camera + radar	Pre-Collision System	5 - 180 km/h (3 - 110 mph)	Later, Default, Earlier	Pre-Collision System	5 - 180 km/h (3 - 110 mph)	On, Off

[1]The owner's manual states that "FCA detects vehicles within a distance of approximately 110 m (360 ft) and operates at all speed" (General Motors LLC, 2024).

[2] The owner's manual states that "The system works when driving a forward gear above 4 km/h (2 mph). It can detect vehicles up to approximately 60 m (197 ft)" (General Motors LLC, 2024).

[3]The FCW speed range is not explicitly stated in the owner's manual. The provided range is that of the pre-collision braking system when the system activates in response to a pedestrian, a cyclist, or a motorcycle (Subaru Corporation, 2024).

[4]When the system activates in response to a pedestrian, a cyclist, or a motorcycle. Otherwise, the owner's manual indicates the upper bound of the pre-collision brake system is <160 km/h (100 mph) (Subaru Corporation, 2024).

[5]NHTSA previously evaluated the AEB performance of this vehicle when presented with a lead vehicle test device designed to emulate a small passenger car (Forkenbrock et al., 2024).

SV Brake and Tire Conditioning

With the exception of one vehicle, the SV brake pads and rotors were burnished according to the Laboratory Test Procedure for FMVSS No. 135, *Light vehicle brake systems* (NHTSA, 2005) before the AEB performance of a given SV was evaluated. Since the Toyota Corolla brake system had been previously burnished as part of a prior test program (Forkenbrock et al., 2024), the brake conditioning procedure specified in FMVSS No. 126, *Electronic stability control systems* (NHTSA, 2008) was used as a precautionary measure to recondition the respective brake systems of these vehicles prior to testing.

SV-Specific Settings

Forward Collision Warning

The SVs were all equipped with driver-configurable FCW settings. Generally speaking, the "nearest" setting was used during conduct of each test condition to provide the shortest SV-to-POV headway at the time of the alert. The only exception was for Cadillac Lyriq tests performed with both bicycle POVs, where the "farthest" setting was unintentionally (but consistently) used for each of those trials.

Regenerative Braking

The Cadillac Lyriq and Tesla Model 3 are fully electric vehicles, and the Toyota Corolla used for this study is equipped with a gasoline electric hybrid engine. Each of these vehicles are equipped with regenerative braking systems. However, only the Cadillac Lyriq had a driver-configurable regenerative braking system setting, where the deceleration magnitude realized by the regenerative braking system was selectable via the "One Pedal Driving" menu. For the Cadillac Lyriq, the one-pedal drive system was set to off during test conduct (the available settings were "Off, Normal, or High") to minimize the amount of speed reduction produced between the time the SV driver released the accelerator pedal and the onset of regenerative braking automatically produced by the SV.

Adaptive Cruise Control

Adaptive cruise control was not used for the tests in this report.

Principal Other Vehicles

Four POVs were used for this report. The two bicycle-based surrogates were the 4active (4a) 4activeBS-adult[1] and AB Dynamics (ABD) Soft Bicycle 360,[2] shown in Figure 2, and are referred to as the "4a bicycle" and "ABD bicycle." The two motorcycle-based surrogates were the 4a 4activeMC-EMT[3] and the ABD Soft Motorcycle 360, shown in Figure 3, and are referred to as the "4a motorcycle" and "ABD motorcycle."

The bicycle-based surrogates were both secured to an ABD LaunchPad 50 or ABD LaunchPad 60 robotic platform, whereas the motorcycle-based surrogates were secured to an ABD LaunchPad 80.[4] The 4a and ABD each state their bicycle and motorcycle surrogates are compliant with ISO 19206-4:2020 and ISO 19206-5:2025 specifications.

Results from an assessment performed to confirm the radar return characteristics of each test surrogate relative to the applicable ISO specifications are in the Bicycle and Motorcycle Surrogate section below.

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[1] 4active Systems, GmbH, Traboch, Austria. The product sheet specifications says, "The approved PTW target for Euro NCAP 2023." www.4activesystems.at/wp-content/uploads/2024/04/240403_4activeMC-EuroNCAP.pdf

[2] AB Dynamics (Anthony Best Dynamics Limited), Bradford on Avon, England. The specification sheet says, "The Soft Bicycle 360 is designed and engineered by Dynamic Research, Inc[.]" (DRI, in California). https://www.abdynamics.com/app/uploads/2024/10/AB-Dynamics-DRI-Soft-Bicycle-360-Product-Specification-ROW.pdf

[3] 4active Systems, GmbH www.4activesystems.at/wp-content/uploads/2024/04/240403_4activeMC-EuroNCAP.pdf

[4] www.abdynamics.com/track-testing/adas-platforms/launchpad-80/

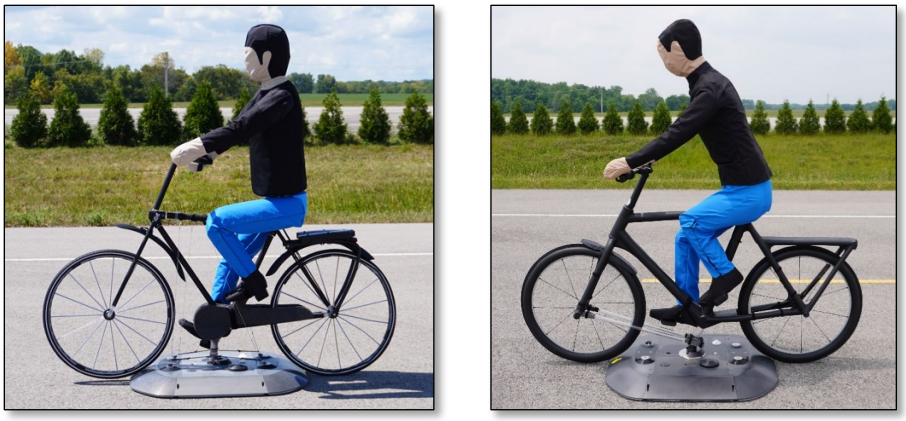

Figure 2. The 4a 4activeBS-adult (left) and ABD Soft Bicycle 360 (right), each secured to an ABD LaunchPad 50 robotic platform

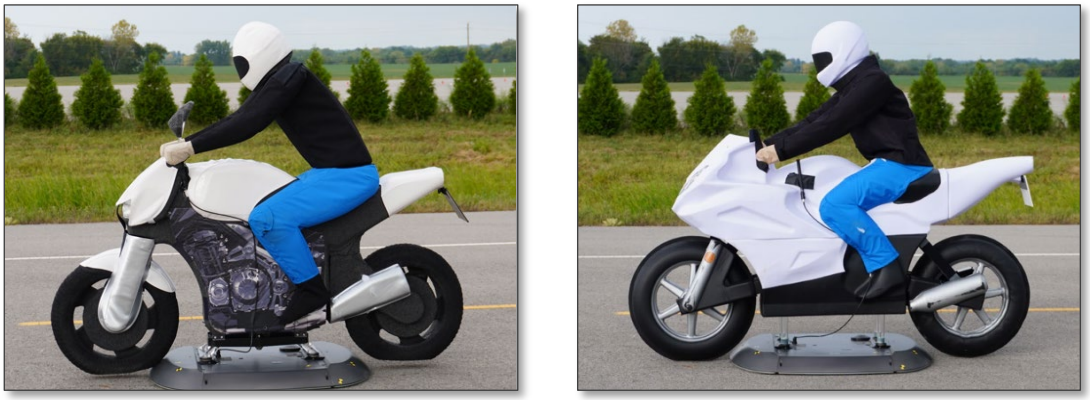

Figure 3. The 4a 4activeMC-EMT (left) and ABD Soft Motorcycle 360 (right), each secured to an ABD LaunchPad 80 robotic platform

For the bicycle surrogates, inclusion of the micro Doppler characteristics associated with rotating wheels and the simulated rider's pedaling legs during LVM and LVD testing is specified in 19206-4:2020. Realizing the proper alignment and operation of the wheels (e.g., that the rotational speed was appropriate for the bicycle's forward velocity) was achieved by carefully adjusting components to set the wheel placement and height such that the tires were lightly contacting the test surface during test conduct. The radar characteristics of the bicycle surrogates' rotating wheels was not measured or verified prior to, or during, the conduct of the tests described in this report.

For the motorcycle surrogates, inclusion of the micro Doppler characteristics associated with rotating wheels during LVM and LVD testing is specified in 19206-5:2025. For the 4a motorcycle, this was achieved (simulated) via operation of two motors, one positioned towards the front of the motorcycle, the other towards the rear, operating with rotational speeds representative of the motorcycle's initial nominal forward velocity.[5] For the ABD motorcycle, wheel placement and height were set per manufacturer specifications such that the tires were

[5] Due to functional limitations associated with using the 4a motorcycle installed on the ABD robotic platform, the simulated wheel speeds remained constant during conduct of the LVD tests, even when the combination was being decelerated to a stop.

lightly contacting the test surface during test conduct. The radar characteristics of the motorcycle surrogates' rotating wheels was not measured or verified prior to, or during, the conduct of the tests described in this report.

Test Equipment and Instrumentation

The equipment and instrumentation used to perform the tests is summarized in Appendix Tables A-3 and A-4. The robotic steering controller described in these tables is shown in Figure 4.

Figure 4. Robotic steering controller installed in an SV

For each test, the SV test driver manually controlled all accelerator pedal inputs. For tests where an FCW alert was observed, the SV driver was also responsible for releasing the accelerator pedal in response to the alert.

Ambient Conditions

The ambient conditions observed during all trials described in this report were within the following parameters.

- The ambient temperature was between 0°C (32°F) and 40°C (104°F).
- The maximum wind speed was generally no greater than 10 m/s (22 mph).[6]
- The environment was free of inclement weather comprised of, but not limited to, rain, snow, hail, fog, smoke, ash, or other particulates.
- During daylight hours with ambient lighting >2000 lux.
- The tests were not conducted with the SV and POV oriented into the sun during very low sun angle conditions (where the sun is oriented 15° or less from horizontal).
- In an area void of overhead signs, bridges, or other significant structures over or near the testing site.
- No vehicles, obstructions, or stationary objects were within one lane width of either side of the SV path.

[6] A limited number of LVS trials were performed with wind gusts that exceeded 10 m/s. However, the SV yaw rate measured during these trials was always withing the acceptable range defined in Appendix Table A-1.

Bicycle and Motorcycle Surrogate Radar Cross Section Measurements

Overview

Before the bicycle and motorcycle surrogates described in this report were used for testing, radar measurements were performed to ensure that each new, not previously struck, test surrogate provided radar cross sections (RCS) in agreement with those described in ISO 19206-4:2020 (for bicycle surrogates) or ISO 19206-5:2025 (for motorcycle surrogates). The RCS boundaries defined in these ISO standards are intended to be representative of the real objects they (the test surrogates) are designed to emulate.

A description of the test equipment, including the two radar sensors used for each measurement, and processes used by NHTSA to measure RCS has been previously documented (49 CFR Parts 571, 595, and 596, 2024) and is applicable to the radar measurements described in this report. Each test surrogate and its respective wheels remained stationary during the measurement process; measurements to assess the test surrogate micro-Doppler properties produced by rotating wheels (or emulations thereof) were not performed.

- Radar measurements were taken with two independent radar sensors operating concurrently (i.e., both sensors were performing measurements at the same time).
- Each test surrogate was in new condition (never struck) at the time when the radar measurements were performed.
- All bicycle surrogate measurements were taken using a fixed viewing angle (180°), variable range approach towards the rear of the surrogate.
- Motorcycle surrogate measurements were taken using fixed viewing angle (180°), variable range approach towards the rear of the surrogate. Additionally, fixed range (30 m), variable viewing angle (360° around the surrogate) measurements were taken at a distance of 30 m from the surrogate's lateral and longitudinal center position.
- Except for those to assess RCS measurement consistency, each set of radar measurements performed for a given test surrogate occurred on different days.
- To assess RCS consistency, three radar measurement sets were performed with one example of each bicycle and motorcycle surrogate used in this study. For each test surrogate, this involved performing the first scan, removing the test surrogate from its robotic platform, disassembling the test surrogate, reassembling the test surrogate, reinstalling the test surrogate onto the robotic platform, then repeating the measurement process. Each of the three repeated measurement sets performed for a given test surrogate occurred on the same day to maximize the consistency of the ambient test conditions.

Bicycle Surrogate Radar Cross Section

Comments Regarding Test Methodology

ISO 19206-4:2020 defines test conditions, test methods, and RCS boundaries applicable to the assessment of RCS characteristics relevant to bicycle surrogates. In this ISO document, the following test parameters are specified.

- Measurements shall be taken during a series of fixed viewing angle, variable range approaches, where the approach aspect remains constant while the measurement distance of the radar sensors to the test device is slowly reduced from 40 m to 4 m.
- The vertical distance of the radar sensors to the ground shall be 500 ± 150 mm.

For the radar measurements performed in this study, the above ISO 19206-4:2020 measurement parameters were adjusted to be in agreement with those specified in the more recently published ISO 19206-3:2021 and 19206-5:2025 documents, which define test conditions, test methods, and RCS boundaries applicable to the assessment of RCS characteristics relevant to vehicle and motorcycle test devices. For this study, the following parameters from ISO 19206-3:2021 and 19206-5:2025 were used during the bicycle RCS measurements.

- The measurement range of 5 to 100 m
- Three vertical sensor heights (230, 480, and 900 mm) were used during RCS *measurement*.[7]

Although ISO 19206-4:2020 provides boundaries for which to compare bicycle surrogate RCS values against, they are only applicable to fixed viewing angle, variable range measurements performed with specific viewing angles, and the number of measurements required to be within bounds is not specified. Therefore, to provide an objective criterion for assessment of whether a bicycle RCS is acceptable (suitable for testing) or not acceptable (unsuitable for testing) for this research, the ISO 19206-3:2021 and ISO 19206-5:2025 recommendation that at least 92 percent of the fixed viewing angle, variable range measurements should be within the applicable boundaries was used.

ISO 19206-4:2020 does not specify use of fixed-range, variable viewing angle measurements for the assessment of bicycle surrogate RCS.

Bicycle Surrogate RCS Versus ISO 19206-4:2020 Boundaries – General Observations

For most of the 5 to 100 m measurement range, the RCS values of the 4a bicycle and ABD bicycle surrogates were found to reside within the boundaries shown in ISO 19206-4:2020.

Figure 5 presents the RCS values of the three 4a bicycles used for the tests described in this report versus the RCS boundaries defined in ISO 19206-4:2020 for a 180° (rear) viewing angle. For the 4a bicycle, each instance of the RCS exceeding an ISO 19206-4:2020 boundary occurred with respect to the upper boundary.

[7] ISO 19206-3:2021 specifies that measurements shall be taken at multiple sensor heights to reduce the effect of multi-path interference which is more prone to occur from measurements taken at a single sensor height.

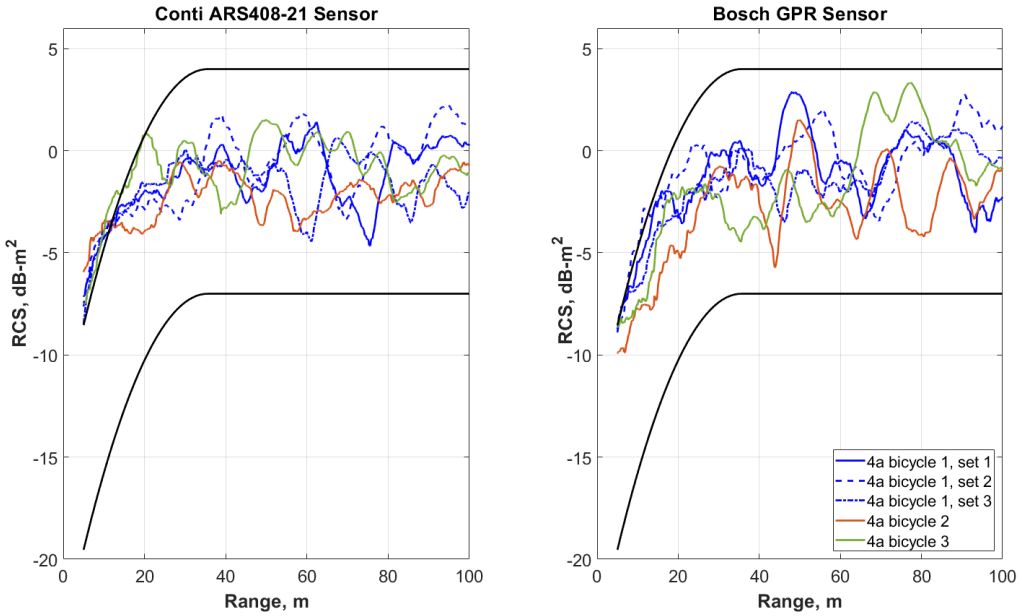

Figure 5. 4a bicycle RCS measurements vs. ISO 19206-4:2020 boundaries (180° viewing angle)

For measurements performed with the Bosch sensor, this slight deviation generally occurred within a range from 5.3 to 6.9 m. The most apparent differences were observed during the third repeated measurement set performed with 4a_bicycle_1, where RCS deviated from the upper boundary within a range of 7.5 and 12.7 m.

For measurements with the Continental sensor, the RCS exceeded the upper boundary within a range beginning at 5.0 m and generally extending to approximately 11.2 to 12.1 m, depending on which 4a bicycle unit or which repeated measurement is considered. The exception to this trend was observed for the RCS measurements associated with 4a_bicycle_3 which exceeded the upper boundary with range of 5.0 to 14.4 m, then dithered above and below the threshold until when the range was 14.4 to 20 m.

Figure 6 presents the RCS values of the two ABD bicycles used for the tests described in this report versus the RCS boundaries defined in ISO 19206-4:2020 for a 180° (rear) viewing angle. For the ABD bicycle, instances of the RCS exceeding an ISO 19206-4:2020 boundary were more isolated and occurred with respect to both the upper and lower boundaries.

For measurements performed with the Bosch sensor, RCS fell below the lower boundary during the first trial of the repeated measurement set performed with ABD_bicycle_2, where it dithered above and below the lower threshold within a range from 44.5 to 50.2 m.

For measurements performed with the Continental sensor, RCS dithered above and below the lower threshold within a range from 72.5 to 75.7 m during the second repeated measurement set performed with ABD_bicycle_2. During the third repeated measurement set performed with ABD_bicycle_2, RCS exceeded the upper boundary within a range from 5.0 to 8.8 m.

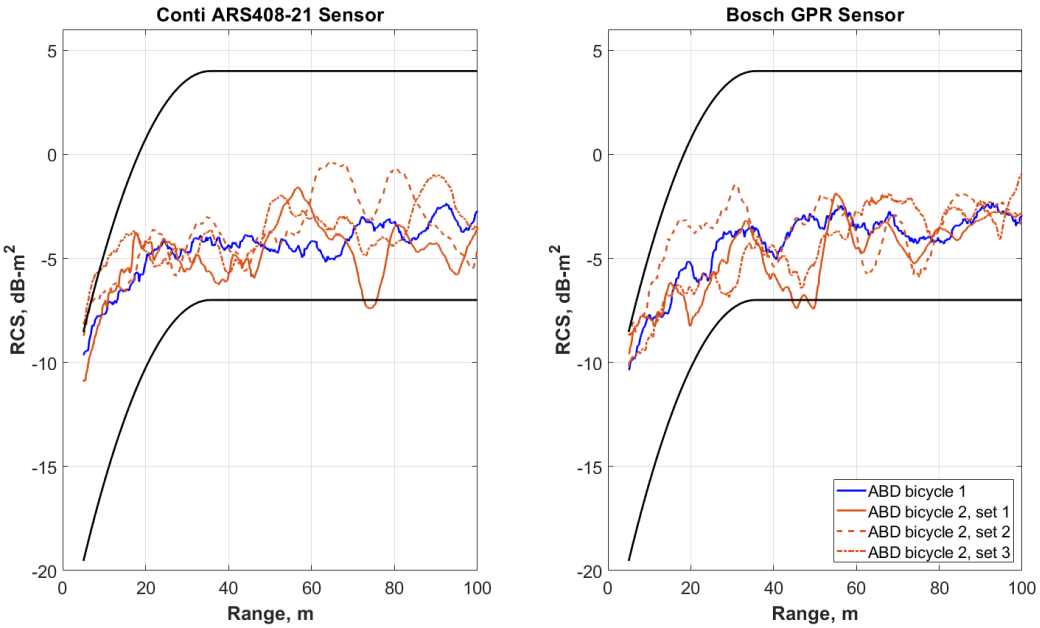

Figure 6. ABD bicycle RCS measurements vs. ISO 19206-4:2020 boundaries (180° viewing angle)

Bicycle Surrogate RCS Versus ISO 19206-4:2020 Boundaries – Percentage Within Bounds

Table 3 shows the overall percentage of RCS values located within the boundaries shown in ISO 19206-4:2020 for a 180° (rear) approach, for each new bicycle surrogate. With four exceptions, two for each bicycle surrogate, the overall percentage of RCS values located within these boundaries was greater than or equal to 92 percent.

Table 3. Bicycle Surrogate RCS "Within Bounds" Summary

Test Surrogate			**Percent Within Fixed Angle, Variable Range Bounds[1]**	
Make and Model	**Unit #**	**Rebuild Set#**	**Bosch Radar**	**Continental Radar**
4a Bicycle	4a_bicycle_1	1	97.9	92.6
	4a_bicycle_1	2	93.7	92.1
	4a_bicycle_1	3	97.5	91.8
	4a_bicycle_2	n/a	100	92.3
	4a_bicycle_3	n/a	99.6	87.3
ABD Bicycle	ABD_bicycle_1	n/a	100	100
	ABD_bicycle_2	1	91.9	100
	ABD_bicycle_2	2	99.3	95.4
	ABD_bicycle_2	3	100	90.5

[1]≥92 percent must be within allowable bounds

For each 4a bicycle, and only considering the first of the three repeated measurement sets for 4a_bicycle_1, the ranges of overall percentages from measurements performed with the Bosch and Continental radar sensors were 97.9 to 100 percent and 87.3 to 92.6 percent.

For the three repeated measurement sets performed with 4a_bicycle_1 the ranges of overall percentages produced with the Bosch and Continental radar sensors were 93.7 to 97.9 percent and 91.8 to 92.6 percent.

For each ABD bicycle, and only considering the first of the three repeated measurement sets for ABD_bicycle_2, the ranges of overall percentages from measurements performed with the Bosch and Continental radar sensors were 91.9 to 100 percent and only 100 percent.

For the three repeated measurement sets performed with ABD_bicycle_2 the ranges of overall percentages produced with the Bosch and Continental radar sensors were 91.9 to 100 percent and 90.5 to 100 percent.

Motorcycle Surrogate Radar Cross Section

Comments Regarding Test Methodology

ISO 19206-5:2025 recommends that at least 95 percent of the fixed-range, variable viewing angle measurements should be within the applicable boundaries defined therein. Similarly, ISO 19206-5:2025 also recommends that at least 92 percent of the fixed viewing angle, variable range measurements should be within the applicable boundaries.

Motorcycle Surrogate RCS Versus ISO 19206-5:2025 Boundaries – General Observations

Figures 7, 8, 9, and 10 present the RCS values of the three 4a motorcycles and three ABD motorcycles used for the tests described in this report versus the RCS boundaries defined in ISO 19206-5:2025. Figures 7 and 8 report measurements produced during the fixed viewing angle, variable range tests performed with a 180° (rear) viewing angle, whereas Figures 9 and 10 present measurements from the fixed range, variable viewing angle tests performed with a range of 30 m.

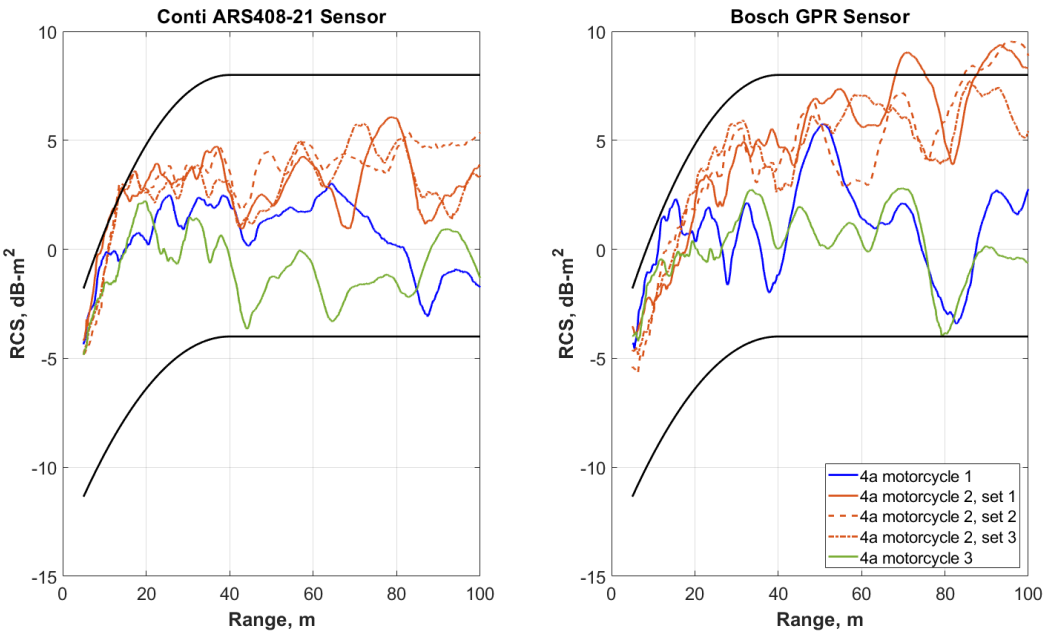

Figure 7. 4a motorcycle RCS measurements vs. ISO 19206-5:2025 boundaries (fixed 180° viewing angle, variable range)

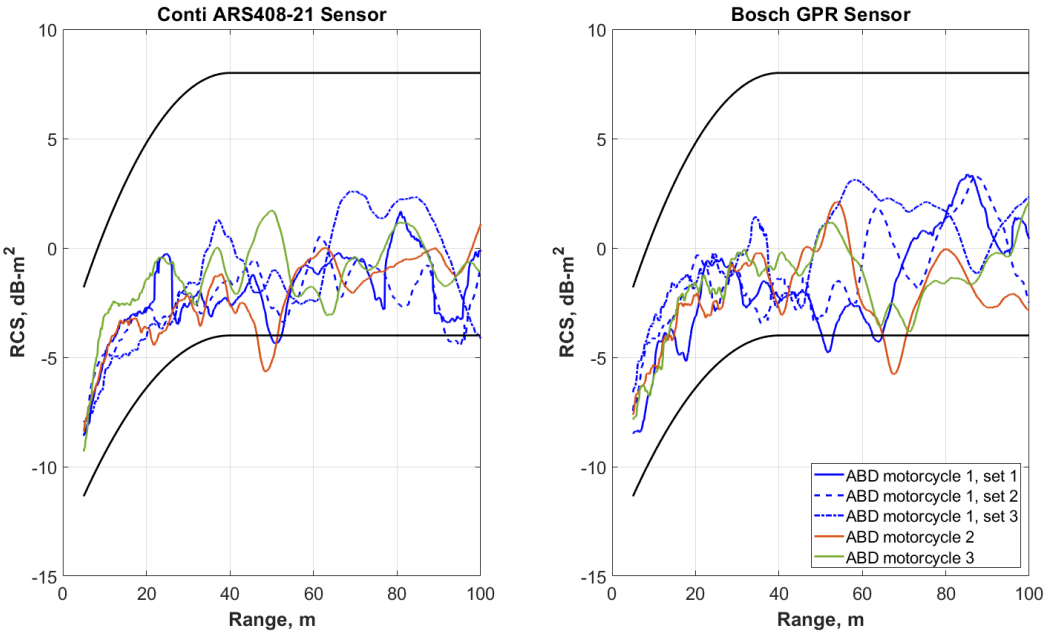

Figure 8. ABD motorcycle RCS measurements vs. ISO 19206-5:2025 boundaries (fixed 180° viewing angle, variable range)

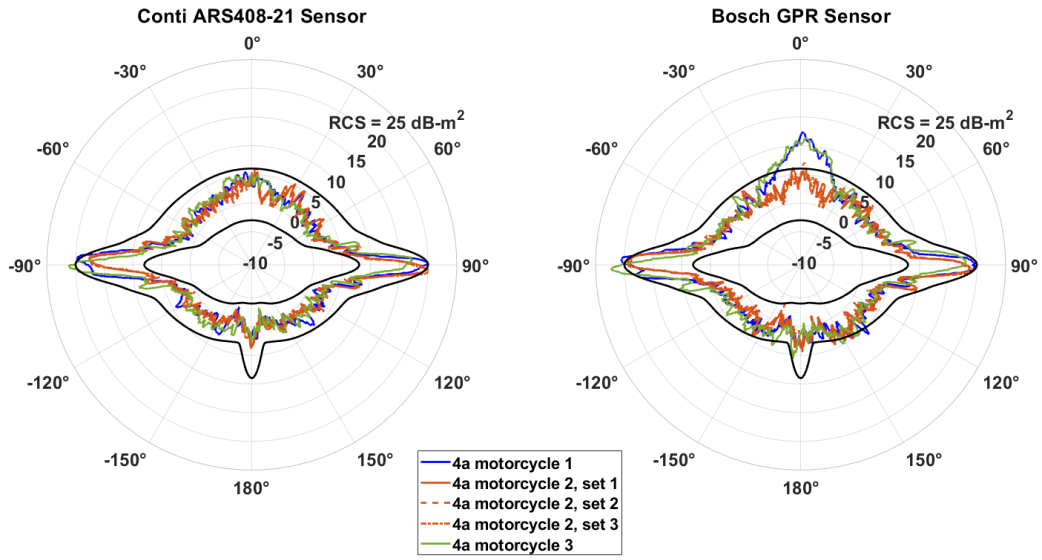

Figure 9. 4a motorcycle RCS measurements vs. ISO 19206-5:2025 boundaries (fixed 30m range, variable viewing angle)

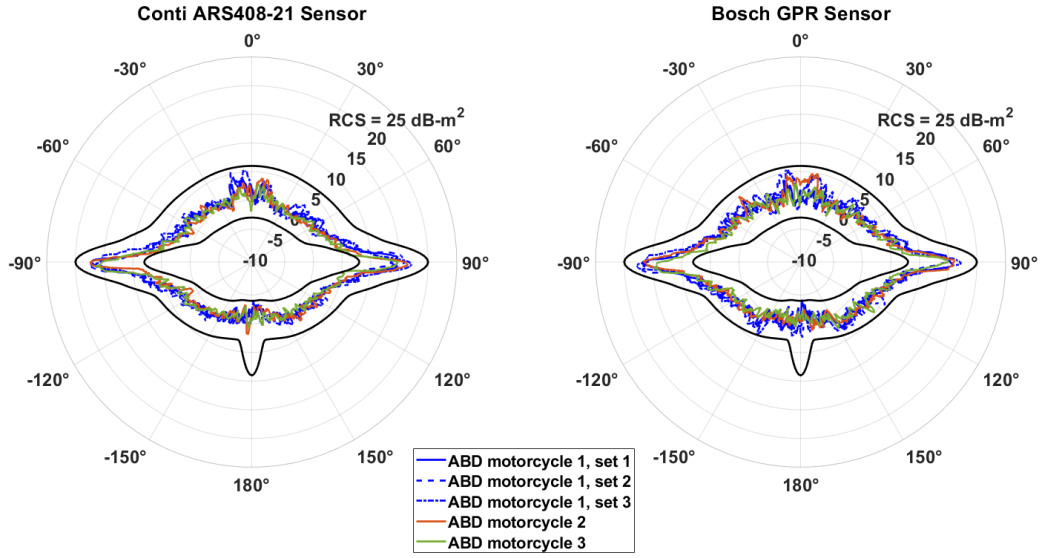

Figure 10. ABD motorcycle RCS measurements vs. ISO 19206-5:2025 boundaries (fixed 30m range, variable viewing angle)

Fixed Viewing Angle, Variable Range Tests

For most of the 5 to 100 m test range, the RCS values of the 4a and ABD motorcycle surrogates were found to reside within the 180° fixed angle, variable range boundaries shown in ISO 19206-5:2025.

4a Motorcycle Results

With the 4a motorcycle, the RCS was above the ISO 19206-5:2025 upper boundary for one of the three units measured.

For measurements performed with the Bosch sensor, the boundary was exceeded at higher ranges during the first and second test sets of the three performed with 4a_motorcycle_2. During the first test set, the lowest range this occurred was at 68.2 m; at higher ranges the RCS dithered above and below the threshold to the farthest measurement distance of 100 m. During the second test set, measured RSC exceeded the upper boundary when the range was 84.6 to 100 m. The RSC values measured for the third test set were 100 percent within the ISO 19206-5:2025 boundaries.

For measurements with the Continental sensor, the RCS exceeded the boundary during each of the three test sets performed with 4a_motorcycle_2. However, the ranges where this was observed were much different than observed during measurements performed with the Bosch sensor (significantly lower) and the extent to which RCS magnitude exceeded the upper boundary was much less. For the first test set performed with 4a_motorcycle_2, the measured RCS dithered above and below the threshold when the range was between 10.8 to 14.6 m. For the second test set performed with 4a_motorcycle_2, the measured RCS exceeded the boundary when the range was between 12.8 to 14.8 m. Similarly, for the third test set performed with 4a_motorcycle_2, the measured RCS exceeded the boundary when the range was between 12.8 to 14.2 m.

ABD Motorcycle Results

With the ABD motorcycle, the RCS exceeded an ISO 19206-5:2025 boundary for two of the three units measured and only with respect to the lower boundary.

For measurements performed with the Bosch sensor, the lower boundary was breached during measurements performed with ABD_motorcycle_1 and ABD_motorcycle_2. For ABD_motorcycle_1, the boundary was only exceeded during the first test set, where the measured RCS dithered above and below the threshold when the range was between 50.3 to 64.8 m. For ABD_motorcycle_2, the measured RCS fell below the lower threshold when the range was between 64.9 to 70.6 m.

For measurements performed with the Continental sensor, the lower boundary was also breached during measurements performed with ABD_motorcycle_1 and ABD_motorcycle_2. For ABD_motorcycle_1, the boundary was exceeded once during the first test set, where the measured RCS was below the threshold for a range between 49.7 to 52.3 m (nearly equivalent the 50.3 to 53.0 m range observed for one of the two breaches detected with the Bosch sensor). For the second ABD_motorcycle_1 test set, the boundary was also exceeded once, but for a range between 91.8 to 96.4 m. For ABD_motorcycle_2, the measured RCS fell below the lower threshold when the range was between 46.5 to 51.4 m, a closer range than a similar breach observed with the Bosch sensor for this ABD unit.

Fixed Range, Variable Viewing Angle Tests

Although most of the 4a and ABD motorcycle surrogate RCS values were found to reside within the fixed range, variable viewing angle boundaries shown in ISO 19206-5:2025, the extent to which this was observed depended on which combination of motorcycle surrogate and radar sensor is considered.

4a Motorcycle Results

With the 4a motorcycle, the RCS exceeded the SO 19206-5:2025 upper boundary for a limited range of viewing angles for each of the three units measured with the Bosch and Continental sensors.

For measurements performed with the Bosch sensor,

- The most noticeable upper boundary exceedance occurred with 4a_motorcycle_1 and 4a_motorcycle_3 for viewing angles of approximately 340 to 19°, with peak deviations of 6.4 dB-m^2 at 0.9° (4a_motorcycle_1) and 5.2 dB-m^2 at 0.9° (4a_motorcycle_3) beyond the upper boundary. The upper boundary was also exceeded during 4a_motorcycle_2 test sets 1 and 3 performed with the Bosch sensor within this viewing angle range, but to a much lesser extent.
- For 4a_motorcycle_1, the upper boundary was also exceeded with viewing angles from approximately 134 to 136°, 144 to 146°; 266°; and 270 to 273°, where deviation magnitudes of up to 1.3 dB-m^2 were observed.
- Collapsing across the three test sets for 4a_motorcycle_2, the upper boundary was also exceeded with viewing angles from approximately 93°; 143 to 146°; 148 to 150°; and 155 to 158°, where deviation magnitudes of up to 0.9 dB-m^2 were observed.
- For 4a_motorcycle_3, the upper boundary was also exceeded with viewing angles from approximately 139 to 143°; 150 to 153°; 198 to 200°; 259°; and 267 to 270°, where deviation magnitudes of up to 2.5 dB-m^2 were observed.

For measurements performed with the Continental sensor,

- For 4a_motorcycle_1, the upper boundary was exceeded with viewing angles between from approximately 90° and 271 to 274°, where deviation magnitudes of up to approximately 0.4 dB-m^2 were observed.
- Collapsing across the three test sets for 4a_motorcycle_2, the upper boundary was also exceeded with viewing angles between from approximately 2 to 3° and 91 to 93°, where deviation magnitudes of up to approximately 0.7 dB-m^2 were observed.
- For 4a_motorcycle_3, the upper boundary was also exceeded with viewing angles between from approximately 268 to 270° and°, where deviation magnitudes of up to approximately 1.2 dB-m^2 were observed.

ABD Motorcycle Results

With the ABD motorcycle, the RCS fell slightly below the lower ISO 19206-5:2025 boundary for a very limited range of viewing angles for one of the three units when measured with the Bosch sensor and for one of the three units when measured with the Continental sensor.

For the first set of ABD_motorcycle_1 measurements performed with the Bosch sensor, the RCS was slightly below the lower boundary associated with a viewing angle of approximately 178°.

For ABD_motorcycle_3 measurements performed with the Continental sensor, the RCS was slightly below the lower boundaries associated with viewing angles of approximately 86 and 96°.

Motorcycle Surrogate RCS Versus ISO 19206-5:2025 Boundaries – Percentage Within Bounds

For each new motorcycle surrogate, Table 4 presents the overall percentage of RCS values located within the 180° fixed viewing angle, variable range and fixed range and variable viewing angle test boundaries shown in ISO 19206-5:2025.

Table 4. Motorcycle Surrogate RCS "Within Bounds" Summary

Test Surrogate			Percent Within Fixed Angle, Variable Range Bounds[1]		Percent Within Fixed Range, Variable Angle Bounds[2]	
Make and Model	**Unit #**	**Rebuild Set #**	**Bosch Radar**	**Continental Radar**	**Bosch Radar**	**Continental Radar**
4a Motorcycle	4a_motorcycle_1	1	100	100	88.8	99.3
	4a_motorcycle_1	2	79.5	96.7	98.9	99.8
	4a_motorcycle_1	3	83.8	97.9	97.9	99.8
	4a_motorcycle_2	n/a	100	99.1	98.9	99.2
	4a_motorcycle_3	n/a	99.9	100	87.7	99.2
ABD Motorcycle	ABD_motorcycle_1	n/a	94.6	97.4	99.8	100
	ABD_motorcycle_2	1	100	95.2	100	100
	ABD_motorcycle_2	2	100	99.6	100	100
	ABD_motorcycle_2	3	94.1	94.7	100	100
	ABD_motorcycle_3	n/a	100	100	100	99.4

[1] ≥92 percent must be within allowable bounds
[2] ≥95 percent must be within allowable bounds

Fixed Viewing Angle, Variable Range Tests

The third and fourth columns of Table 4 presents the overall percentage of RCS values located within the fixed viewing angle, variable range test boundaries shown in ISO 19206-5:2025 for a 180° approach for each motorcycle surrogate. With two exceptions observed for the 4a motorcycle, the overall percentage of RCS values located within these boundaries was greater than or equal to 92 percent.

For each 4a motorcycle, and only considering the first of the three repeated measurement sets for 4a_motorcycle_1, the ranges of overall percentages from measurements performed with the Bosch and Continental radar sensors were 99.9 to 100 percent and 99.1 to 100 percent.

For the three repeated measurement sets performed with 4a_motorcycle_1 the ranges of overall percentages produced with the Bosch and Continental radar sensors were 79.5 to 100 percent and 96.7 to 100 percent.

For each ABD motorcycle, and only considering the first of the three repeated measurement sets for ABD_motorcycle_2, the ranges of overall percentages from measurements performed with the Bosch and Continental radar sensors were 94.6 to 100 percent and 95.2 to 100 percent.

For the three repeated measurement sets performed with ABD motorcycle unit ABD_motorcycle_2 the ranges of overall percentages produced with the Bosch and Continental radar sensors were 94.1 to 100 percent and 94.7 to 99.6 percent.

Fixed Range, Variable Viewing Angle Tests

Columns six and seven of Table 4 present the overall percentage of RCS values located within the fixed range, variable viewing angle test boundaries shown in ISO 19206-5:2025, for each motorcycle surrogate. With two exceptions observed for the 4a motorcycle, the overall percentage of RCS values located within these boundaries was greater than or equal to 95 percent.

For each 4a motorcycle, and only considering the first of the three repeated measurement sets for 4a_motorcycle_1, the ranges of overall percentages from measurements performed with the Bosch and Continental radar sensors were 87.7 to 98.9 percent and 99.2 to 99.3 percent.

For the three repeated measurement sets performed with 4a_motorcycle_1, the ranges of overall percentages produced with the Bosch and Continental radar sensors were 88.8 to 98.9 percent and 99.3 to 99.8 percent.

For each ABD motorcycle, and only considering the first of the three repeated measurement sets for ABD_motorcycle_2, the ranges of overall percentages from measurements performed with the Bosch and Continental radar sensors were 99.8 to 100 percent and 99.4 to 100 percent.

For the three repeated measurement sets performed with ABD_motorcycle_2, 100 percent of the overall percentages produced with the Bosch and Continental radar sensors were within the boundaries.

Additional Radar Measurements Performed During Testing

In addition to the radar measurements taken when the bicycle and motorcycle surrogates were new, measurements were also performed after a surrogate was reassembled after:

- Being struck with a high relative speed.
- Having incurred notable visual wear.
- After replacement of one or more components (e.g., wheels, tires, spokes, frames, simulated suspension components, etc.).

If an appropriate percentage of the radar measurements were within the applicable boundaries (previously described in S3.2 and S3.3) for at least one of the two radar sensors, then the test surrogate was retained for further use. If not, then either the affected components were replaced and the radar measurement and verification process was performed again to confirm an appropriate RCS had been realized, or the entire test surrogate was replaced with a new version of the same make and model. Results from radar measurements of bicycle and motorcycle surrogates that had been struck are not presented or discussed in this report.

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AEB Performance Test Results

Summaries of FCW and AEB brake onset timing, and of crash avoidance and relative impact speed, are discussed here. First, results from each SV are presented separately per surrogate type (i.e., bicycle or motorcycle) and results from each test scenario and overlap are included within each high-level reporting. Then, a similar format is used but the primary sections are based on test scenario, then surrogate type, then SV. Due to the limited number of repeated trials performed, the statistical significance of the test results was not evaluated. Rather, a combination of direct reporting, trend analyses, and overall observations is provided.

FCW and AEB Brake Onset Timing

Figures 11 to 18 visually present how FCW and AEB brake onset timing, represented as time-to-collision (TTC), changed as a function of nominal test speed for each test condition. These figures provide an efficient way to compare the relationship of onset timing and how the SV responded to different test surrogates for the same combinations of scenario, speed, and overlap. Figures 11 to 14 show results from tests performed with one bicycle surrogate (Subaru Crosstrek and Toyota Corolla) or two bicycle surrogates (Cadillac Lyriq and Tesla Model 3). Results from tests performed with both motorcycle surrogates (all four SVs) are shown Figures 15 to 18. In each figure,

- The vertical bars are defined by the minimum and maximum values observed for the respective test condition (if multiple trials are performed).
- A diamond marker is generally used to indicate the mean FCW onset TTC of given test condition. If only one trial was performed for that test condition then the diamond marker is used to report the FCW onset TTC of that trial.
- An asterisk marker is generally used to indicate the mean AEB brake onset value of given test condition. If only one trial was performed for that test condition then the asterisk marker is used to report the AEB brake onset TTC of that trial.
- The vertical bar shading color (where applicable) and the color of the markers are used to indicate the surrogate make (red = ABD, blue = 4a).

For reporting purposes, the FCW onset timing was based the output of a microphone used to measurement the auditory alert, while AEB braking onset was taken to be the instant when the AEB system achieved a deceleration of ≥ 0.25g. Also, in these figures, no distinction is made between test trials that conclude with contact versus no contact. However, it was observed that trials where contact and no contact occur within the same test condition often resulted in a wider range of reported TTC values.

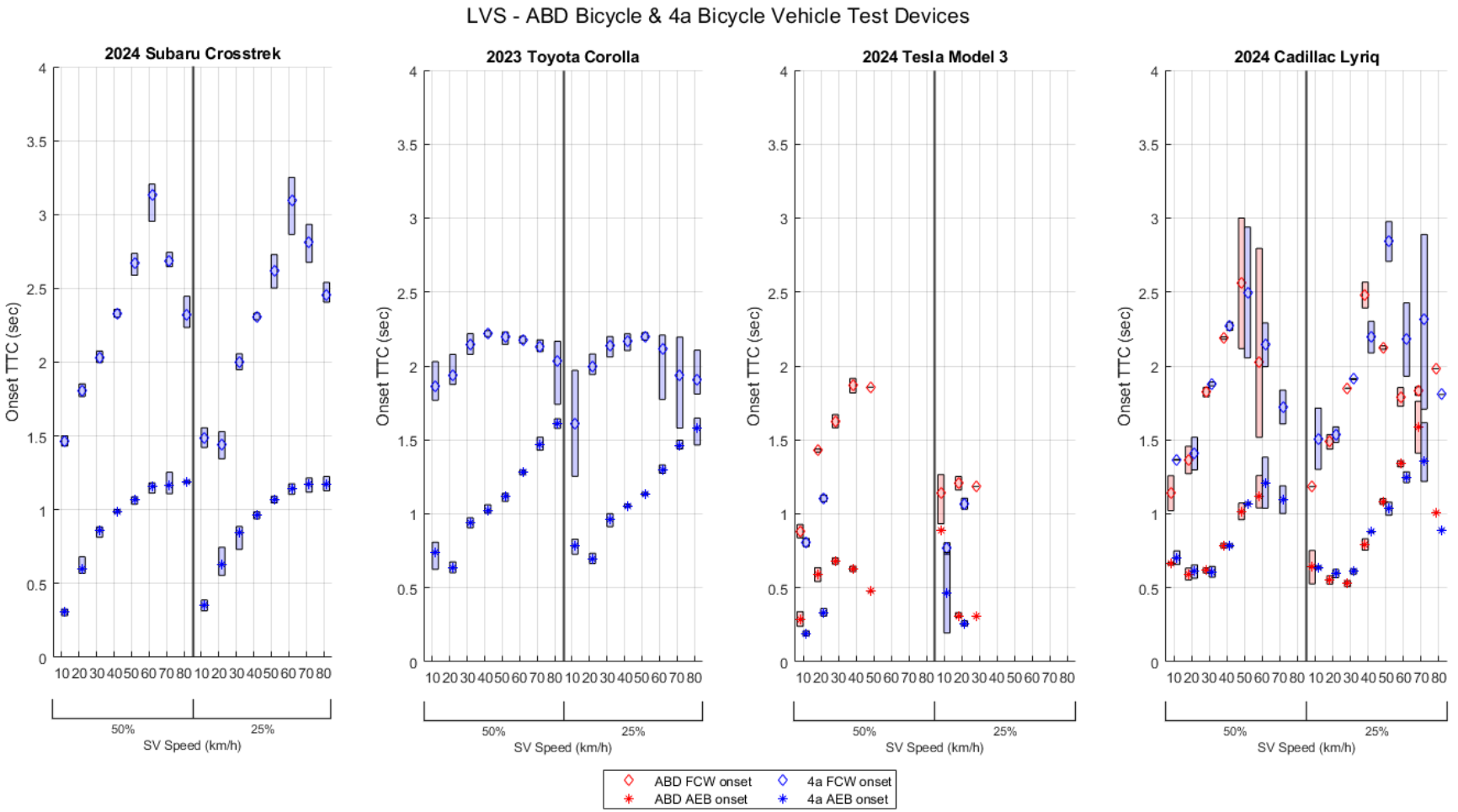

Figure 11. LVS FCW and AEB braking onset TTCs (bicycle surrogates)

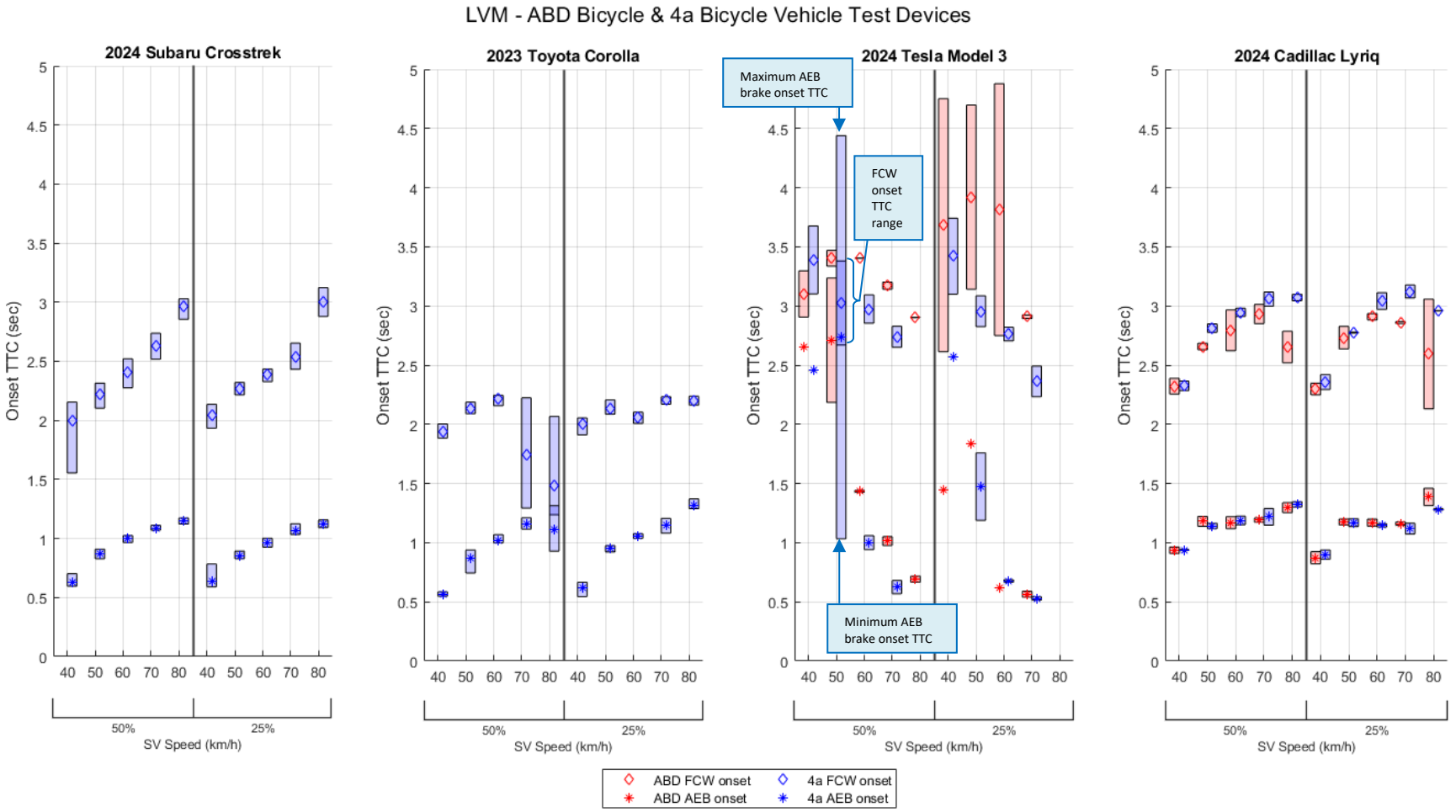

Figure 12. LVM FCW and AEB braking onset TTCs (bicycle surrogates)

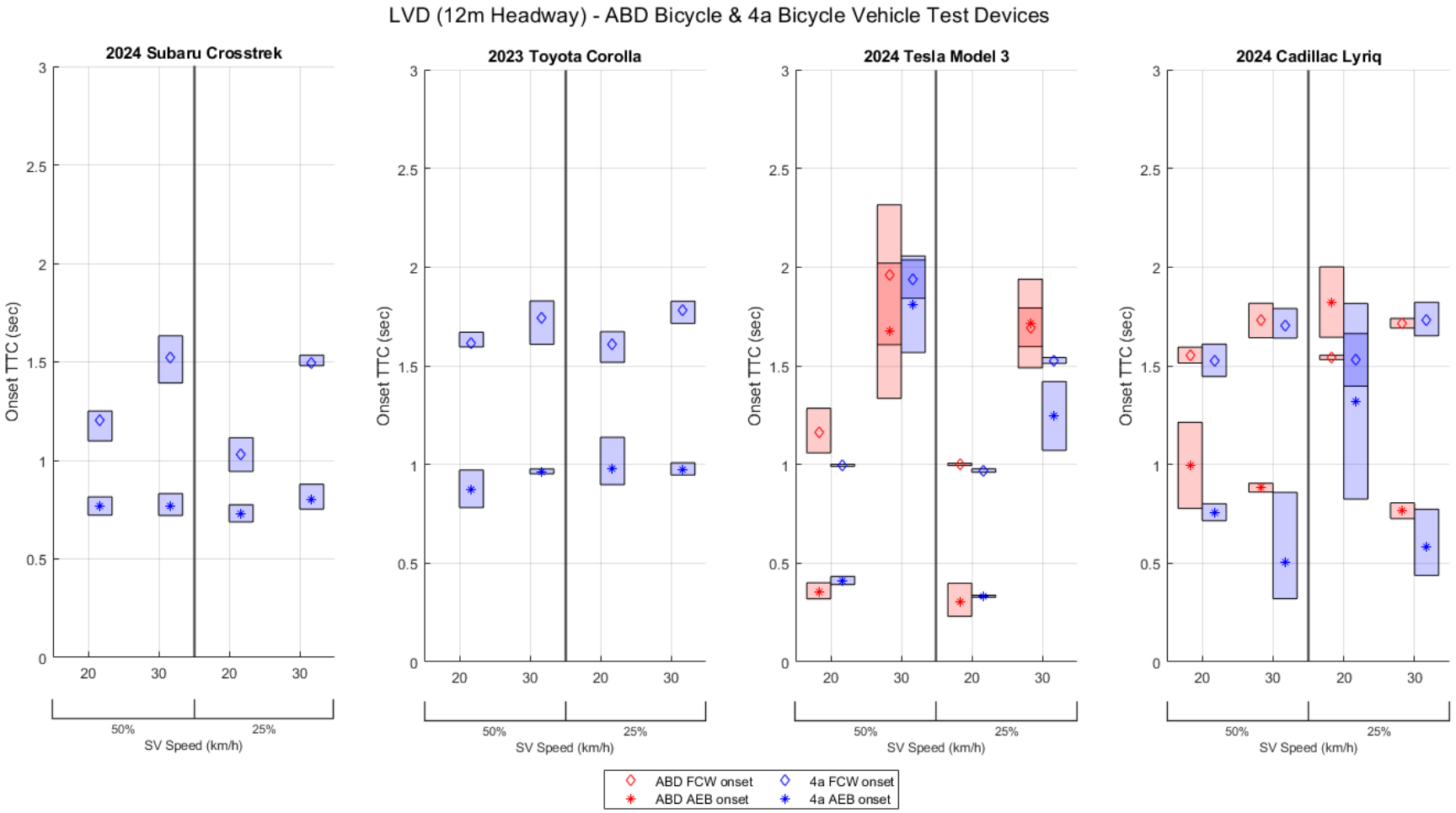

Figure 13. LVD FCW and AEB braking onset TTCs (12 m headway; bicycle surrogates)

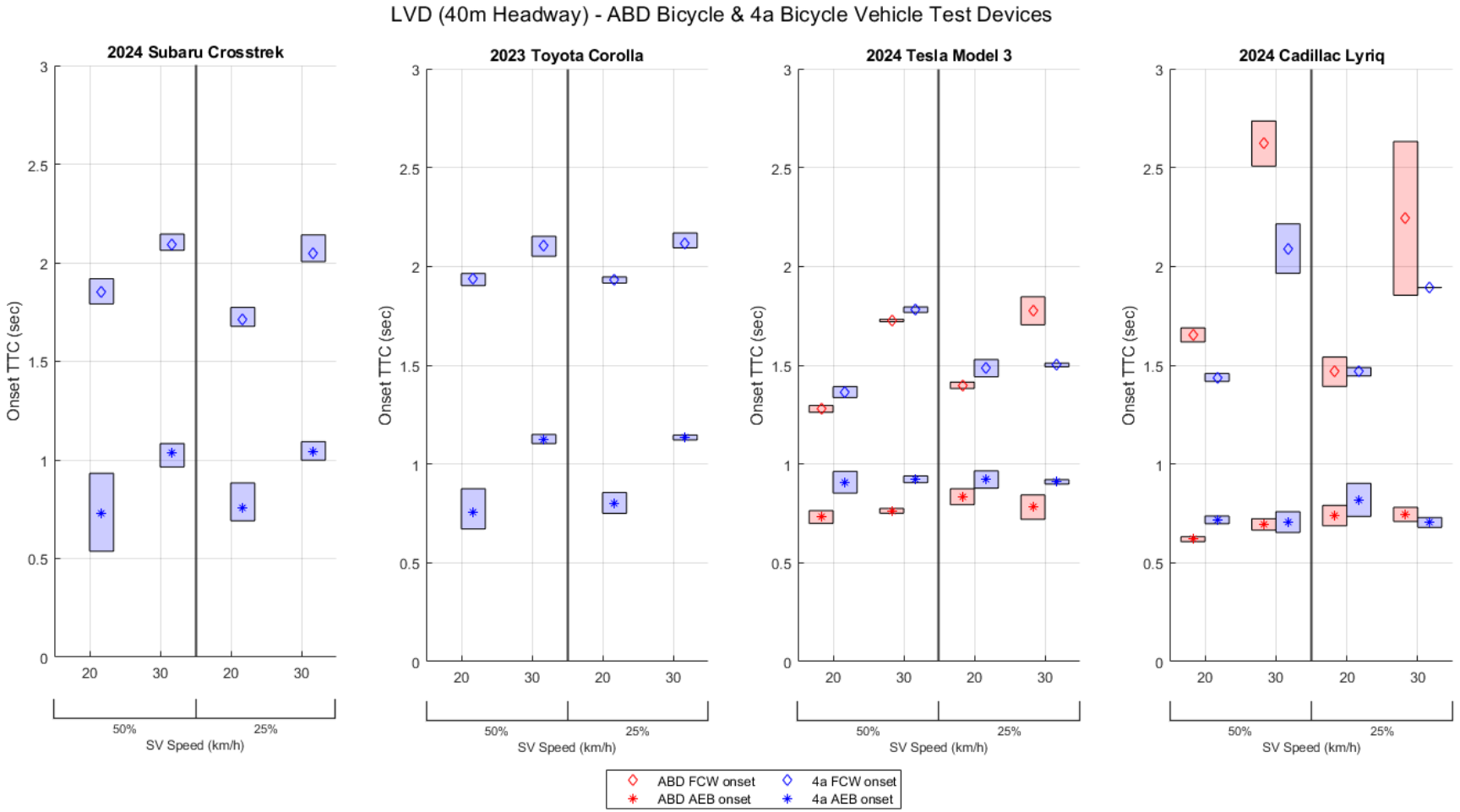

Figure 14. LVD FCW and AEB braking onset TTCs (40 m headway; bicycle surrogates)

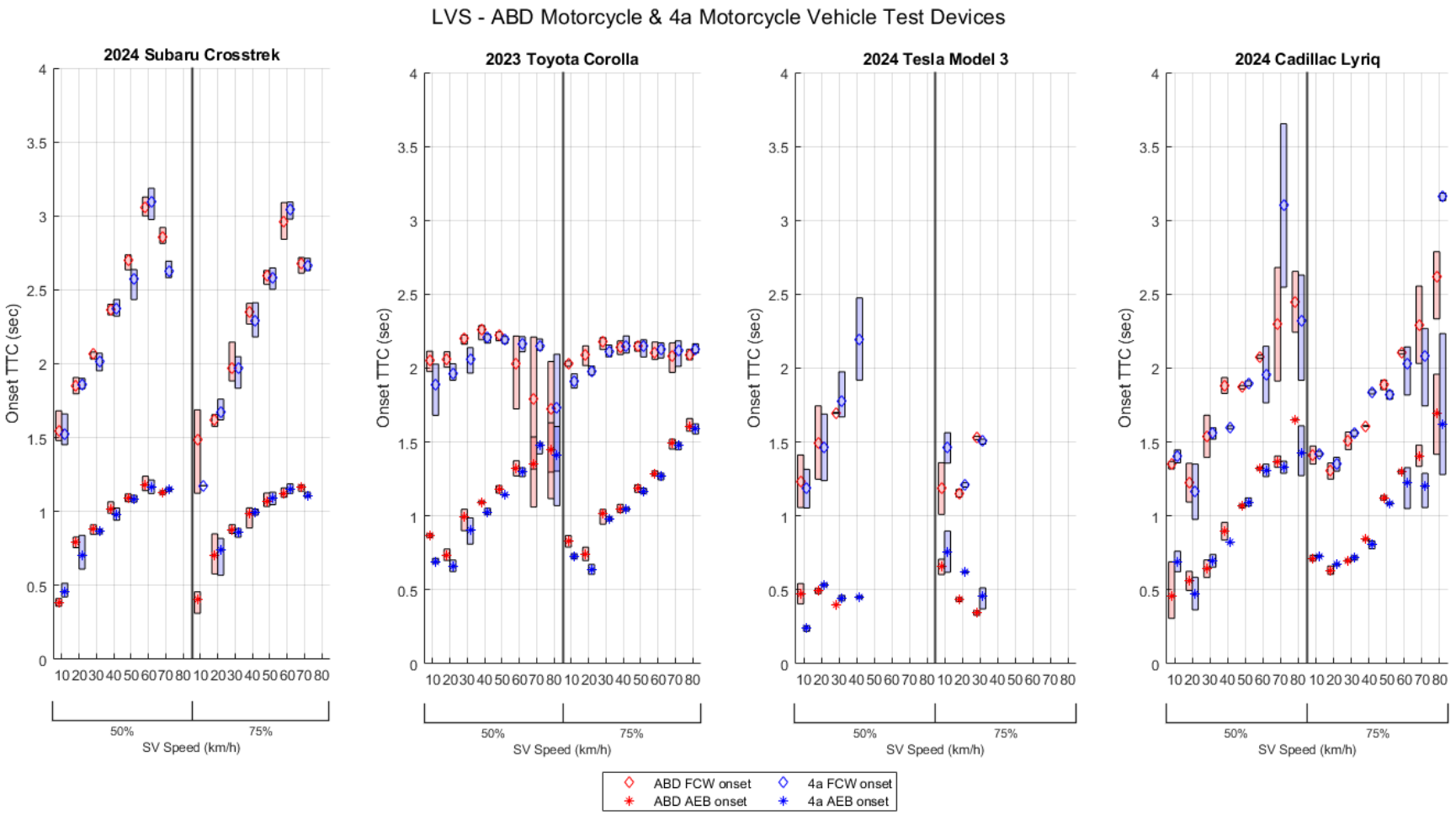

Figure 15. LVS FCW and AEB braking onset TTCs (motorcycle surrogates)

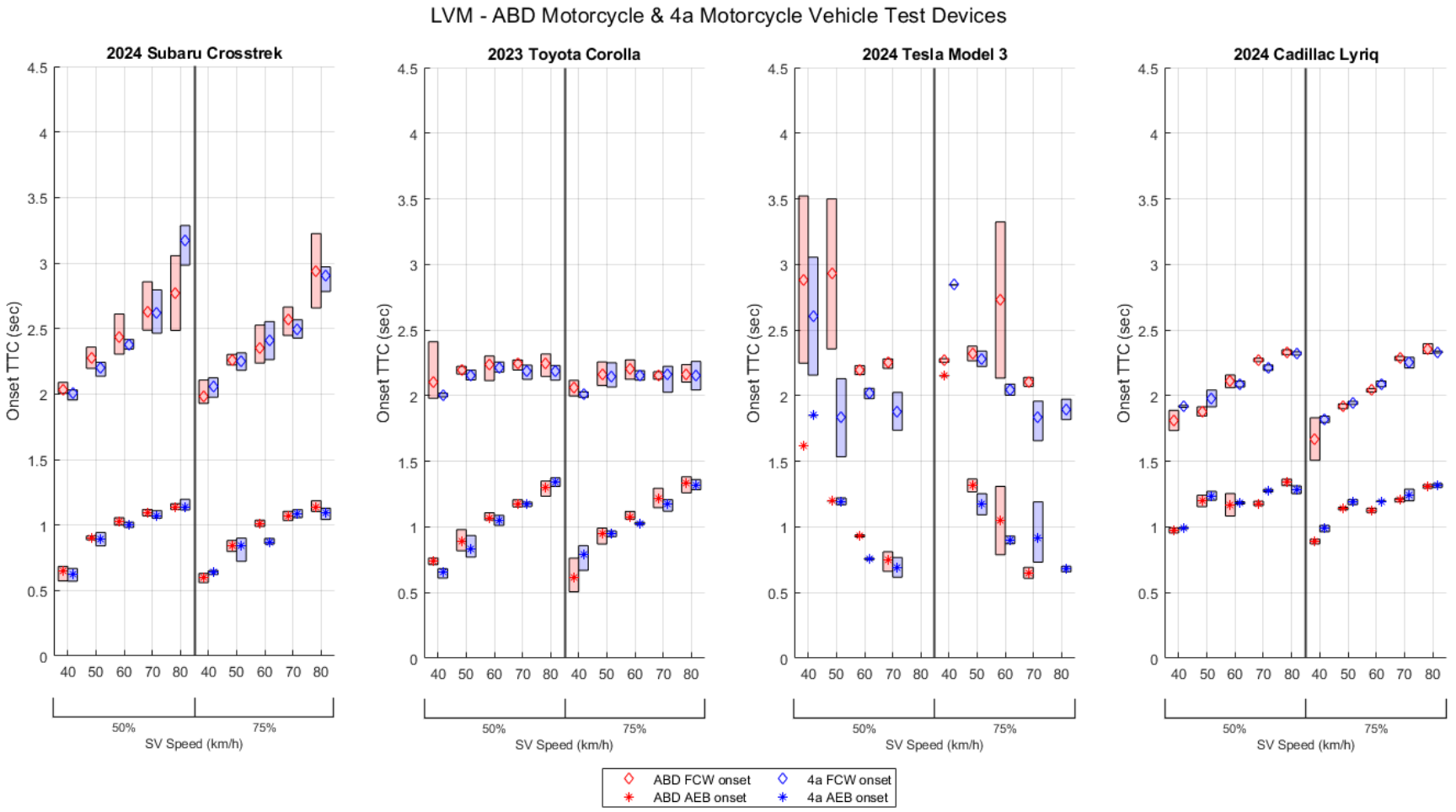

Figure 16. LVM FCW and AEB braking onset TTCs (motorcycle surrogates)

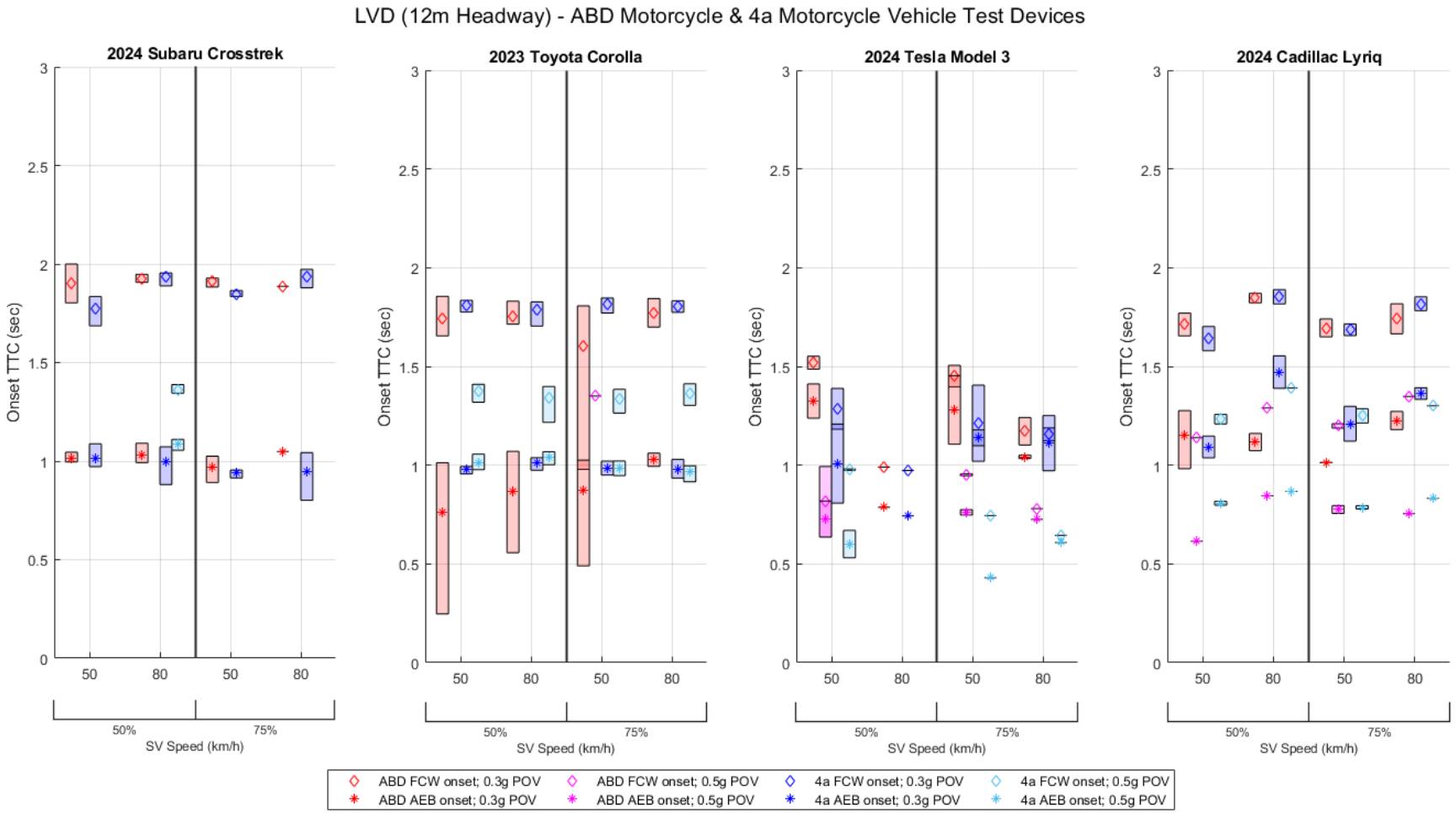

Figure 17. LVD FCW and AEB braking onset TTCs (12 m headway; motorcycle surrogates)

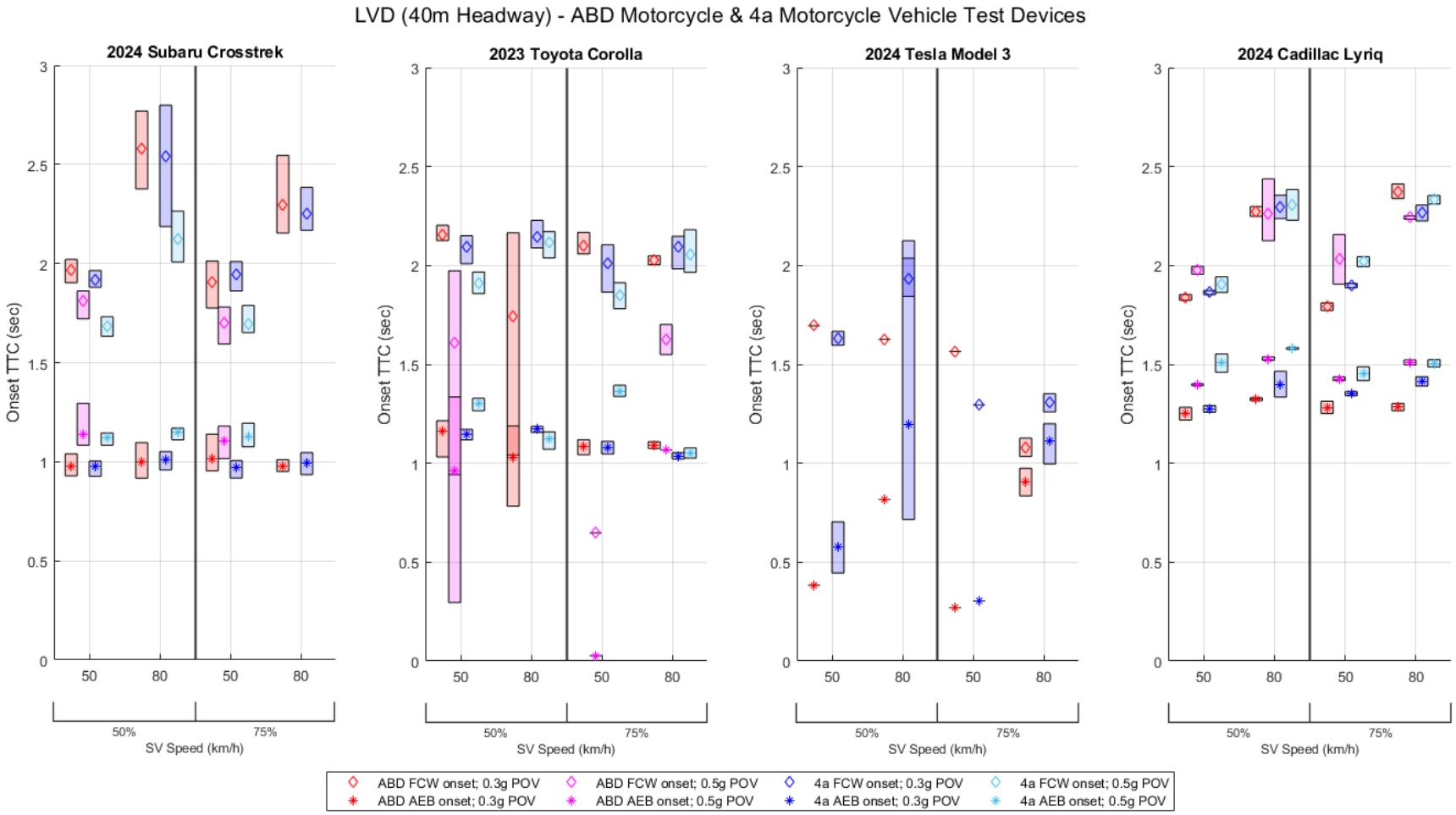

Figure 18. LVD FCW and AEB braking onset TTCs (40 m headway; motorcycle surrogates)

Bicycle POV

The following high-level trends in FCW and AEB brake onset TTC were subjectively observed during trials performed with a bicycle POV. Due to availability constraints, the 4a bicycle was the only bicycle surrogate used for Subaru Crosstrek and Toyota Corolla bicycle POV testing. Conversely, the 4a and ABD bicycle surrogates were both used during Cadillac Lyriq and Tesla Model 3 tests.

Subaru Crosstrek

FCW Onset TTC

For LVS tests performed with SV speeds from 10 to 60 km/h, FCW alert TTCs generally increased as a function of test speed, after which they generally decreased with subsequent incremental increases. A similar trend was observed for LVM trials performed with SV speeds from 40 to 80 km/h (i.e., trials performed with relative speeds from 20 to 60 km/h), and for the LVD trials performed with 20 and 30 km/h tests speeds (with 12 and 40 m initial headways). These trends were observed for tests performed with the 50 and 25 percent surrogate overlaps.

AEB Brake Onset TTC

The AEB brake onset TTCs generally increased as a function of speed over the entire LVS test speed range. However, the incremental change was less pronounced as test speed increased from 60 to 80 km/h. A similar trend was observed for LVM trials performed with SV speeds from 40 to 80 km/h, for the LVD trials performed with 20 and 30 km/h tests speeds and a 40 m headway. These trends were observed for tests performed with the 50 and 25 percent surrogate overlaps. Although this trend in increasing TTC was also observed for LVD trials performed with 20 and 30 km/h tests speeds and a 12 m headway, it was more apparent for trials performed with the 25-percent overlap; when the 50-percent overlap was used, similar ranges of the AEB brake onset TTC were observed (i.e., during trials performed with the 20 km/h versus 30 km/h test speeds).

Toyota Corolla

FCW Onset TTC

For the LVS tests, FCW alert onset TTC generally increased as a function of test speed from 10 km/h to either 40 km/h (50-percent overlap) or 50 km/h (25-percent overlap), then generally decreased as the test speed was increased. While LVM tests performed with the 50-percent overlap and comparable relative speeds showed a similar trend, those performed with the 25-percent overlap and comparable relative speeds did not; the reduction in FCW alert onset TTC was not observed for the LVM tests performed with relative test speeds of 50 and 60 km/h and the 25-percent overlap. FCW alert onset TTC also increased as a test speed was increased during LVD tests for the two surrogate overlaps used for each initial headway. However, for trials performed with a 12 m headway and a 50 percent surrogate overlap, some similarity of the TTC ranges was observed during trials performed with the 20 km/h versus 30 km/h test speeds).

AEB Brake Onset TTC

AEB braking onset TTCs generally increased as a function of relative speed during conduct of LVS and LVM trials performed with a bicycle POV, except for the LVS trials performed at 20 km/h (25 and 50-percent overlaps) and LVM tests performed with an SV speed of 60 km/h and a 50-percent overlap). The same was observed for LVD trials performed with an initial headway of 40 m for both surrogate overlaps and, to a lesser extent LVD trials performed with an initial headway of 12 m and 50 percent surrogate overlap. When the combination of an initial headway of 12 m and 25 percent surrogate overlap was used, the range of AEB braking onset TTCs observed during the 30 km/h trials was completely within the range observed for the 20 km/h trials. Although none of the LVM trials performed with the combination of a 4a bicycle, an SV test speed of 80 km/h, and an overlap of 50 percent resulted in SV-to-POV contact, the range of AEB brake onset TTCs were partially equivalent to the range of FCW onset TTCs for this test condition.

Cadillac Lyriq

FCW Onset TTC

For LVS tests performed with SV speeds from 10 to 50 km/h, a 50-percent overlap, and both bicycle surrogates, FCW alert onset TTCs generally increased as a function of test speed, after which they generally decreased with subsequent incremental increases. A similar trend was observed when a 25-percent overlap was used with the 4a bicycle. However, the FCW alert onset TTCs associated with the 70 km/h test speed varied considerably. With otherwise comparable test conditions but using the ABD bicycle, FCW alert onset TTCs generally increased as a function of test speed from 10 to 40 km/h, decreased as a function of test speed from 50 and 60, then increased from 60 to 80 km/h.

When testing the LVM scenario, a 50-percent overlap, and both bicycle surrogates, FCW alert onset TTCs generally increased as a function of SV test speed from 40 to 70 km/h, after which they plateaued (4a bicycle) or decreased (ABD bicycle) during trials performed with an SV speed of 80 km/h. The FCW alert onset TTCs observed during tests performed with an SV test speed of 40 to 70 km/h, the 4a bicycle, and 25-percent overlap followed the same trend as similar tests performed with a 50-percent overlap; however, the FCW alert onsets observed during the tests performed with an SV test speed of 80 km/h were lower than those associated with the otherwise comparable test performed with an SV test speed of 70 km/h. When the ABD bicycle was used, FCW alert onset TTCs generally increased as SV test speed was incrementally increased from 40 to 60 km/h, after which they decreased with subsequent increases in SV test speed. That said, the range of FCW alert onset TTCs observed during all trials performed with a 25-percent overlap, the ABD bicycle, and test speeds from 40 to 70 km/h all fell within the range of FCW alert onset TTCs observed during comparable trials performed from 80 km/h.

For LVD tests performed with a 12 m initial headway, FCW alert onset TTCs generally increased as a function of test speed, for both surrogate overlaps, for both bicycle surrogates. For three of the four 12 m headway test conditions, the range of FCW alert onset TTCs observed during trials performed with the ABD bicycle was completely within that of comparable trials performed with the 4a bicycle. For the single exception, 30 km/h trials performed with a 50 percent surrogate overlap, the range of FCW alert onset TTCs observed during trials performed with the 4a bicycle was completely within that of comparable trials performed with the ABD bicycle.

For LVD tests performed with a 40 m initial headway, FCW alert onset TTCs also increased as a function of test speed, for both surrogate overlaps, for both bicycle surrogates. With this initial headway and a 50 percent surrogate overlap, the range of FCW alert onset TTCs observed during trials performed with the ABD bicycle were each greater than the respective ranges for the 4a bicycle and there was no range overlap. However, when a 25 percent surrogate overlap was used, the range of FCW alert onset TTCs observed during trials performed with the 4a bicycle were both within the respective ranges observed for the ABD bicycle.

AEB Brake Onset TTC

The trends in AEB onset TTCs for a given combination of overlap and bicycle surrogate were generally consistent for a given test speed for LVS trials performed with the Cadillac Lyriq, with only a minor divergence observed for the trials performed with a 30 km/h test speed. For LVS tests performed at the 30 km/h test speed and a 50 percent offset, the mean AEB onset TTCs associated with the 4a and ABD bicycles were slightly less and slightly greater, than those observed during the 20 km/h test speed. However, an opposite trend was observed when a 25-percent overlap was used. For test speeds of 30 to 60 km/h, AEB onset TTC increased as a function of test speed for trials performed with both bicycle surrogates and the 50-percent overlap, before decreasing during trials performed with a test speed of 70 km/h (4a bicycle only and with TTC values that contained or were partially equivalent to those associated with the 50 and 60 km/h test speeds). The trends in AEB onset TTC tests performed with an overlap of 25 percent were similar to those of the 50-percent overlap. However, the test speed range over which the AEB onset TTC tests increased as a function of test speed was broader for trials performed with both bicycle surrogate, from 30 to 70 km/h, after which the AEB onset TTCs fell to magnitudes less than those observed during the respective trials performed at 50 km/h.

During LVM tests performed with a 50-percent overlap, the overall trend in AEB onset TTC for both bicycle surrogates was to increase as a function of SV test speed, with similar ranges of the AEB onset TTC observed for SV test speeds from 50 to 70 km/h. LVM tests performed with a 25-percent overlap revealed a similar overall trend. However, for SV test speeds from 50 to 70 km/h AEB onset TTC remained nearly identical for trials performed with the ABD bicycle and decreased slightly as a function of SV speed during trials performed with the 4a bicycle.

For LVD tests performed with a 12 m initial headway the overall trend in AEB onset TTC for both bicycle surrogates was to decrease as a function of SV test speed for each surrogate overlaps. That said, when the 50-percent overlap was used with the ABD bicycle all AEB onset TTCs observed during trials conducted with the 30 km/h test speed were completely within the range established during the otherwise equivalent 20 km/h trials. Similarly, when the 50-percent overlap was used with the 4a bicycle, all AEB onset TTCs observed during trials conducted with the 20 km/h test speed were completely within the range established during the otherwise equivalent 30 km/h trials. During trials performed with the ABD bicycle, a 20 km/h test speed, and a 25-percent overlap, a test condition that did not produce instances of SV-to-POV contact, the AEB onset TTCs exceeded that of the FCW alert onset TTC for each trial. For the same test condition, overlap of the AEB onset and FCW alert onset TTCs occurred during trials performed with the 4a bicycle (no contact was observed during these trials as well), with the upper bound of the AEB onset TTC range exceeding both FCW alert onset TTCs used to define the respective range.

For LVD tests performed with a 40 m initial headway, AEB onset TTC was largely consistent across the various combinations of test speed, surrogate overlap, and bicycle surrogate make. For trials performed with the ABD bicycle, AEB onset TTC increased slightly as a function of test speed when a 50 percent surrogate overlap was used, but the ranges were nearly equivalent for trials performed with the 25-percent overlap. Similarly, with the 4a bicycle, AEB onset TTC was nearly equivalent for trials performed with the two test speeds and a 50-percent overlap. However, when the 25-percent overlap was used, AEB onset TTC decreased slightly as test speed was increased.

Tesla Model 3

FCW Onset TTC

Although the number of LVS trials for consideration is limited, available data from testing performed with the 50-percent overlap and the ABD bicycle indicate FCW alert onset TTC incrementally increased as a function of test speed from 10 to 40 km/h, after which it plateaued during the single trial performed at 50 km/h. The LVS trials performed with test speeds of 10 and 20 km/h, a 50-percent overlap, and the 4a bicycle revealed a similar trend, albeit with lower magnitudes then seen for the 4a bicycle. With the 25-percent overlap, FCW onset TTC increased as a function of test speed from 10 to 20 km for both bicycle surrogates, after which it plateaued during the single trial performed at 30 km/h with the ABD motorcycle.

When evaluated with the LVM scenario, a 50-percent overlap, and the ABD bicycle, the Tesla Model 3 FCW onset TTC incrementally increased as a function of SV test speed from 40 to 50 km/h, after which it plateaued then decreased as SV test speed was increased from 60 to 80 km/h. Using a 4a bicycle but otherwise comparable test conditions, the average FCW onset TTC per SV test speed incrementally decreased as these speeds were increased from 40 to 70 km/h. Similar trends in FCW alert onset TTC were observed during LVM tests performed with a 25-percent overlap, for both surrogate bicycles. However, the ranges of FCW alert onset TTC associated with the tests performed with the ABD bicycle and SV test speeds of 40, 50, and 60 km/h were each quite broad and largely similar (the range of FCW onset TTCs observed for the tests performed with an SV speed of 40 km/h were completely within the ranges of otherwise equivalent tests performed with SV speeds of 40 and 60 km/h, and the ranges of tests performed with SV speeds of 40 and 60 km/h were nearly equivalent).

For LVD tests performed with a 12 m initial headway, AEB brake onset TTC increased as a function of test speed for trials performed with both bicycle surrogates and both surrogate overlaps. With the exception of when the combination of a 50 percent surrogate overlap and 30 km/h test speed was used, the ranges of AEB brake onset TTCs associated with the ABD bicycle were greater than the comparable ranges observed during trials performed with the 4a bicycle.

For LVD tests performed with a 40 m initial headway and a 50 percent surrogate overlap, AEB brake onset TTC increased as a function of test speed for trials performed with both bicycle surrogates. Although a similar trend was observed during LVD trials performed with the 40 m initial headway, a 25 percent surrogate overlap, and the ABD bicycle, comparable trials performed with the 4a bicycle produced nearly equivalent AEB brake onset TTCs for trials performed at the two test speeds. With this initial headway, the AEB brake onset TTCs for the two bicycle surrogates were similar for three of the four combinations of surrogate overlap and test speed; however, the AEB brake onset TTCs associated with the ABD bicycle were greater

than those observed during trials performed with the 4a bicycle when the combination of a 25-percent overlap and 30 km/h test speed was used.

AEB Brake Onset TTC

During the LVS testing performed with the 50-percent overlap and the ABD bicycle, AEB brake onset TTC increased as a function of test speed from 10 to 30 km/h, after which it decreased during subsequent trials performed with test speeds from 40 and 50 km/h. The limited number of LVS trials performed with test speeds of 10 and 20 km/h, the same offset, but 4a bicycle increased as a function of test speed, but with lower magnitudes than produced during AEB motorcycle tests performed with the same test speed. When Tesla Model 3 LVS tests were performed with a 25-percent overlap, AEB brake onset TTC decreased as a function of increasing test speed, for both bicycle surrogates.

For LVM tests performed with a 50-percent overlap, AEB brake onset TTC generally decreased as SV test speed was increased. However, the broad range of values observed for each bicycle surrogate during trials performed with an SV speed of 50 km/h. For this speed, one of the two trials performed for each bicycle surrogate produced an AEB brake onset TTC value significantly greater (earlier) than either observed during the respective test performed with a 40 km/h SV test speed. When LVM tests were performed with a 25-percent overlap, AEB brake onset TTC generally decreased as SV test speed was increased for both bicycle surrogates (with the only exception being the single test trial performed with an ABD bicycle and an SV test speed of 50 km/h). Considering all combinations of LVM test conditions performed with bicycle surrogates, the ABD bicycle generally produced the AEB brake onset TTCs earlier than those observed during trials performed with the 4a bicycle, with a notable exception being trials performed with a 25-percent overlap and SV test speeds of 60 and 70 km/h, where the respective AEB brake onset TTCs were nearly equivalent for each bicycle surrogate. Finally, the range of AEB brake onset TTCs was partially equivalent to that of the FCW onset TTCs for the 4a bicycle when a combination of a 50-percent overlap and a 50 km/h test speed was used (a test condition that did not produce instances of SV-to-POV contact for the Tesla Model 3).

For LVD tests performed with a 12 m initial headway, increasing SV test speed resulted in the increase in AEB brake onset TTC, and with the exception of trials performed with a 25-percent overlap and a test speed of 30 km/h, AEB brake onset TTCs were nearly equivalent for trials performed with each bicycle surrogate per test condition. Also, the ranges of AEB brake onset TTCs were partially equivalent to those of the FCW onset TTCs for both bicycle surrogates using a combination of a 50-percent overlap and a 30 km/h test speed (no SV-to-POV contact occurred during any of these trials). Although no SV-to-POV contact was observed, this was also observed for trials performed with the ABD bicycle, a 25 percent surrogate overlap, and a test speed of 30 km/h.

For each bicycle surrogate, LVD tests performed with a 40 m initial headway produced similar AEB brake onset TTCs regardless of test speed and surrogate overlap. However, for each test condition, the AEB brake onset TTCs observed during trials performed with the ABD bicycle were lower than comparable values produced with the 4a bicycle. The magnitude of these differences depends on what combination of bicycle surrogate overlap and test speed is considered but was generally more prominent for tests performed with a 50-percent overlap.

Motorcycle POV

The following high-level trends in FCW and AEB brake onset TTC were subjectively observed during trials performed with a motorcycle POV. 4a and ABD motorcycle surrogates were both used for each SV.

Subaru Crosstrek

FCW Onset TTC

For LVS tests performed with SV speeds from 10 to 60 km/h, FCW onset TTCs generally increased as a function of test speed, after which they generally decreased with subsequent incremental increases. A similar trend was observed for LVM trials performed with trials performed with an SV test speed of 40 to 80 km/h, where the relative speeds ranged from 20 to 60 km/h. These trends were generally observed for tests performed with both the 50 and 75-percent overlaps.

LVD tests using an initial headway of 12 m and a POV deceleration of 0.3g, FCW onset TTCs were largely similar across the two surrogate overlaps, test speeds, and motorcycle surrogate makes; with the exception of the range associated with the 50 km/h test speed, 50-percent overlap, and 4a motorcycle test condition, the range of FCW onset TTCs observed during trials performed with a 50 km/h test speed, 50-percent overlap, and the ABD motorcycle was broad enough to contain all other FCW onset TTCs.

Due to SV-to-POV contact observed during most LVD tests using an initial headway of 12 m and a POV deceleration of 0.3g, only a limited number of LVD tests were conducted with a POV deceleration of 0.5g; these trials were only performed with the combination of the 4a bicycle, a 80 km/h test speed, and a 50-percent overlap. The resulting range of FCW onset TTCs was significantly lower than those observed for all trials performed with the 0.3g POV deceleration.

When LVD tests were performed with a 40 m initial headway, the range of FCW onset TTCs from each combination of motorcycle surrogate, surrogate overlap, and POV deceleration increased as a function of test speed (where applicable). When tests were performed with both POV decelerations for a given combination of test conditions, range of FCW onset TTCs associated with trials performed with a POV deceleration of 0.5g were generally less than those of comparable tests performed with the lower 0.3g POV deceleration. When results from each motorcycle surrogate were compared for an equivalent test condition, there was overlap for each range of FCW onset TTCs.

AEB Brake Onset TTC

The AEB brake onset TTCs observed during LVS testing increased as a function of speed from 10 to 60 km/h then generally decreased slightly during trials performed with the 70 km/h test speed. However, trials performed with the 4a motorcycle and 75 percent offset increased slightly from values observed during the 60 km/h tests (albeit with a slight overlap of TTC values). A similar overall trend was generally observed for LVM trials performed with an SV test speed of 40 to 80 km/h for both overlaps. However, the combination of LVM scenario, an SV test speed of 60 km/h, the 75-percent overlap, and 4a bicycle produced AEB brake onset TTCs completely within the range of values observed for otherwise comparable trials performed with a 50 km/h test speed.

For LVD tests using an initial headway of 12 m, AEB brake onset TTCs were largely similar across the two surrogate overlaps, test speeds, POV decelerations, and motorcycle surrogate makes; although the range of values produced with trials performed with an 80 km/h test speed, 75-percent overlap, and the 4a motorcycle was broader, and the lower bound slightly lower, than those associated with the other ranges.

For LVD tests using an initial headway of 40 m, AEB brake onset TTCs were largely similar across the two surrogate overlaps, test speeds, POV decelerations, and motorcycle surrogate makes; although the upper bound of the range produced with the combination of a 50 km/h test speed, 50-percent overlap, and the ABD motorcycle was greater than those associated with the other ranges.

Toyota Corolla

FCW Onset TTC

For the LVS tests, FCW alert onset TTC generally increased as a function of test speed from 10 km/h to either 40 km/h (50-percent overlap) or approximately 50 km/h (25-percent overlap), then generally decreased with subsequent increases in test speed. However, the manner and extent to which the FCW TTC reduction occurred varied as a function of test speed, overlap, and surrogate make. For the LVM tests, FCW alert onset TTC generally increased as the SV test speed was increased from 40 to 60 km/h, but then remained largely consistent during trials performed with subsequent increases in test speed.

For LVD tests using an initial headway of 12 m, FCW alert onset TTCs were generally similar across the two surrogate overlaps, test speeds, and motorcycle surrogate make for a given POV deceleration. The exception to this trend was observed for the combination of a 50 km/h test speed, 75-percent overlap, and the ABD motorcycle, where the lower bound of the AEB brake onset TTC range, defined by one of the two trials which resulted in SV-to-POV contact with this test series, was much lower than those of the other test conditions.

When LVD tests were performed with an initial headway of 40 m, trends in FCW alert onset TTC were found to depend on what combination of other motorcycle surrogate and test conditions are considered. However, FCW alert onset TTCs produced during trials performed with the ABD motorcycle were generally more disparate than comparable trials performed with the 4a motorcycle. With the exception of the broad range of values observed for two test conditions performed with the ABD motorcycle and a 50 percent surrogate overlap, the FCW alert onset TTCs produced during trials conducted with the 50-percent overlap were largely in agreement with those of otherwise equivalent tests performed with a 75-percent overlap.

For trials performed with an initial headway of 40 m, the ABD motorcycle, and a POV deceleration of 0.3g, the FCW alert onset TTCs generally decreased as the test speed was increased, and ranges of values observed for trials performed with a test speed of 80 km/h and a 50-percent overlap was significantly larger than for any other condition inclusive of the same POV deceleration. Conversely, use of an initial headway of 40 m and the 4a motorcycle generally resulted in FCW alert onset TTCs increasing as the test speed was increased for a given surrogate overlap, for POV deceleration magnitudes.

AEB Brake Onset TTC

With the exception of LVS trials performed with an SV speed of 20 km/h (for both overlaps and both motorcycle surrogates) AEB braking onset TTCs generally increased as a function of SV speed during conduct of LVS and LVM trials performed with a motorcycle POV for the Toyota Corolla. Although none of the LVS trials performed with the combination of an ABD motorcycle, a test speed of 70 km/h, and an overlap of 50 percent resulted in SV-to-POV contact, the range of AEB brake onset TTCs were partially equivalent to the range of FCW onset TTCs for this test condition.

For LVD tests using an initial headway of 12 m, AEB brake onset TTCs were generally similar across the two surrogate overlaps, test speeds, POV deceleration, and motorcycle surrogate make. The exception to this trend was observed for trials performed with the ABD motorcycle, a POV deceleration of 0.3g, both test speeds for the 50-percent overlap, and the 50 km/h test speed for the 75-percent overlap. For those exceptions, the range of AEB brake onset TTCs was much larger than those associated with the other test conditions.

Compared to results produced from LVD tests using an initial headway of 12 m, the AEB brake onset TTCs produced from trials performed with an initial headway of 40 m were more disparate, particularly for tests performed with the ABD motorcycle, a test speed of 50 km/h, and a POV deceleration of 0.5g where a broad range of AEB brake onset TTCs were observed for trials performed with a 50 percent surrogate overlap (and to a lesser extent for trials performed with the ABD motorcycle, a test speed of 80 km/h, and a POV deceleration of 0.3g), and for the single trial performed with a 75 percent surrogate overlap (0.03 s) were a very low AEB brake onset TTC was observed. Also, a marked decrease in AEB brake onset TTCs were observed as test speed was increased from 50 to 80 km/h during trials performed with the 4a motorcycle and a POV deceleration of 0.5g; a trend not as apparent for the other LVD test conditions performed with the 40m headway.

Cadillac Lyriq

FCW Onset TTC

For both overlaps and motorcycle surrogate makes, FCW alert onset TTCs generally decreased as a test speed was increased from 10 to 20 km/h during LVS testing. With two exceptions (trials performed with a 50-percent overlap and an 80 km/h test speed, and trials performed with a 75-percent overlap and a 50 km/h test speed, both using the 4a motorcycle), subsequent increases in LVS test speed from 30 to 80 km/h generally resulted in an incremental increase in FCW alert onset TTC.

Increasing SV test speed from 40 to 70 km/h produced incremental increases in FCW alert onset TTCs during LVM tests performed with the Cadillac Lyriq using both overlaps and motorcycle surrogate makes. For each combination of overlap and SV test speed, the FCW alert onset TTCs observed for the two motorcycle surrogates were generally in good agreement, although the range of values produced during ABD motorcycle trials performed with an SV speed of 40 km/h and a 75-percent overlap was larger than that of the 4a motorcycle in the same test condition and for the ABD motorcycle using the same SV speed but 50-percent overlap.

For LVD tests using an initial headway of 12 m, FCW onset TTCs observed for trials performed with the same combinations of test speed, POV deceleration, and motorcycle surrogate, but different surrogate overlap, were largely comparable. This observation not only includes

similarities in FCW onset TTC magnitude, but also how the values increased as a function of increasing test speed, and how they were affected by the two POV decelerations (i.e., the FCW onset TTCs observed for trials performed with a POV deceleration of 0.5g are markedly lower [later] than those produced during comparable trials performed with a POV deceleration of 0.3g).

For LVD tests using an initial headway of 40 m and the ABD motorcycle, FCW onset TTCs observed for trials performed with the same combinations of test speed and POV deceleration, but different surrogate overlap, were largely comparable. This observation not only includes similarities in FCW onset TTC magnitude, but also how the values increased as a function of increasing test speed, and how they were affected by the two POV decelerations.

AEB Brake Onset TTC

With regard to AEB brake onset TTC, the effect of increasing test speed was largely consistent with that observed for FCW onset TTC. For LVS trials performed with both overlaps and 4a motorcycle, AEB brake onset TTC decreased as a test speed was increased from 10 to 20 km/h. This was also observed for LVS trials performed with the 75-percent overlap and ABD motorcycle, whereas AEB brake onset TTC increased as a test speed was increased from 10 to 20 km/h when the 50-percent overlap was used. With one exception (trials performed with a 75-percent overlap, a 70 km/h test speed, and the 4a motorcycle), subsequent increases in LVS test speed from 30 to 80 km/h generally resulted in an incremental increase in AEB brake onset TTC.

With regard to the AEB brake onset TTCs observed during LVM testing, the trends for trials performed with the two overlaps and motorcycle surrogate makes were generally consistent. For each combination of overlap and motorcycle surrogate, AEB brake onset TTCs increased as the SV test speed was increased from 40 to 50 km/h, remained largely equivalent for trials performed with SV test speeds of 50 to 70 km/h, then increased slightly in response to the SV test speed being increased from 70 to 80 km/h.

For LVD tests using an initial headway of 12 m, AEB brake onset TTCs observed for trials performed with the same combinations of test speed, POV deceleration, and motorcycle surrogate, but different surrogate overlap, were largely comparable. This observation not only includes similarities in FCW onset TTC magnitude, but also how the values increased as a function of increasing test speed, and how they were affected by the two POV decelerations (i.e., the FCW onset TTCs observed for trials performed with a POV deceleration of 0.5g are markedly lower [later] than those produced during comparable trials performed with a POV deceleration of 0.3g).

For LVD tests using an initial headway of 40 m, AEB brake onset TTCs observed for trials performed with the same combinations of test speed, POV deceleration, and motorcycle surrogate, but different surrogate overlap, were generally comparable.

Tesla Model 3

FCW Onset TTC

Results from the limited number of Tesla Model 3 LVS trials performed with a 50-percent overlap show that FCW onset TTC increased as a function of test speed from 10 to 30 km/h for the ABD motorcycle and from 10 to 40 km/h for the 4a motorcycle. When the 75-percent overlap was used for LVS testing, the FCW onset timing decreased as test speed was increased from 10 to 20 km/h, then increased as test speed was increased from 20 to 30 km/h during tests

performed with each motorcycle surrogate. That said, the range of FCW alert TTCs recorded during trials performed with the ABD motorcycle and a 20 km/h test speed was completely within the range of values recorded during the 10 km/h tests and the range of FCW alert TTCs recorded during trials performed with the 4a motorcycle and a 10 km/h test speed was completely within the range of values recorded during the 30 km/h tests.

With a 50-percent overlap, FCW onset TTC responses observed during LVM trials performed with the Tesla Model 3 varied as a function of SV test speed and motorcycle surrogate make. During trials performed with the 4a motorcycle, FCW onset TTC decreased as SV test speed was increased from 10 to 20 km/h and the range of TTC values produced during the 10 km/h trials did not overlap those observed during trials performed with SV test speeds of 50, 60, or 70 km/h. However, subsequent increases in SV test speed from 50 to 70 km/h resulted in the mean FCW onset TTC values increasing then decreasing, and the range of FCW onset TTCs observed during the trials performed with SV test speeds of 60 and 70 km/h fell completely within the range associated with the SV test speed of 50 km/h. Results from Tesla Model 3 tests performed with the ABD motorcycle were also disparate, where increases in FCW onset TTC occurred as SV test speed was increased from 10 to 20 km/h (versus the decrease observed with the 4a motorcycle), followed by a markedly lower range of FCW onset TTCs during the 30 km/h test speed, then a small increase during the 40 km/h tests.

Using a 75-percent overlap, the Tesla Model 3 FCW onset TTCs observed during LVM trials continued to vary as a function of SV test speed and motorcycle surrogate make. During trials performed with the ABD motorcycle, FCW onset TTC increased as SV test speed was increased from 40 to 60 km/h, with the values observed during the 40 and 50 km/h trials being completely within the range observed during use of the 60 km/h SV test speed. Increasing the SV test speed to 60 km/h resulted in mean FCW onset TTC lower than the ranges observed for SV test speed from 10 to 50 km/h. Use of the 4a motorcycle in this test condition produced more consistent and continuous results, where reductions in FCW onset TTC were observed as SV speed was increased from 40 to 70 km/h. The mean FCW onset TTC increased as SV test speed was increased from 70 to 80 km/h, with considerable overlap between the ranges of FCW onset TTC observed for the two ranges.

For LVD tests using an initial headway of 12 m, the FCW onset TTCs observed during testing depended on what combination of motorcycle surrogate, test speed, POV deceleration, and surrogate overlap is considered. The FCW onset TTC produced during trials performed with each surrogate, a 50 km/h test speed, a POV deceleration of 0.3g, and a 50-percent overlap were generally in agreement with the values observed for the respective test condition performed with the 75-percent overlap. When using this POV deceleration, increasing the test speed to 80 km/h resulted in largely comparable FCW onset TTCs for the two surrogates for a given surrogate overlap, but the extent to which the values observed during tests performed with a 50-percent overlap were included in the range of values observed with the 75-percent overlap test condition differed. For trials performed with a POV deceleration of 0.5g, all FCW onset TTCs observed during testing (i.e., inclusive of all trials performed with both surrogates, both test speeds, and both surrogate overlaps) fell within the range of values produced with the ABD motorcycle surrogate, a 50 km/h test speed, and a 50-percent overlap.

As was observed for LVD tests performed with the 12 m headway, the FCW onset TTCs observed during LVD tests using an initial headway of 40 m depended on what combination of motorcycle surrogate and surrogate overlap is considered. The FCW onset TTC produced during trials performed with the ABD motorcycle and a 50-percent overlap remained nearly equivalent as the test speed was increased from 50 to 80 km/h. The same comparison made for trials performed with the 4a motorcycle resulted in an increase in FCW onset TTC. Conversely, the FCW onset TTC produced during trials performed with the ABD motorcycle and a 75-percent overlap decreased markedly as the test speed was increased from 50 to 80 km/h but remained nearly equivalent for the same comparison made for trials performed with the 4a motorcycle. With respect to FCW onset TTC magnitude, the values observed for a given combination of test speed and motorcycle surrogate were lower for trials performed with a 75 versus 50-percent overlap although the differential depended on what combination is compared. Regarding the similarity of FCW onset TTC between the two motorcycle surrogates for a given combination of test speed and surrogate offset, the values were nearly equivalent when for 50 km/h and 50 percent offset condition. However, the other comparisons were more disparate. For the 50 km/h and 75 percent offset condition, the FCW onset TTC associated with the 4a motorcycle was less than that from the ABD motorcycle. However, the opposite was observed when results from the trials performed with an 80 km/h test speed are considered, where the FCW onset TTCs associated with the 4a motorcycle was greater than those of the ABD motorcycle tests for both surrogate overlaps.

AEB Brake Onset TTC

With a 50-percent overlap, the AEB brake onset TTCs observed during LVS trials performed with the Tesla Model 3 varied as a function of SV test speed and motorcycle surrogate make. Using the 10 km/h test speed, the magnitudes of the AEB brake onset TTCs observed during trials performed the 4a motorcycle were markedly lower than those from the ABD motorcycle at the same test speed and all other LVS trials performed with the 4a motorcycle and 50-percent overlap using different test speeds. However, as the test speed increased from 10 to 20 km/h, and then again from 20 to 30 km/h, the AEB brake onset TTCs observed for both motorcycle surrogates increased then decreased and had similar magnitudes. When the test speed was increased to 40 km/h during tests performed with the 4a motorcycle, the effect on AEB brake onset TTC was minimal, with only a slight increase in the mean AEB brake onset TTC observed.

For tests performed with both motorcycle surrogates and a 75-percent overlap, incrementally increasing test speed from 10 to 30 km/h resulted in subsequent decreases of AEB brake onset TTC during LVS trials performed Tesla Model 3. The extent to which the AEB brake onset TTCs varied as a function of motorcycle surrogate varied depending on what test speed is considered.

When compared to FCW onset TTC, the AEB onset TTCs observed during LVM testing generally followed a more consistent trend; regardless of offset or motorcycle surrogate make, increases in SV tests speed generally resulted in a decrease in FCW onset TTC. The sole exception was observed during 4a motorcycle tests performed with a 75-percent overlap and an SV test speed of 70 km/h, where the increase in SV test speed from 60 km/h resulted in an increase in the mean AEB onset TTC. However, the range of AEB onset TTCs observed for trials performed with the 60 km/h SV test speed was completely within the limits of what was produced during the tests performed with an SV speed of 70 km/h.

For LVD tests using an initial headway of 12 m, and with a few exceptions, the AEB brake onset TTCs observed for a given combination of motorcycle surrogate and POV deceleration were largely comparable across all applicable combinations of test speed of surrogate overlap, although greater overall disparity among the various test conditions was observed for trials performed with a POV deceleration of 0.3g. Notable exceptions to this trend were the AEB brake onset TTCs observed for with the 80 km/h test speed and 50 percent offset (for both motorcycle surrogates) and for the trial performed with the combination of the 4a motorcycle, 50 km/h test speed, and 75-percent overlap whose AEB brake onset TTCs were lower than the other trials performed within the same respective POV decelerations.

With an initial headway of 12 m, four LVD test conditions produced ranges of AEB onset TTCs that were partially equivalent to with the respective ranges of FCW alert onset TTC despite no SV-to-POV contact being observed for the associated trials. When a 50-percent overlap was used, this included trials performed with the 4a motorcycle, a 50 km/h test speed, and a 0.3g POV deceleration. When a 75-percent overlap was used in conjunction with a 50 km/h test speed and a 0.3g POV deceleration, this included trials performed with both motorcycle surrogates. Finally, when a 75-percent overlap was used in conjunction with an 80 km/h test speed and a 0.3g POV deceleration, this included trials performed with the 4a motorcycle.

For LVD tests using an initial headway of 40 m, the AEB brake onset TTCs associated with trials performed with a test speed of 50 km/h, for both surrogate overlaps, were low and each increased when test speed was changed to 80 km/h, particularly for the trials performed with the 75-percent overlap. With regard to surrogate comparability, the AEB brake onset TTCs were generally similar, with the values recorded during trials performed with the 4a motorcycle being slightly greater than those associated with the ABD motorcycle. However, a notable difference was observed during trials performed with a test speed of 80 km/h and a surrogate overlap of 50 percent where the AEB brake onset TTC observed during the trial performed with the 4a motorcycle was markedly higher than that produced with the ABD motorcycle.

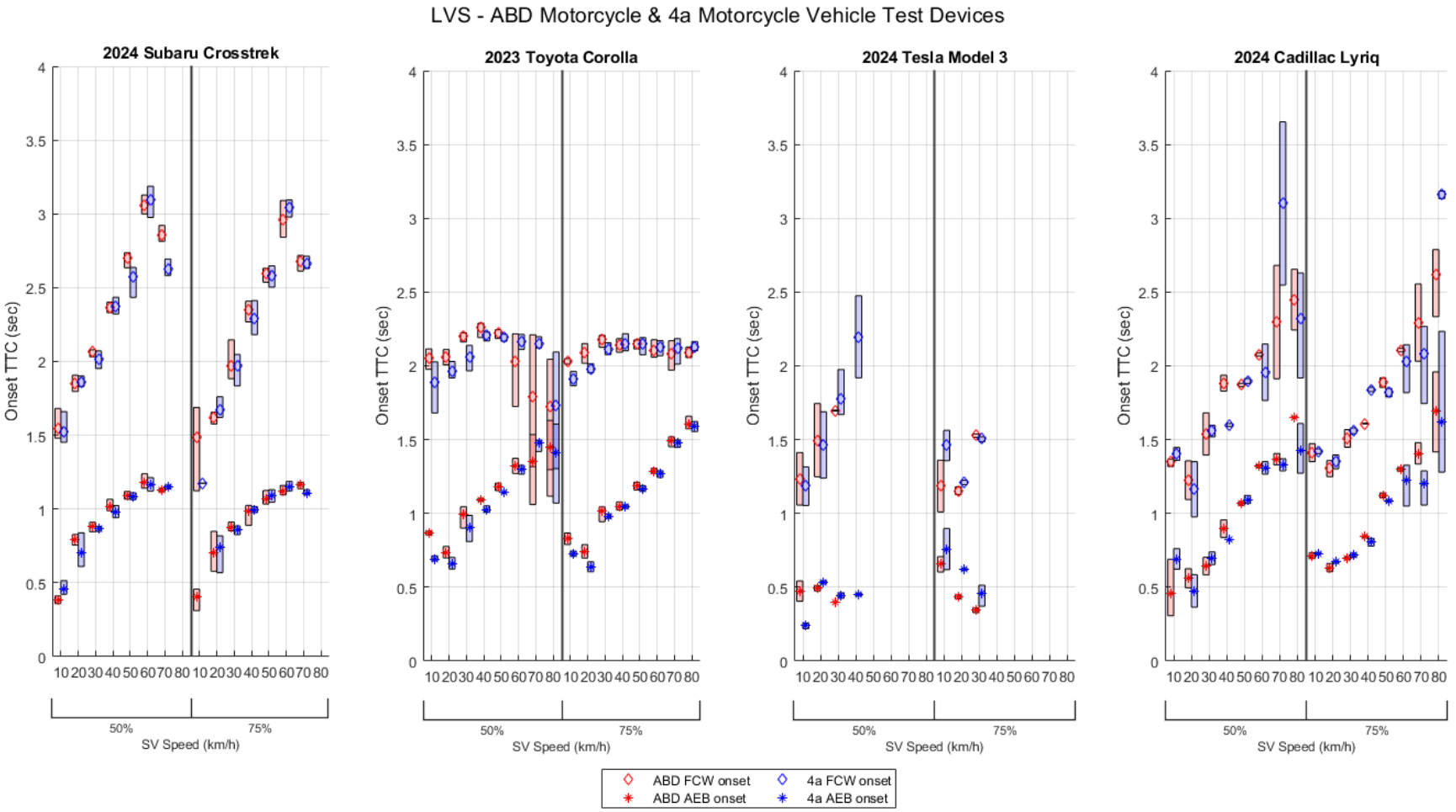

Figure 19. LVS FCW and AEB braking onset TTCs (motorcycle surrogates)

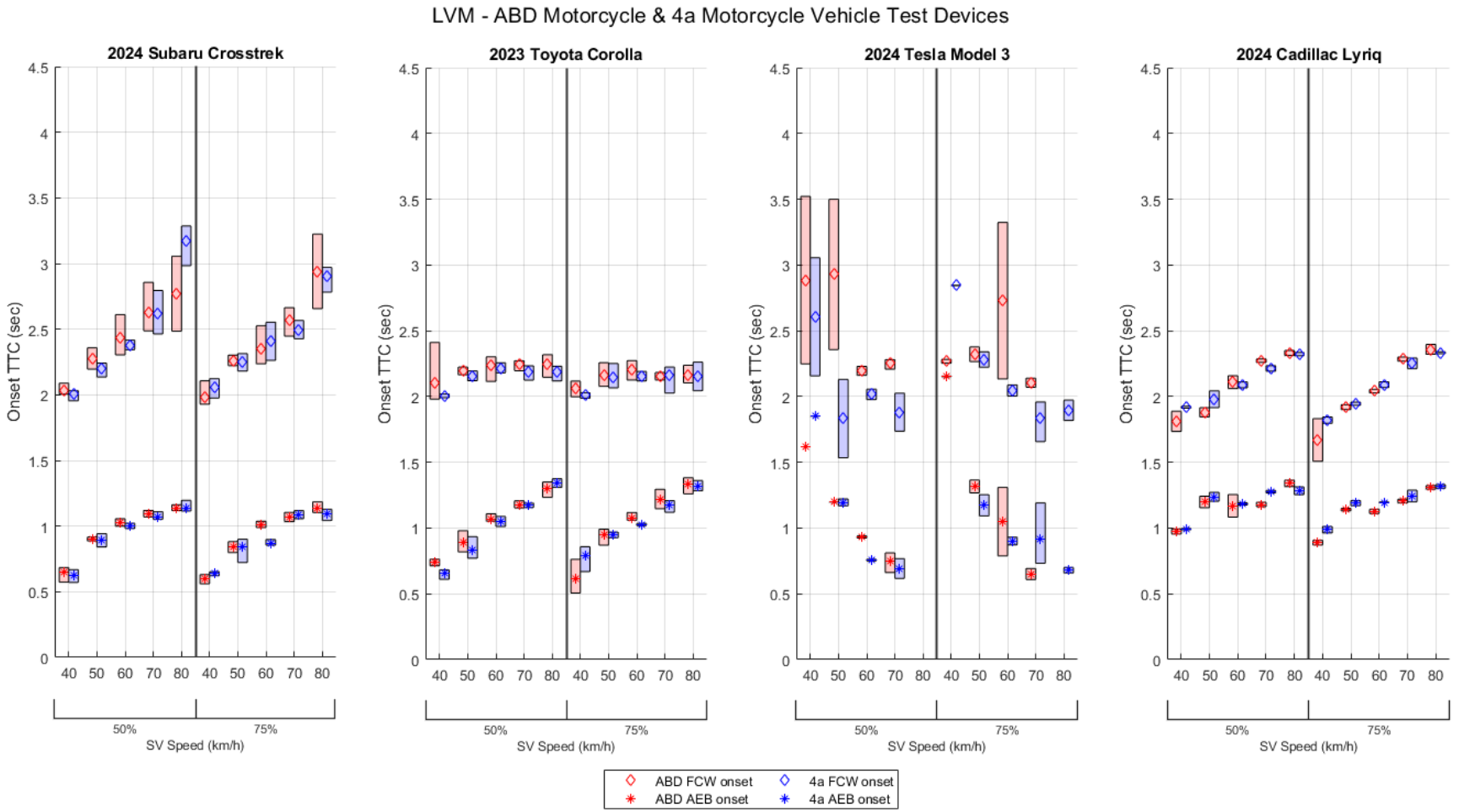

Figure 20. LVM FCW and AEB braking onset TTCs (motorcycle surrogates)

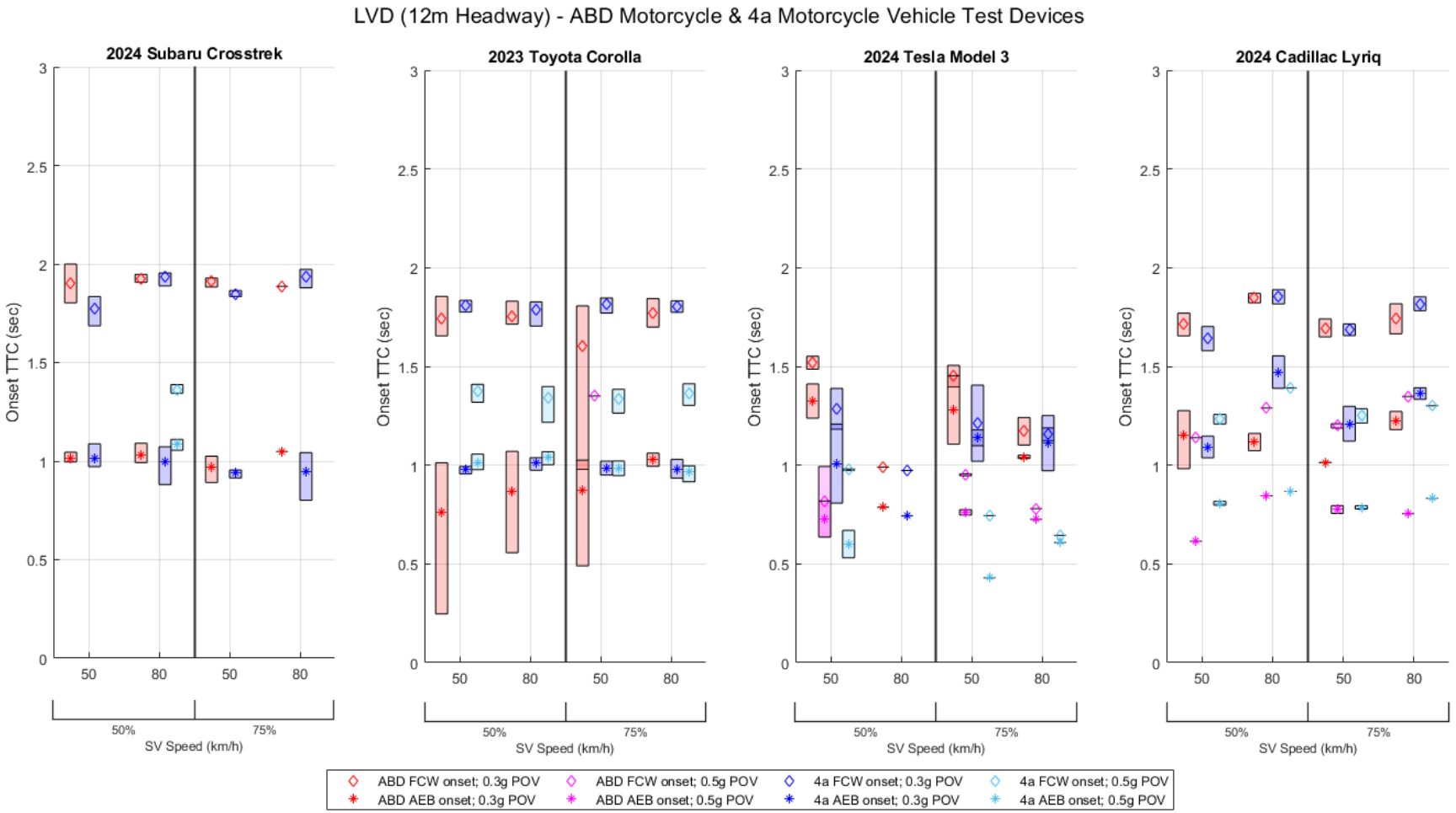

Figure 21. LVD FCW and AEB braking onset TTCs (12 m headway; motorcycle surrogates)

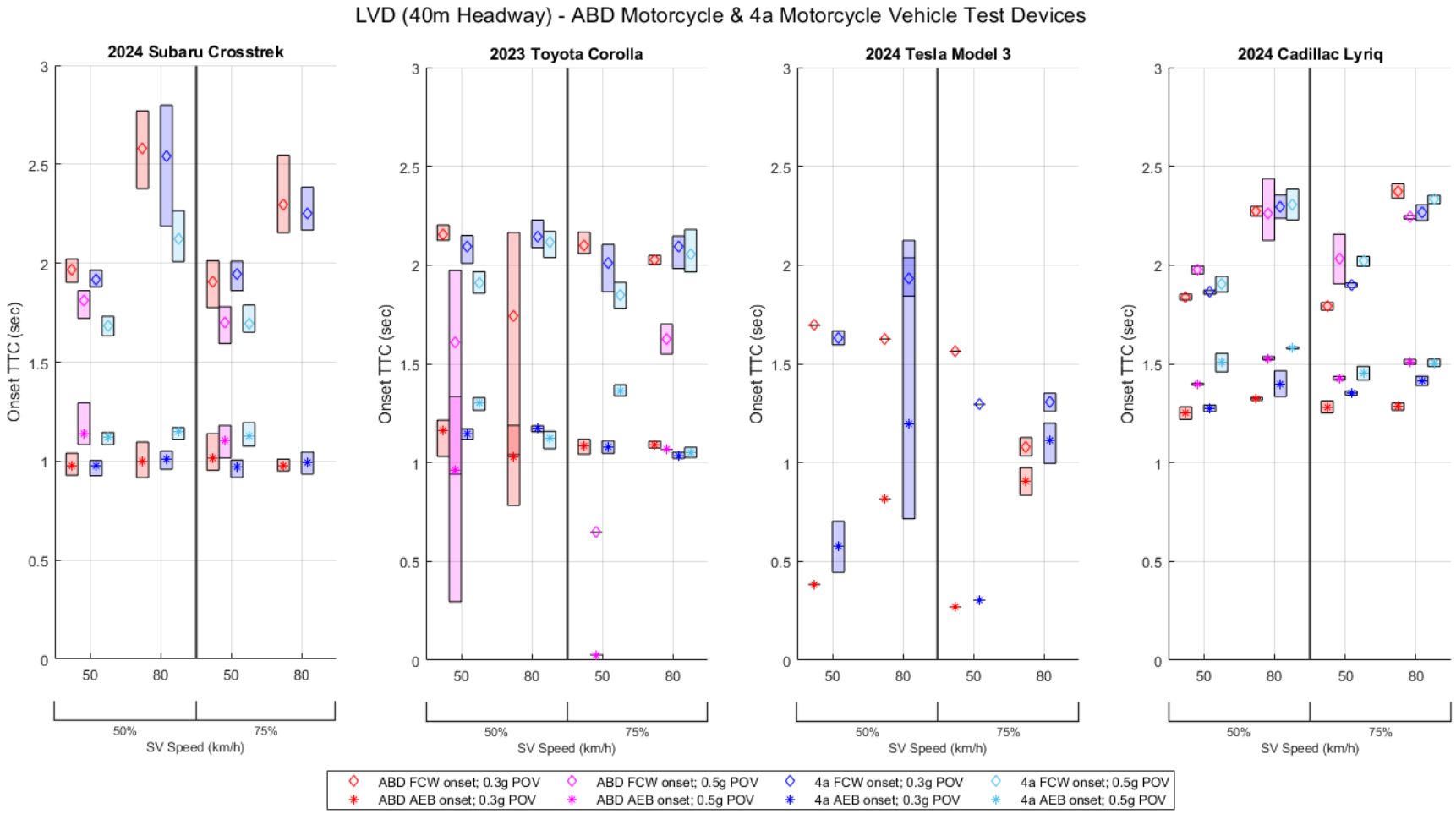

Figure 22. LVD FCW and AEB braking onset TTCs (40 m headway; motorcycle surrogates)

Crash Avoidance and Relative Impact Speeds

Tables 5 to 18, presented at the end of this section, provide an overall summary of the work described in this report. Trials where crash avoidance was observed are highlighted in green and labeled "CA." Trials highlighted in red indicate an SV-to-POV contact was observed, and the relative impact speed is shown.

LVS Performance

Bicycle POV

Subaru Crosstrek, Toyota Corolla, and Cadillac Lyric Test Results

For LVS tests with speeds up to 50 km/h, the Subaru Crosstrek, Toyota Corolla, and Cadillac Lyric were able to avoid contact with the bicycle POV during each trial, regardless of test speed or overlap.

When the SV speed was increased to 60 km/h and the 4a bicycle was used, the Subaru Crosstrek, Toyota Corolla, and Cadillac Lyriq avoided contact during each trial, regardless of overlap. Results were more disparate at this speed with the combination of the ABD bicycle and the Cadillac Lyric, where no contact was observed during the two 60 km/h LVS trials performed with an overlap of 25 percent, but with an overlap of 50 percent, 5.8 to 9.4 km/h (3.6 to 5.8 mph) impacts occurred (i.e., during two of the three trials performed). The ABD bicycle was not used during Subaru Crosstrek or Toyota Corolla testing.

The Toyota Corolla continued to avoid the 4a bicycle, for both overlaps, during LVS tests performed at 70 km/h. With this combination of test speed and test surrogate, the Subaru Crosstrek achieved avoidance during each of the five trials performed with an overlap of 50 percent, but with an overlap of 25 percent, 7.8 and 9.4 km/h (4.8 and 5.8 mph) impacts occurred (i.e., during two of the five trials performed). When the Cadilliac Lyric was evaluated at this speed with the 4a bicycle, a combination of avoidance and impacts was observed for both overlaps; impacts at 5.7 and 28.4 km/h (3.5 and 17.6 mph) and occurred when the overlap was 50 percent, and at 9.0 km/h (5.6 km/h) when the overlap was 25 percent. Cadilliac Lyric LVS tests performed from 70 km/h using the ABD bicycle were only conducted with a 25-percent overlap, and no contact was observed during either of the two trials.

For the Subaru Crosstrek and Cadillac Lyriq, each LVS test performed at 80 km/h resulted in contact with the surrogate bicycle, regardless of overlap. When evaluated with a 50-percent overlap, the three trials were performed with the Subaru Crosstrek and impacts speeds ranged from 24.9 to 31.4 km/h (15.5 to 19.5 mph). With the three Subaru Crosstrek trials performed using a 25-percent overlap, similar results were observed where the impact speeds ranged from 29.2 to 37.9 km/h (18.1 to 23.5 mph). For the Cadillac Lyriq, only two LVS trials were performed from 80 km/h, one per test surrogate, and both concluded with an impact. With the 4a and ABD bicycles, impact speeds of 49.4 km/h (30.7 mph) and 41.8 km/h (26.0 mph) were observed for these 80 km/h tests.

Tesla Model 3 Results

For the Tesla Model 3, the occurrence of a no contact result depended on the combination of test speed and surrogate make during trials performed with a 50-percent overlap. This trend was not

as apparent during test performed with the 25-percent overlap where the test results were more consistent.

For Tesla Model 3 tests performed with the 50-percent overlap and the 4a surrogate bicycle, no contact was observed during both trials performed from 10 km/h, and during one of three trials performed from 20 km/h where impacts of 2.0 and 5.9 km/h (1.2 and 3.7 mph) occurred. These results were markedly different from the trials performed with the same overlap but with the ABD bicycle, where no contact was observed during each trial performed from 10 to 40 km/h, but an impact of 27.6 km/h (17.4 mph) occurred during the single trial performed from 50 km/h.

When the Tesla Model 3 was evaluated with a 25-percent overlap and the 4a bicycle, no contact was observed during both trials performed at 10 km/h, while impacts occurred for both trials performed from 20 km/h, with impact speeds of 8.1 and 10.0 km/h (5.0 and 6.2 mph). This contrasts the more disparate results observed when the ABD bicycle was used, where contact occurred during one of the two trials performed at each test speed of 10 and 20 km/h, and during the only trial performed at 30 km/h. When contact occurred, the impact speeds for the 10, 20, and 30 km/h trials were 4.8 km/h (3.0 mph), 0.3 km/h (0.2 mph), and 18.4 km/h (11.4 mph).

Motorcycle POV

Toyota Corolla Test Results

For LVS tests performed with SV speeds up to 70 km/h, the Toyota Corolla avoided contact with the motorcycle POV during each trial, regardless of overlap or surrogate model. However, when the SV speed was increased to 80 km/h during trials performed with a 50-percent overlap and the 4a motorcycle, contact was observed during three of the four trials, where impact speeds pf 2.3, 6.2, and 31.6 km/h (1.4, 3.9, and 19.6 mph) were observed. Contrasting this, contact was observed during one of the five trials performed with otherwise comparable test conditions but with the ABD surrogate motorcycle, where an impact of 22.4 km/h (13.9 mph) occurred.

Subaru Crosstrek Test Results

During LVS tests conducted with a 50-percent overlap, the Subaru Crosstrek avoided contact with the motorcycle POV during each trial performed with SV speeds up to 60 km/h regardless of motorcycle surrogate make. Similarly, when a 75-percent overlap was used, the Subaru Crosstrek avoided contact with the ABD motorcycles during each trial performed with SV speeds up to 60 km/h. Results observed during LVS trials performed with a 75-percent overlap and the 4a motorcycle were similar. However, no contact was only observed during each trial performed with nominal SV speeds of 20 to 60 km/h. The three LVS tests performed from 10 km/h with Subaru Crosstrek and 4a motorcycle produced contact with impact speeds of 9.8, 10.4, and 10.7 km/h (6.1, 6.4, and 6.6 mph).

When the SV speed was increased to 70 km/h, the Subaru Outback contacted the ABD motorcycle during each of the three trials performed for both overlaps; the impact speeds associated with a 50-percent overlap were 5.6, 13.2, and 17.5 km/h (3.5, 8.2, and 10.9 mph) and those associated with a 75-percent overlap were 8.5, 12.6, and 16.2 km/h (5.3, 7.8, and 10.1 mph). When the 4a motorcycle was used during LVS tests performed at this SV speed, contact was observed during three of the four trials performed with an overlap of 50 percent, where impact speeds of 8.5, 11.6, and 16.0 km/h (5.3, 7.2, and 9.4 mph) occurred, and during each of the three trials performed with the 75-percent overlap, where impacts speeds of 14.4, 15.9, and 16.6 km/h (8.9, 9.9, and 10.3 mph) occurred.

Cadillac Lyriq Test Results

With two exceptions, the Cadillac Lyriq avoided impacts with the motorcycle POV during each LVS trial performed with an overlap of 50 percent. With this overlap, the Cadillac Lyric contacted the ABD motorcycle during one of the three trials performed with an SV test speed of 10 km/h, where an impact speed of 3.2 km/h (2.0 mph) occurred. Also with this overlap, but during a trial using an SV test speed of 80 km/h and the 4a motorcycle, contact was observed for one of the three trials performed with the Cadillac Lyriq, where an impact speed of 13.6 km/h (8.5 mph) occurred.

When an overlap of 75 percent was used, the Cadillac Lyriq avoided contact with the ABD motorcycle during each LVS trial performed with an SV test speed up to 70 km/h, and during two of the three LVS trials performed from 80 km/h, where an impact speed of 3.9 km/h (2.4 mph) was observed. Using this overlap and the 4a motorcycle, contact was observed during one of the three trials performed from 60 and 70 km/h, where the respective impact speeds were 25.9 and 29.1 km/h (16.1 and 18.1 mph), and during two of the three trials performed from 80 km/h, where the impact speeds were 5.0 and 14.9 km/h (3.1 and 9.3 mph).

Tesla Model 3 Test Results

For LVS tests performed with SV speeds of 10 and 20 km/h, the Tesla Model 3 avoided contact with the motorcycle POV during each trial, regardless of overlap or surrogate model.

When the SV speed was increased to 30 km/h and the ABD motorcycle was used, both Tesla Model 3 trials performed per overlap resulted in contact. When a 50-percent overlap was used, impact speeds of 7.4 and 8.2 km/h (4.6 and 5.1 mph) occurred. When tested with a 75-percent overlap, impact speeds of 12.7 and 14.4 km/h (7.9 and 8.9 mph) occurred.

Using an SV speed of 30 km/h, the 4a motorcycle, and a 50-percent overlap, contact was observed during one of the three trials performed with the Tesla Model 3, where an impact speed of 8.0 km/h (5.0 mph) occurred during the trial. When tested with a 75-percent overlap, contact was observed during two of the three trials performed, where impact speeds of 1.2 and 11.4 km/h (0.7 and 7.1 mph) where occurred.

Two Tesla Model 3 trials were performed with an SV speed of 40 km/h. These trials were only performed using the 50-percent overlap and the 4a motorcycle. Contact occurred during both of these trials, where impact speeds of 8.0 and 16.5 km/h (5.0 and 10.3 mph) were observed.

LVM Performance

Bicycle POV

Subaru Crosstrek, Toyota Corolla, and Cadillac Lyric Test Results

The Subaru Crosstrek, Toyota Corolla, and Cadillac Lyric were able to avoid contact with the bicycle POV during each LVM trial performed, regardless of test speed or overlap. Additionally, for the Cadillac Lyric, no contact was observed during LVM test trials performed with both bicycle surrogates (only the 4a bicycle was used for the Subaru Crosstrek and Toyota Corolla).

Tesla Model 3 Test Results

For the Tesla Model 3, no contact was observed during LVM tests performed with both bicycle surrogate makes and both overlaps when SV speeds up to 60 km/h were used (40 km/h relative velocity). When the SV speed was increased to 70 km/h, crash avoidance only occurred during

the LVM trials performed with the combination of ABD bicycle and 50-percent overlap. Using the same test speeds and overlap but with the 4a bicycle, impact speeds of 7.6 and 13.9 km/h (4.7 and 8.6 mph) were observed during the two trials performed. With an SV speed of 70 km/h and overlap of 25 percent, impacts of 17.7 and 22.8 km/h (11.0 and 14.2 mph) were observed during tests performed with the 4a bicycle versus 6.0 and 12.0 km/h (3.7 and 7.5 mph) when the ABD bicycle was used.

When the SV speed was increased to 80 km/h during Tesla Model 3 tests performed with the combination of the LVM scenario, ABD bicycle, and 50-percent overlap, impacts during both of the two trials performed occurred, where impact speeds of 14.8 and 18.8 km/h (9.2 and 11.7 mph) where observed.

Comparison With LVS Test Results

For the Subaru Crosstrek, Toyota Corolla, and Cadillac Lyriq, the LVM results produced from tests performed with bicycle surrogates were generally consistent with those observed during LVS tests performed with the same combination of SV, bicycle surrogate make, overlap, and relative speed, with the sole exception being the outcome of the 80 km/h LVM tests (i.e., tests performed with the POV traveling at 20 km/h, or a relative speed of 60 km/h) versus the 60 km/h LVS tests performed with the combination of the Cadillac Lyric, the ABD bicycle, and a 50-percent overlap. Although no contact occurred during the LVM tests performed with this combination of vehicle, surrogate, overlap combination, and a relative speed of 60 km/h, impacts speeds of 5.8 and 9.4 km/h (3.6 and 5.8 mph) were observed during the 60 km/h LVS tests performed with the otherwise equivalent test configuration.

For the Tesla Model 3, no contact was observed with either bicycle surrogate, or either surrogate overlap, during LVM trials performed with relative speeds up to 40 km/h. Although this was also observed for LVS trials performed with test speeds up to 40 km/h using the ABD bicycle and a 50-percent overlap, results from LVS trials performed with the 4a bicycle and this overlap differed; the SV highest speed where no contact was only 20 km/h (one of the three trials conducted in this condition, impact speeds of 2.0 and 5.9 km/h were observed during the other two). When a 25-percent overlap was used during LVS tests performed with the Tesla Model 3, no contact was only observed during the two 10 km/h trials performed with the 4a bicycle, and during two of the three trials performed with and SV speed of 20 km/h and the ABD bicycle (an impact speed of 0.3 km/h was observed during the trial where contact occurred).

Motorcycle POV

Subaru Crosstrek, Toyota Corolla, and Cadillac Lyric Test Results

The Subaru Crosstrek, Toyota Corolla, and Cadillac Lyric were able to avoid contact with the motorcycle POV during each LVM trial performed, regardless of test speed, surrogate make, and surrogate overlap.

Tesla Model 3 Test Results

The Tesla Model 3 avoided contact with the motorcycle POV during each LVM trial performed with SV speeds from 40 to 60 km/h regardless of surrogate make and surrogate overlap.

During LVM tests performed with an SV speed of 70 km/h, a 50-percent overlap, and the 4a motorcycle, impacts occurred during both of the two trials, where impact speeds of 11.8 and 21.6 km/h (7.3 and 13.4 mph) were observed. Using this combination of SV speed and overlap in

conjunction with the ABD motorcycle, impacts occurred during two of the three trials performed, where impact speeds of 7.3 and 11.3 km/h (4.5 and 7.0 mph) were observed.

When LVM tests were performed with an SV speed of 70 km/h, a 75-percent overlap, and the 4a motorcycle, contact with an impact speed of 10.6 km/h (6.6 mph) was observed during one of the three trials performed. With this combination of SV speed and overlap and the ABD motorcycle, impacts were observed during both of the two trials performed, where impact speeds of 14.2 and 19.4 km/h (8.8 and 12.1 mph) occurred.

The only LVM tests performed with the Tesla Model 3 and an 80 km/h SV test speed used a combination of a 75 percent surrogate overlap and a 4a motorcycle. Impacts were observed during both of the two trials performed, with impact speeds of 26.4 and 28.5 km/h (16.4 and 17.7 mph).

Comparison With LVS Test Results

For the Subaru Crosstrek, Toyota Corolla, and Cadillac Lyriq the LVM results produced from tests performed with a relative speed up to 60 km/h were generally consistent with those observed during LVS testing performed with the same combination of SV, motorcycle surrogate make, overlap, and relative speed, with the following exceptions:

- The three LVS tests performed from 10 km/h with Subaru Crosstrek, 75-percent overlap, and the 4a motorcycle each produced contact. However, no contact was observed during LVM tests performed with the same relative speed (i.e., those performed with SV and motorcycle POV speeds of 30 and 20 km/h).
- One 10 km/h LVS test performed with the Cadillac Lyriq, 50-percent overlap, and the ABD motorcycle produced contact, whereas no contact occurred during LVM tests performed with the same relative speed (i.e., those performed with SV and motorcycle POV speeds of 30 and 20 km/h).
- One 60 km/h LVS test performed with the Cadillac Lyriq, 75-percent overlap, and the 4a motorcycle produced contact. However, no contact was observed during LVM tests performed with the same relative speeds (i.e., those performed with SV and motorcycle POV speeds of 80 and 20 km/h).

Results from Tesla Model 3 LVM testing performed with a relative speed up to 20 km/h were consistent with those observed during LVS testing performed with the same combination of SV, motorcycle surrogate make, overlap, and relative speed. However, differences between the results observed during LVS and LVM tests performed with the same 30 km/h (and 40 km/h, where applicable) nominal relative speeds were present.

- One impact was observed during conduct three LVS trials performed with the Tesla Model 3, a 30 km/h SV speed, the 4a motorcycle, and a 50-percent overlap. When the overlap was a changed to 75 percent during otherwise equivalent test conditions, contact occurred during two of the three trials. Additionally, contact was observed for each LVS trial performed with an SV speed of 30 km/h and the ABD motorcycle regardless of overlap. These LVS results contrast those from LVM trials performed with the same relative speed, where no contact was observed (i.e., during LVM trials performed with SV and motorcycle POV speeds of 50 and 20 km/h).
- Contact occurred during both of the two 40 km/h LVS trials performed with the Tesla Model 3, the 4a motorcycle, and a 50-percent overlap. However, no contact was

observed during LVM trials performed with the same relative speed and overlap (i.e., during LVM trials performed with SV and motorcycle POV speeds of 60 and 20 km/h).

LVD Performance

Bicycle POV

12 m Headway Test Results

The Subaru Crosstrek and Toyota Corolla, Cadillac Lyric were able to avoid contact with the bicycle POV during each LVD trial performed with a headway of 12 m, regardless of test speed or overlap.

For the Cadillac Lyric, no contact was observed during LVD trials performed with a test speed of 20 km/h and a headway of 12 m, regardless of surrogate make or overlap. When the test speed was increased to 30 km/h, no contact was observed during both LVD trials performed with a headway of 12 m and the ABD bicycle, for each overlap condition. However, when these test conditions were present during trials performed with the 4a bicycle, two of the three trials resulted in contact when the 50-percent overlap was used, where 18.0 and 19.2 km/h (11.2 and 11.9 mph) impact speeds were observed, and one of the three trials produced contact when the 25-percent overlap was used, where an impact speed of 8.7 km/h (5.4 mph) was observed.

With the Tesla Model 3, no contact was observed during LVD trials performed with a test speed of 20 km/h, a headway of 12 m, 50-percent overlap, and the 4a bicycle. When the ABD bicycle was used in an otherwise equivalent test condition, contact occurred during two of the three trials performed, where impact speeds of 5.1 and 6.0 km/k (3.2 and 3.7 mph) were observed. Impacts were observed during each LVD trial performed with a test speed of 20 km/h, a headway of 12 m, and an overlap of 25 percent, regardless of which bicycle surrogate was used. With this test condition, impact speeds of 6.3 and 7.2 km/h (3.9 and 4.5 mph) were observed during trials performed with the 4a bicycle, whereas impact speeds of 9.4 and 9.9 km/h (5.8 and 6.2 mph) occurred in trials using the ABD bicycle surrogate.

40 m Headway Test Results

The Subaru Crosstrek, Toyota Corolla, Cadillac Lyric, and Tesla Model 3 were able to avoid contact with the bicycle POV during each LVD trial performed with a headway of 40 m, regardless of test speed or overlap. Additionally, for the Cadillac Lyric and Tesla Model 3, no contact was observed during LVD test trials performed a headway of 40 m with both bicycle surrogates (only the 4a bicycle was used for the Subaru Crosstrek and Toyota Corolla).

Motorcycle POV

50 km/h, 12 m Headway Test Results

With one exception, no contact was observed for all LVD trials performed with the Toyota Corolla, a test speed of 50 km/h, a headway of 12 m, and a 4a motorcycle, regardless of motorcycle POV deceleration or overlap. However, otherwise equivalent trials performed with an ABD motorcycle differ markedly in this test condition, as the test outcome was less consistent.

- During Toyota Corolla tests performed with the 4a motorcycle, the sole instance of contact occurred during one of the five trials performed in the 75-percent overlap and a 0.5g motorcycle POV deceleration.
- With the Toyota Corolla, the ABD motorcycle, a 50-percent overlap, and a motorcycle POV deceleration of 0.3g, contact was observed during three of the four trials performed, where the impact speeds were 8.6, 9.3, and 21.8 km/h (5.3, 5.8, and 13.5 mph). No tests were performed with this combination of overlap and motorcycle surrogate make, but with a 0.5g motorcycle deceleration, for the Toyota Corolla.
- With the Toyota Corolla, the ABD motorcycle, a 75-percent overlap, and a motorcycle POV deceleration of 0.3g, contact was observed during two of the five trials performed, where the impact speeds were 11.8 and 28.4 km/h (7.3 and 17.6 mph). Using this combination of overlap and motorcycle surrogate make, but with a 0.5g motorcycle deceleration, only one trial was performed. An impact speed of 37.9 km/h (23.5 mph) occurred during this test.

With one exception, no contact was observed for all LVD trials performed with the Cadillac Lyric and Tesla Model 3 using a test speed of 50 km/h, a headway of 12 m, and a motorcycle POV deceleration of 0.3g, regardless of motorcycle surrogate make and overlap. In this test condition, contact was made during one of the three trials performed using a combination of the Cadillac Lyriq and ABD motorcycle, where an impact of 3.4 km/h (2.1 mph) was observed. However, when the motorcycle POV deceleration was changed to 0.5g using the same 50 km/h test speed and 12 m headway, contact was observed during all trials performed with the Cadillac Lyric and Tesla Model 3 regardless of motorcycle surrogate make or overlap.

The Cadillac Lyriq impact speeds, for the two trials that used a 50-percent overlap and the 4a motorcycle, were both 15.8 km/h (9.8 mph). Using the same test conditions but with an ABD motorcycle, an impact speed of 24.7 km/h (15.3 mph) was observed during the single trial performed.

The Cadillac Lyriq impact speeds, for the two trials that used a 75-percent overlap and the 4a motorcycle, were 15.8 and 17.5 km/h (9.8 and 10.9 mph). Using the same test conditions but with an ABD motorcycle, impact speeds of 18.2 and 18.5 km/h (11.3 and 11.4 mph) were observed during the two trials performed.

The Tesla Model 3 impact speeds, for the two trials that used a 50-percent overlap and the 4a motorcycle, were 13.6 and 20.7 km/h (8.5 and 12.9 mph). Using the same test conditions but with an ABD motorcycle, impact speeds of 10.7 and 16.6 km/h (6.6 and 10.3 mph) were observed during the two trials performed.

The Tesla Model 3 impact speed, for the one trial performed with a 75-percent overlap and the 4a motorcycle, was 26.0 km/h (16.2 mph). Using the same test conditions but with an ABD motorcycle, impact speeds of 0.3 and 12.5 km/h (0.2 and 7.8 mph) was observed.

With one exception, contact was observed for all LVD trials performed with the Subaru Crosstrek using a test speed of 50 km/h, a headway of 12 m, and a motorcycle POV deceleration of 0.3g, regardless of motorcycle surrogate make and overlap. No tests were performed with this combination of test speed and headway, but with a 0.5g motorcycle deceleration, for the Subaru Crosstrek.

- The impact speeds for the three Subaru Crosstrek trials that used a 50-percent overlap and the 4a motorcycle, were 8.3, 9.0, and 11.1 km/h (5.2, 5.6, and 6.9 mph). Using the same test conditions but with an ABD motorcycle, impact speeds of 8.9, 9.7, and 9.8 km/h (5.5, 6.0, and 6.1 mph) were observed during the three trials performed.
- The impact speeds for the three Subaru Crosstrek trials that used a 75-percent overlap and the 4a motorcycle, were 4.8, 5.1, and 9.4 km/h (3.0, 3.2, and 5.8 mph). Using the same test conditions but with an ABD motorcycle, contact occurred during three of the four trials performed, where impact speeds of 10.9, 10.9, and 12.7 km/h (6.8, 6.8, and 7.9 mph) were observed.

50 km/h, 40 m Headway Test Results

The Subaru Crosstrek and Cadillac Lyric were able to avoid contact with the bicycle POV during all LVD trials performed with a test speed of 50 km/h and a headway of 40 m, regardless of motorcycle surrogate make, motorcycle POV deceleration, or overlap.

No contact was observed for all LVD trials performed with the Toyota Corolla, a test speed of 50 km/h, a headway of 40 m, and a 4a motorcycle, regardless of motorcycle POV deceleration or overlap. However, the test outcome of otherwise equivalent trials performed with an ABD motorcycle were less consistent:

- With a 50-percent overlap and a nominal motorcycle POV deceleration of 0.3g, contact occurred during one of the five trials performed. The impact speed of this trial was 47.5 km/h (29.5 mph). For otherwise equivalent test conditions but with a 75-percent overlap, no contact was observed for each of the 5 trials performed.
- With a 50-percent overlap and a nominal motorcycle POV deceleration of 0.5g, contact occurred during three of the five trials performed. The impact speeds of these trials were 47.8, 48.0, and 48.5 km/h (29.7, 29.8, and 30.1 mph). For otherwise equivalent test conditions but with a 75-percent overlap, an impact speed of 49.4 km/h (30.7 mph) was observed during the only trial performed in this test condition.

For the Tesla Model 3, contact with the motorcycle POV occurred during each LVD test performed with the 50 km/h test speed, 40 m headway, and 0.3g nominal motorcycle POV deceleration, regardless of the motorcycle surrogate make or overlap.

- For the two trials Tesla Model 3performed with the 50-percent overlap and 4a motorcycle, impact speeds of 14.6 and 31.3 km/h (9.1 and 19.4 mph) occurred. An impact speed of 32.9 km/h (20.4 mph) was observed during the single trial performed with the ABD motorcycle in this test condition.

- With the 75-percent overlap, one Tesla Model 3 trial was performed with each motorcycle surrogate make, and both trials resulted in contact with comparable impact speeds. For the trial performed with the 4a motorcycle, an impact speed of 38.1 km/h (23.7 mph) occurred. Similarly, an impact speed of 36.9 km/h (22.9 mph) was observed during the trial performed with the ABD motorcycle.

No Tesla Model 3 trials were performed with the 50 km/h test speed, 40 m headway, and 0.5g nominal motorcycle POV deceleration test condition.

80 km/h, 12 m Headway Test Results

With the Subaru Crosstrek and Toyota Corolla, use of an 80 km/h test speed and a 12 m headway produced results markedly different outcomes depending on what combination of POV deceleration, overlap, and motorcycle surrogate was used.

With a 0.3g motorcycle POV deceleration and a 50-percent overlap, no contact was observed during four of the five trials performed with the 4a motorcycle; for the single trials with contact, impact speeds of 13.6 and 15.6 km/h (8.6 and 9.7 mph) occurred, for the Subaru Crosstrek and Toyota Corolla respectively. However, for both of these SVs, impacts were observed for each of the three trials performed with the ABD motorcycle in this condition. With the Subaru Crosstrek, the impact speeds for these trials were 10.4, 15.0, and 15.5 km/h (6.5, 9.3, and 9.6 mph), whereas the impact speeds for the Toyota Corolla trials were 10.4, 15.0, and 15.5 km/h (6.5, 9.3, and 9.6 mph).

Due to the number of impacts observed during their respective tests performed with a 0.3g motorcycle POV deceleration, Subaru Crosstrek and Toyota Corolla LVD tests using an 80 km/h test speed, 12 m headway, 50-percent overlap, and a POV deceleration of 0.5g were not performed with the ABD motorcycle. When the 4a motorcycle was used in this condition, the Toyota Corolla results similar to those observed when the lower POV deceleration was used, where no contact occurred during four of the five trials performed. In this test series, the single instance of contact occurred with an impact speed of 2.7 km/h (1.7 mph). However, the Subaru Crosstrek made contact with the 4a motorcycle during each of the trials performed, where impact speeds of 14.4, 16.7, 17.6 km/h (8.9, 10.4, and 10.9 mph) were observed.

With a 0.3g motorcycle POV deceleration and a 75-percent overlap, no contact was observed during each of the five trials performed with the 4a motorcycle and Toyota Corolla. However, contact was observed during both of the two trials performed with the ABD motorcycle in this condition, where impact speeds of 5.1 and 14.3 km/h (3.2 and 8.9 mph) were observed. When the combination of the 4a motorcycle and a motorcycle POV deceleration of 0.5g was during otherwise equivalent test conditions, the Toyota Corolla contact was observed during three of four trials, where impact speeds of 3.4, 4.3, and 4.6 km/h (2.1, 2.7, and 2.9 mph) occurred. No trials were conducted with the ABD motorcycle in this test condition for the Toyota Corolla.

For the Subaru Crosstrek, contact was observed during three of the five trials performed with a 0.3g motorcycle POV deceleration, 75-percent overlap, and the 4a motorcycle, where impact speeds were 12.4, 13.6, and 15.3 km/h (7.7, 8.5, and 9.5 mph). When an ABD motorcycle was used, an impact speed of 14.7 km/h (9.1 mph) was observed during the single trial performed. Due to the impacts observed during conduct of trials performed with 0.3g motorcycle POV deceleration, tests using a 0.5g motorcycle deceleration but otherwise equivalent test conditions were not performed for the Subaru Crosstrek with either motorcycle surrogate make.

For the Cadillac Lyriq and Tesla Model 3, considered individually, the number of impacts observed during each LVD tests performed with a 80 km/h test speed and 12 m headway were consistent for each within-overlap test condition, regardless of which combination of motorcycle surrogate make was used.

No contact was observed during both of the two trials performed with each motorcycle surrogate and the Cadillac Lyriq when a 50-percent overlap and a 0.3g motorcycle POV deceleration was used. Conversely, when a 0.5g motorcycle POV deceleration was used with otherwise equivalent test conditions contact was observed during each of the single trials performed per motorcycle

surrogate make, where impact speeds of 11.8 and 14.2 km/h (7.3 and 8.8 mph) occurred with the 4a and ABD motorcycles.

The crash avoidance results observed for Cadillac Lyriq trials performed with a 75-percent overlap followed a similar trend to that observed with the 50-percent overlap. No contact was observed during both of the two trials performed with each motorcycle surrogate and the Cadillac Lyriq when a 75-percent overlap and a 0.3g motorcycle POV deceleration was used. Conversely, when a 0.5g motorcycle POV deceleration was used with otherwise equivalent test conditions contact was observed during each of the single trials performed per motorcycle surrogate make, where impact speeds of 14.6 and 18.5 km/h (9.1 and 11.5 mph) occurred with the 4a and ABD motorcycles.

With a 50-percent overlap and a 0.3g motorcycle POV deceleration, impact speeds observed during the single Tesla Model 3 trials performed with the 4a and ABD motorcycle surrogates were nearly identical, with values of 11.2 km/h (7.0 mph) and 11.3 km/h (7.0 mph).

With a 75-percent overlap, the Tesla Model 3 avoided the motorcycle POV during each trial performed with a motorcycle POV deceleration of 0.3g, regardless of motorcycle surrogate make. When the motorcycle POV deceleration was increased to 0.5g, the impact speeds observed during the single trials performed with the 4a and ABD motorcycle surrogates were 17.3 km/h (10.7 mph) and 13.2 km/h (8.2 mph).

80 km/h, 40 m Headway Test Results

Use of an 80 km/h test speed and a 40 m headway also produced crash avoidance results generally dependent on what combination of SV, overlap, POV deceleration, and motorcycle surrogate was used.

For the Subaru Crosstrek, use of the 4a motorcycle produced instances of both impacts and no contact during tests performed with a 0.3g motorcycle POV deceleration and both overlaps; a trend not observed during tests conducted with the ABD motorcycle, where contact occurred during each of the three trials performed with each overlap.

- With a 50-percent overlap, the Subaru Crosstrek contacted the 4a motorcycle during two of the five trials performed, with impact speeds of 10.5 and 11.0 km/h (6.5 and 6.9 mph). In this test condition, tests performed with the ABD motorcycle resulted in impact speeds of 3.9, 10.0, and 17.4 km/h (2.4, 4.3, and 10.8 mph).
- With a 75-percent overlap, the Subaru Crosstrek contacted the 4a motorcycle during three of the five trials performed, with impact speeds of 3.7, 6.8, and 14.9 km/h (2.3, 4.3, and 9.3 mph). In this test condition, tests performed with the ABD motorcycle resulted in impact speeds of 8.4, 9.3, and 10.4 km/h (5.2, 5.8, and 6.5 mph).

Due to the impacts observed during tests performed with a 0.3g motorcycle POV deceleration, the only Subaru Crosstrek tests conducted with an 80 km/h test speed, and a 0.5g motorcycle POV deceleration were performed using 50-percent overlap and the 4a motorcycle. Contact was observed during each of these trials, where impact speeds of 22.7, 24.4, and 27.2 km/h (14.1, 15.2, and 16.9 mph) were observed.

With the Toyota Corolla, the following results were observed during LVD trials performed with combinations of an 80 km/h test speed, a 40 m headway, a 0.3g motorcycle POV deceleration, and the two overlaps.

- No contact was observed each of the five LVD trials performed with the Toyota Corolla, a 50-percent overlap and the 4a motorcycle.
- Using the same test condition but the ABD motorcycle, an impact occurred during three of the five trials performed, where the impact speeds were 6.4, 18.8, and 23.1 km/h (4.0, 11.7, and 14.4 mph).
- For an otherwise equivalent test condition but performed with a 75 percent offset, the Toyota Corolla had no contact with either motorcycle surrogate make during either of the two trials performed per surrogate.

When Toyota Corolla LVD tests were conducted with a combination of the 80 km/h test speed, a 40 m headway, and a 0.5g motorcycle POV deceleration, impacts occurred during each trial performed.

- Using a 50-percent overlap, the Toyota Corolla contacted the 4a motorcycle during each of the three trials conducted, and the impact speeds were 17.5, 21.6, and 28.3 km/h (10.9, 13.4, and 17.6 mph). No trials were performed with the ABD motorcycle in this condition due to impacts observed during conduct of otherwise equivalent tests using a 0.3g motorcycle POV deceleration.
- When a 75-percent overlap, the Toyota Corolla contacted the 4a motorcycle during each of the three trials conducted, and the impact speeds were 25.6, 26.2, and 35.4 km/h (15.9, 16.3, and 21.4 mph). When the same test conditions were used during trials performed with the ABD motorcycle, impacts of 26.4 and 69.7 km/h (13.3 and 43.3 mph) were observed.

For the Cadillac Lyriq LVD trials performed with an 80 km/h test speed and a 40 m headway, contact was observed for two of the three tests performed with a combination of the ABD motorcycle, a motorcycle POV deceleration of 0.3g, and a 50 percent offset, where impact speeds of 2.4 and 5.7 km/h (1.5 and 3.5 mph) where observed. No contact was observed during the other Cadillac Lyriq LVD trials performed with this combination of test speed and headway, regardless of POV deceleration, overlap, or surrogate make.

With the Tesla Model 3, LVD trials conducted with an 80 km/h test speed and a 40 m headway produced impacts with both motorcycle surrogate makes during tests performed with a 0.3g motorcycle POV deceleration, for both overlaps.

- Using a 50-percent overlap and the 4a motorcycle, contact was observed during two of the three trials, where impact speeds of 26.2 and 27.0 km/h (16.3 and 16.8 mph) occurred. Using the same test condition, but with an ABD motorcycle, contact was observed during the single test performed, where an impact speed of 21.3 km/h (13.2 mph) occurred.
- Using a 75-percent overlap and the 4a motorcycle, contact was observed during two of the three trials, where impact speeds of 3.1 and 18.0 km/h (1.9 and 11.2 mph) occurred. Using the same test condition, but with an ABD motorcycle, contact was observed during both tests performed, where impact speeds of 5.2 and 22.9 km/h (3.2 and 14.2 mph) occurred.

Due to the occurrence of impacts during Tesla Model 3 LVD trials performed with a 0.3g motorcycle POV deceleration, no tests were performed with the combination of a 80 km/h test speed, a 40 m headway, and a 0.5g motorcycle POV deceleration.

Table 5. LVS Crash Avoidance and Relative Impact Speed Summary (Bicycle POV; 50% Overlap)

Test Conditions	Trial #	2024 Subaru Crosstrek		2023 Toyota Corolla Hybrid		2024 Cadillac Lyriq		2024 Tesla Model 3	
		4a	ABD	4a	ABD	4a	ABD	4a	ABD
SV = 10 km/h POV = 0 km/h	1	CA	n/a	CA	n/a	CA	CA	CA	CA
	2	CA	n/a	CA	n/a	CA	CA	CA	CA
	3	CA	n/a	CA	n/a	--[2]	--[2]	--[2]	--[2]
	4	CA	n/a	CA	n/a	n/a			
	5	CA	n/a	CA	n/a				
SV = 20 km/h POV = 0 km/h	1	CA	n/a	CA	n/a	CA	CA	CA	CA
	2	CA	n/a	CA	n/a	CA	CA	2.0	CA
	3	CA	n/a	CA	n/a	--[2]	--[2]	5.9	--[2]
	4	CA	n/a	CA	n/a	n/a			
	5	CA	n/a	CA	n/a				
SV = 30 km/h POV = 0 km/h	1	CA	n/a	CA	n/a	CA	CA	--[1]	CA
	2	CA	n/a	CA	n/a	CA	CA	--[1]	CA
	3	CA	n/a	CA	n/a	--[2]	--[2]	--[1]	--[1]
	4	CA	n/a	CA	n/a	n/a			
	5	CA	n/a	CA	n/a				
SV = 40 km/h POV = 0 km/h	1	CA	n/a	CA	n/a	CA	CA	--[1]	CA
	2	CA	n/a	CA	n/a	CA	CA	--[1]	CA
	3	CA	n/a	CA	n/a	--[2]	--[2]	--[1]	--[1]
	4	CA	n/a	CA	n/a	n/a			
	5	CA	n/a	CA	n/a				
SV = 50 km/h POV = 0 km/h	1	CA	n/a	CA	n/a	CA	CA	--[1]	27.6
	2	CA	n/a	CA	n/a	CA	CA	--[1]	--[1]
	3	CA	n/a	CA	n/a	--[2]	--[2]	--[1]	--[1]
	4	CA	n/a	CA	n/a	n/a			
	5	CA	n/a	CA	n/a				
SV = 60 km/h POV = 0 km/h	1	CA	n/a	CA	n/a	CA	CA	--[1]	--[1]
	2	CA	n/a	CA	n/a	CA	9.4	--[1]	--[1]
	3	CA	n/a	CA	n/a	--[2]	5.8	--[1]	--[1]
	4	CA	n/a	CA	n/a	n/a			
	5	CA	n/a	CA	n/a				
SV = 70 km/h POV = 0 km/h	1	CA	n/a	CA	n/a	28.4	--[1]	--[1]	--[1]
	2	CA	n/a	CA	n/a	5.7	--[1]	--[1]	--[1]
	3	CA	n/a	CA	n/a	--[1]	--[1]	--[1]	--[1]
	4	CA	n/a	CA	n/a	n/a			
	5	CA	n/a	CA	n/a				
SV = 80 km/h POV = 0 km/h	1	24.9	n/a	3.0	n/a	--[1]	--[1]	--[1]	--[1]
	2	31.4	n/a	CA	n/a	--[1]	--[1]	--[1]	--[1]
	3	28.3	n/a	CA	n/a	--[1]	--[1]	--[1]	--[1]
	4	--[1]	n/a	CA	n/a	n/a			
	5	--[1]	n/a	CA	n/a				

[1]Test not performed due to previously observed SV-to-POV contact.
[2]No contact was observed during the first two test trials, so a third trial was not performed.
CA = Crash Avoidance.

Table 6. LVS Crash Avoidance and Relative Impact Speed Summary (Bicycle POV; 25% Overlap)

Test Conditions	Trial #	2024 Subaru Crosstrek		2023 Toyota Corolla Hybrid		2024 Cadillac Lyriq		2024 Tesla Model 3	
		4a	ABD	4a	ABD	4a	ABD	4a	ABD
SV = 10 km/h POV = 0 km/h	1	CA	n/a	CA	n/a	CA	CA	CA	CA
	2	CA	n/a	CA	n/a	CA	CA	CA	4.8[3]
	3	CA	n/a	CA	n/a	--[2]	--[2]	--[2]	6.3[3]
	4	CA	n/a	CA	n/a	n/a			
	5	CA	n/a	CA	n/a				
SV = 20 km/h POV = 0 km/h	1	CA	n/a	CA	n/a	CA	CA	8.1	0.3
	2	CA	n/a	CA	n/a	CA	CA	10.0	CA
	3	CA	n/a	CA	n/a	--[2]	--[2]	--[1]	CA
	4	CA	n/a	CA	n/a	- n/a			
	5	CA	n/a	CA	n/a				
SV = 30 km/h POV = 0 km/h	1	CA	n/a	CA	n/a	CA	CA	--[1]	18.4
	2	CA	n/a	CA	n/a	CA	CA	--[1]	--[1]
	3	CA	n/a	CA	n/a	--[2]	--[2]	--[1]	--[1]
	4	CA	n/a	CA	n/a	n/a			
	5	CA	n/a	CA	n/a				
SV = 40 km/h POV = 0 km/h	1	CA	n/a	CA	n/a	CA	CA	--[1]	--[1]
	2	CA	n/a	CA	n/a	CA	CA	--[1]	--[1]
	3	CA	n/a	CA	n/a	--[2]	--[2]	--[1]	--[1]
	4	CA	n/a	CA	n/a	n/a			
	5	CA	n/a	CA	n/a				
SV = 50 km/h POV = 0 km/h	1	CA	n/a	CA	n/a	CA	CA	--[1]	--[1]
	2	CA	n/a	CA	n/a	CA	CA	--[1]	--[1]
	3	CA	n/a	CA	n/a	--[2]	--[2]	--[1]	--[1]
	4	CA	n/a	CA	n/a	n/a			
	5	CA	n/a	CA	n/a				
SV = 60 km/h POV = 0 km/h	1	CA	n/a	CA	n/a	CA	CA	--[1]	--[1]
	2	CA	n/a	CA	n/a	CA	CA	--[1]	--[1]
	3	CA	n/a	CA	n/a	--[2]	--[2]	--[1]	--[1]
	4	CA	n/a	CA	n/a	n/a			
	5	CA	n/a	CA	n/a				
SV = 70 km/h POV = 0 km/h	1	CA	n/a	CA	n/a	9.0	CA	--[1]	--[1]
	2	CA	n/a	CA	n/a	CA	CA	--[1]	--[1]
	3	9.4	n/a	CA	n/a	CA	--[2]	--[1]	--[1]
	4	CA	n/a	CA	n/a	n/a			
	5	7.8	n/a	CA	n/a				
SV = 80 km/h POV = 0 km/h	1	29.7	n/a	10.0	n/a	49.4	41.8	--[1]	--[1]
	2	29.2	n/a	8.5	n/a	--[1]	--[1]	--[1]	--[1]
	3	37.9	n/a	CA	n/a	--[1]	--[1]	--[1]	--[1]
	4	--[1]	n/a	CA	n/a	n/a			
	5	--[1]	n/a	CA	n/a				

[1]Test not performed due to previously observed SV-to-POV contact.

[2]No contact was observed during the first two test trials, so a third trial was not performed.

[3]SV deceleration did not meet or exceed 0.25g during this trial.

CA = Crash Avoidance.

Table 7. LVM Crash Avoidance and Relative Impact Speed Summary (Bicycle POV; 50% Overlap)

Test Conditions	Trial #	2024 Subaru Crosstrek		2023 Toyota Corolla Hybrid		2024 Cadillac Lyriq		2024 Tesla Model 3	
		4a	ABD	4a	ABD	4a	ABD	4a	ABD
SV = 40 km/h POV = 20 km/h	1	CA	n/a	CA	n/a	CA	CA	CA	CA
	2	CA	n/a	CA	n/a	CA	CA	CA[3]	CA[3]
	3	CA	n/a	CA	n/a	--[2]	--[2]	--[2]	--[2]
	4	CA	n/a	CA	n/a	n/a			
	5	CA	n/a	CA	n/a				
SV = 50 km/h POV = 20 km/h	1	CA	n/a	CA	n/a	CA	CA	CA	CA
	2	CA	n/a	CA	n/a	CA	CA	CA	CA
	3	CA	n/a	CA	n/a	--[2]	--[2]	--[2]	--[2]
	4	CA	n/a	CA	n/a	n/a			
	5	CA	n/a	CA	n/a				
SV = 60 km/h POV = 20 km/h	1	CA	n/a	CA	n/a	CA	CA	CA	CA
	2	CA	n/a	CA	n/a	CA	CA	CA	CA
	3	CA	n/a	CA	n/a	--[2]	--[2]	--[2]	--[2]
	4	CA	n/a	CA	n/a	n/a			
	5	CA	n/a	CA	n/a				
SV = 70 km/h POV = 20 km/h	1	CA	n/a	CA	n/a	CA	CA	13.9	CA
	2	CA	n/a	CA	n/a	CA	CA	7.6	CA
	3	CA	n/a	CA	n/a	--[2]	--[2]	--[1]	--[2]
	4	CA	n/a	CA	n/a	n/a			
	5	CA	n/a	CA	n/a				
SV = 80 km/h POV = 20 km/h	1	CA	n/a	CA	n/a	CA	CA	--[1]	14.8
	2	CA	n/a	CA	n/a	CA	CA	--[1]	18.8
	3	CA	n/a	CA	n/a	--[2]	--[2]	--[1]	--[1]
	4	CA	n/a	CA	n/a	n/a			
	5	CA	n/a	CA	n/a				

[1]Test not performed due to previously observed SV-to-POV contact.

[2]No contact was observed during the first two test trials, so a third trial was not performed.

[3]SV deceleration did not meet or exceed 0.25g during this trial.

CA = Crash Avoidance.

Table 8. LVM Crash Avoidance and Relative Impact Speed Summary (Bicycle POV; 25% Overlap)

Test Conditions	Trial #	2024 Subaru Crosstrek		2023 Toyota Corolla Hybrid		2024 Cadillac Lyriq		2024 Tesla Model 3	
		4a	ABD	4a	ABD	4a	ABD	4a	ABD
SV = 40 km/h POV = 20 km/h	1	CA	n/a	CA	n/a	CA	CA	CA	CA
	2	CA	n/a	CA	n/a	CA	CA	CA[3]	CA[3]
	3	CA	n/a	CA	n/a	--[2]	--[2]	--[2]	--[2]
	4	CA	n/a	CA	n/a	n/a			
	5	CA	n/a	CA	n/a				
SV = 50 km/h POV = 20 km/h	1	CA	n/a	CA	n/a	CA	CA	CA	CA
	2	CA	n/a	CA	n/a	CA	CA	CA	CA[3]
	3	CA	n/a	CA	n/a	--[2]	--[2]	--[2]	--[2]
	4	CA	n/a	CA	n/a	n/a			
	5	CA	n/a	CA	n/a				
SV = 60 km/h POV = 20 km/h	1	CA	n/a	CA	n/a	CA	CA	CA	CA
	2	CA	n/a	CA	n/a	CA	CA	CA	CA[3]
	3	CA	n/a	CA	n/a	--[2]	--[2]	--[2]	--[2]
	4	CA	n/a	CA	n/a	n/a			
	5	CA	n/a	CA	n/a				
SV = 70 km/h POV = 20 km/h	1	CA	n/a	CA	n/a	CA	CA	17.7	6.0
	2	CA	n/a	CA	n/a	CA	CA	22.8	12.0
	3	CA	n/a	CA	n/a	--[2]	--[2]	--[1]	--[1]
	4	CA	n/a	CA	n/a	n/a			
	5	CA	n/a	CA	n/a				
SV = 80 km/h POV = 20 km/h	1	CA	n/a	CA	n/a	CA	CA	--[1]	--[1]
	2	CA	n/a	CA	n/a	CA	CA	--[1]	--[1]
	3	CA	n/a	CA	n/a	--[2]	--[2]	--[1]	--[1]
	4	CA	n/a	CA	n/a	n/a			
	5	CA	n/a	CA	n/a				

[1]Test not performed due to previously observed SV-to-POV contact.

[2]No contact was observed during the first two test trials, so a third trial was not performed.

[3]SV deceleration did not meet or exceed 0.25g during this trial.

CA = Crash Avoidance.

Table 9. LVD Crash Avoidance and Relative Impact Speed Summary (Bicycle POV; 50% Overlap)

Test Conditions	Trial #	2024 Subaru Crosstrek		2023 Toyota Corolla Hybrid		2024 Cadillac Lyriq		2024 Tesla Model 3	
		4a	ABD	4a	ABD	4a	ABD	4a	ABD
SV = 20 km/h POV = 20 km/h POV decel = 0.3g SV-to-POV headway = 12 m	1	CA	n/a	CA	n/a	CA	CA	CA	CA
	2	CA	n/a	CA	n/a	CA	CA	CA	5.1
	3	CA	n/a	CA	n/a	--[2]	--[2]	--[2]	6.0
	4	CA	n/a	CA	n/a	n/a			
	5	CA	n/a	CA	n/a				
SV = 30 km/h POV = 30 km/h POV decel = 0.3g SV-to-POV headway = 12 m	1	CA	n/a	CA	n/a	CA	CA	CA	CA
	2	CA	n/a	CA	n/a	19.2	CA	CA	CA
	3	CA	n/a	CA	n/a	18.0	--[2]	--[2]	--[2]
	4	CA	n/a	CA	n/a	n/a			
	5	CA	n/a	CA	n/a				
SV = 20 km/h POV = 20 km/h POV decel = 0.3g SV-to-POV headway = 40 m	1	CA	n/a	CA	n/a	CA	CA	CA	CA
	2	CA	n/a	CA	n/a	CA	CA	CA	CA
	3	CA	n/a	CA	n/a	--[2]	--[2]	--[2]	--[2]
	4	CA	n/a	CA	n/a	n/a			
	5	CA	n/a	CA	n/a				
SV = 30 km/h POV = 30 km/h POV decel = 0.3g SV-to-POV headway = 40 m	1	CA	n/a	CA	n/a	CA	CA	CA	CA
	2	CA	n/a	CA	n/a	CA	CA	CA	CA
	3	CA	n/a	CA	n/a	--[2]	--[2]	--[2]	--[2]
	4	CA	n/a	CA	n/a	n/a			
	5	CA	n/a	CA	n/a				

[1]Test not performed due to previously observed SV-to-POV contact.

[2]No contact was observed during the first two test trials, so a third trial was not performed.

CA = Crash Avoidance.

Table 10. LVD Crash Avoidance and Relative Impact Speed Summary (Bicycle POV; 25% Overlap)

Test Conditions	Trial #	2024 Subaru Crosstrek		2023 Toyota Corolla Hybrid		2024 Cadillac Lyriq		2024 Tesla Model 3	
		4a	ABD	4a	ABD	4a	ABD	4a	ABD
SV = 20 km/h POV = 20 km/h POV decel = 0.3g SV-to-POV headway = 12 m	1	CA	n/a	CA	n/a	CA	CA	7.2	9.9
	2	CA	n/a	CA	n/a	CA	CA	6.3	9.4
	3	CA	n/a	CA	n/a	--[2]	--[2]	--[1]	--[1]
	4	CA	n/a	CA	n/a	n/a			
	5	CA	n/a	CA	n/a				
SV = 30 km/h POV = 30 km/h POV decel = 0.3g SV-to-POV headway = 12 m	1	CA	n/a	CA	n/a	8.7	CA	CA	CA
	2	CA	n/a	CA	n/a	CA	CA	CA	CA
	3	CA	n/a	CA	n/a	CA	--[2]	--[2]	--[2]
	4	CA	n/a	CA	n/a	n/a			
	5	CA	n/a	CA	n/a				
SV = 20 km/h POV = 20 km/h POV decel = 0.3g SV-to-POV headway = 40 m	1	CA	n/a	CA	n/a	CA	CA	CA	CA
	2	CA	n/a	CA	n/a	CA	CA	CA	CA
	3	CA	n/a	CA	n/a	--[2]	--[2]	--[2]	--[2]
	4	CA	n/a	CA	n/a	n/a			
	5	CA	n/a	CA	n/a				
SV = 30 km/h POV = 30 km/h POV decel = 0.3g SV-to-POV headway = 40 m	1	CA	n/a	CA	n/a	CA	CA	CA	CA
	2	CA	n/a	CA	n/a	CA	CA	CA	CA
	3	CA	n/a	CA	n/a	--[2]	--[2]	--[2]	--[2]
	4	CA	n/a	CA	n/a	n/a			
	5	CA	n/a	CA	n/a				

[1]Test not performed due to previously observed SV-to-POV contact.

[2]No contact was observed during the first two test trials, so a third trial was not performed.

CA = Crash Avoidance.

Table 11. LVS Crash Avoidance and Relative Impact Speed Summary (Motorcycle POV; 50% Overlap)

Test Conditions	Trial #	2024 Subaru Crosstrek		2023 Toyota Corolla Hybrid		2024 Cadillac Lyriq		2024 Tesla Model 3	
		4a	ABD	4a	ABD	4a	ABD	4a	ABD
SV = 10 km/h POV = 0 km/h	1	CA	CA	CA	CA	CA	CA	CA	CA
	2	CA	CA	CA	CA	CA	3.2	CA	CA
	3	CA	CA	CA	CA	--[2]	CA	--[2]	--[2]
	4	CA	CA	CA	CA	n/a			
	5	CA	CA	CA	CA				
SV = 20 km/h POV = 0 km/h	1	CA	CA	CA	CA	CA	CA	CA	CA
	2	CA	CA	CA	CA	CA	CA	CA	CA
	3	CA	CA	CA	CA	--[2]	--[2]	--[2]	--[2]
	4	CA	CA	CA	CA	n/a			
	5	CA	CA	CA	CA				
SV = 30 km/h POV = 0 km/h	1	CA	CA	CA	CA	CA	CA	CA	7.4
	2	CA	CA	CA	CA	CA	CA	8.0	8.2
	3	CA	CA	CA	CA	--[2]	--[2]	CA	--[1]
	4	CA	CA	CA	CA	n/a			
	5	CA	CA	CA	CA				
SV = 40 km/h POV = 0 km/h	1	CA	CA	CA	CA	CA	CA	8.0	--[1]
	2	CA	CA	CA	CA	CA	CA	16.5	--[1]
	3	CA	CA	CA	CA	--[2]	--[2]	--[1]	--[1]
	4	CA	CA	CA	CA	n/a			
	5	CA	CA	CA	CA				
SV = 50 km/h POV = 0 km/h	1	CA	CA	CA	CA	CA	CA	--[1]	--[1]
	2	CA	CA	CA	CA	CA	CA	--[1]	--[1]
	3	CA	CA	CA	CA	--[2]	--[2]	--[1]	--[1]
	4	CA	CA	CA	CA	n/a			
	5	CA	CA	CA	CA				
SV = 60 km/h POV = 0 km/h	1	CA	CA	CA	CA	CA	CA	--[1]	--[1]
	2	CA	CA	CA	CA	CA	CA	--[1]	--[1]
	3	CA	CA	CA	CA	--[2]	--[2]	--[1]	--[1]
	4	CA	CA	CA	CA	n/a			
	5	CA	CA	CA	CA				
SV = 70 km/h POV = 0 km/h	1	8.5	17.5	CA	CA	CA	CA	--[1]	--[1]
	2	CA	5.6	CA	CA	CA	CA	--[1]	--[1]
	3	11.6	13.2	CA	CA	--[2]	--[2]	--[1]	--[1]
	4	16.0	--[1]	CA	CA	n/a			
	5	--[1]	--[1]	CA	CA				
SV = 80 km/h POV = 0 km/h	1	--[1]	--[1]	CA	22.4	13.6	CA	--[1]	--[1]
	2	--[1]	--[1]	31.6	CA	CA	CA	--[1]	--[1]
	3	--[1]	--[1]	2.3	CA	CA	--[2]	--[1]	--[1]
	4	--[1]	--[1]	6.2	CA	n/a			
	5	--[1]	--[1]	--[1]	CA				

[1]Test not performed due to previously observed SV-to-POV contact.

[2]No contact was observed during the first two test trials, so a third trial was not performed.

CA = Crash Avoidance.

Table 12. LVS Crash Avoidance and Relative Impact Speed Summary (Motorcycle POV; 75% Overlap)

Test Conditions	Trial #	2024 Subaru Crosstrek		2023 Toyota Corolla Hybrid		2024 Cadillac Lyriq		2024 Tesla Model 3	
		4a	ABD	4a	ABD	4a	ABD	4a	ABD
SV = 10 km/h POV = 0 km/h	1	10.4[3]	CA	CA	CA	CA	CA	CA	CA
	2	10.7[3]	CA	CA	CA	CA	CA	CA	CA
	3	9.8[3]	CA	CA	CA	--[2]	--[2]	--[2]	--[2]
	4	--[1]	CA	CA	CA	n/a			
	5	--[1]	CA	CA	CA				
SV = 20 km/h POV = 0 km/h	1	CA	CA	CA	CA	CA	CA	CA	CA
	2	CA	CA	CA	CA	CA	CA	CA	CA
	3	CA	CA	CA	CA	--[2]	--[2]	--[2]	--[2]
	4	CA	CA	CA	CA	n/a			
	5	CA	CA	CA	CA				
SV = 30 km/h POV = 0 km/h	1	CA	CA	CA	CA	CA	CA	CA	14.4
	2	CA	CA	CA	CA	CA	CA	11.4	12.7
	3	CA	CA	CA	CA	--[2]	--[2]	1.2	--[1]
	4	CA	CA	CA	CA	n/a			
	5	CA	CA	CA	CA				
SV = 40 km/h POV = 0 km/h	1	CA	CA	CA	CA	CA	CA	--[1]	--[1]
	2	CA	CA	CA	CA	CA	CA	--[1]	--[1]
	3	CA	CA	CA	CA	--[2]	--[2]	--[1]	--[1]
	4	CA	CA	CA	CA	n/a			
	5	CA	CA	CA	CA				
SV = 50 km/h POV = 0 km/h	1	CA	CA	CA	CA	CA	CA	--[1]	--[1]
	2	CA	CA	CA	CA	CA	CA	--[1]	--[1]
	3	CA	CA	CA	CA	--[2]	--[2]	--[1]	--[1]
	4	CA	CA	CA	CA	n/a			
	5	CA	CA	CA	CA				
SV = 60 km/h POV = 0 km/h	1	CA	CA	CA	CA	25.9	CA	--[1]	--[1]
	2	CA	CA	CA	CA	CA	CA	--[1]	--[1]
	3	CA	CA	CA	CA	CA	--[2]	--[1]	--[1]
	4	CA	CA	CA	CA	n/a			
	5	CA	CA	CA	CA				
SV = 70 km/h POV = 0 km/h	1	15.9	16.2	CA	CA	CA	CA	--[1]	--[1]
	2	16.6	8.5	CA	CA	29.1	CA	--[1]	--[1]
	3	14.4	12.6	CA	CA	CA	--[2]	--[1]	--[1]
	4	--[1]	--[1]	CA	CA	n/a			
	5	--[1]	--[1]	CA	CA				
SV = 80 km/h POV = 0 km/h	1	--[1]	--[1]	16.8	22.1	14.9	CA	--[1]	--[1]
	2	--[1]	--[1]	17.3	14.1	CA	3.9	--[1]	--[1]
	3	--[1]	--[1]	12.3	12.2	5.0	CA	--[1]	--[1]
	4	--[1]	--[1]	--[1]	--[1]	n/a			
	5	--[1]	--[1]	--[1]	--[1]				

[1]Test not performed due to previously observed SV-to-POV contact.

[2]No contact was observed during the first two test trials, so a third trial was not performed.

[3]SV deceleration did not meet or exceed 0.25g during this trial.

CA = Crash Avoidance.

Table 13. LVM Crash Avoidance and Relative Impact Speed Summary (Motorcycle POV; 50% Overlap)

Test Conditions	Trial #	2024 Subaru Crosstrek		2023 Toyota Corolla Hybrid		2024 Cadillac Lyriq		2024 Tesla Model 3	
		4a	ABD	4a	ABD	4a	ABD	4a	ABD
SV = 40 km/h POV = 20 km/h	1	CA	CA	CA	CA	CA	CA	CA[3]	CA
	2	CA	CA	CA	CA	CA	CA	CA	CA[3]
	3	CA	CA	CA	CA	--[2]	--[2]	--[2]	--[2]
	4	CA	CA	CA	CA	n/a			
	5	CA	CA	CA	CA				
SV = 50 km/h POV = 20 km/h	1	CA	CA	CA	CA	CA	CA	CA	CA[3]
	2	CA	CA	CA	CA	CA	CA	CA	CA
	3	CA	CA	CA	CA	--[2]	--[2]	--[2]	--[2]
	4	CA	CA	CA	CA	n/a			
	5	CA	CA	CA	CA				
SV = 60 km/h POV = 20 km/h	1	CA	CA	CA	CA	CA	CA	CA	CA
	2	CA	CA	CA	CA	CA	CA	CA	CA
	3	CA	CA	CA	CA	--[2]	--[2]	--[2]	--[2]
	4	CA	CA	CA	CA	n/a			
	5	CA	CA	CA	CA				
SV = 70 km/h POV = 20 km/h	1	CA	CA	CA	CA	CA	CA	11.8	11.3
	2	CA	CA	CA	CA	CA	CA	21.6	CA
	3	CA	CA	CA	CA	--[2]	--[2]	--[1]	7.3
	4	CA	CA	CA	CA	n/a			
	5	CA	CA	CA	CA				
SV = 80 km/h POV = 20 km/h	1	CA	CA	CA	CA	CA	CA	--[1]	--[1]
	2	CA	CA	CA	CA	CA	CA	--[1]	--[1]
	3	CA	CA	CA	CA	--[2]	--[2]	--[1]	--[1]
	4	CA	CA	CA	CA	n/a			
	5	CA	CA	CA	CA				

[1]Test not performed due to previously observed SV-to-POV contact.

[2]No contact was observed during the first two test trials, so a third trial was not performed.

[3]SV deceleration did not meet or exceed 0.25g during this trial.

CA = Crash Avoidance.

Table 14. LVM Crash Avoidance and Relative Impact Speed Summary (Motorcycle POV; 75% Overlap)

Test Conditions	Trial #	2024 Subaru Crosstrek		2023 Toyota Corolla Hybrid		2024 Cadillac Lyriq		2024 Tesla Model 3	
		4a	ABD	4a	ABD	4a	ABD	4a	ABD
SV = 40 km/h POV = 20 km/h	1	CA	CA	CA	CA	CA	CA	CA[3]	CA
	2	CA	CA	CA	CA	CA	CA	CA[3]	CA
	3	CA	CA	CA	CA	--[2]	--[2]	--[2]	--[2]
	4	CA	CA	CA	CA	n/a			
	5	CA	CA	CA	CA				
SV = 50 km/h POV = 20 km/h	1	CA	CA	CA	CA	CA	CA	CA	CA
	2	CA	CA	CA	CA	CA	CA	CA	CA
	3	CA	CA	CA	CA	--[2]	--[2]	--[2]	--[2]
	4	CA	CA	CA	CA	n/a			
	5	CA	CA	CA	CA				
SV = 60 km/h POV = 20 km/h	1	CA	CA	CA	CA	CA	CA	CA	CA
	2	CA	CA	CA	CA	CA	CA	CA	CA
	3	CA	CA	CA	CA	--[2]	--[2]	--[2]	--[2]
	4	CA	CA	CA	CA	n/a			
	5	CA	CA	CA	CA				
SV = 70 km/h POV = 20 km/h	1	CA	CA	CA	CA	CA	CA	CA	14.2
	2	CA	CA	CA	CA	CA	CA	10.6	19.4
	3	CA	CA	CA	CA	--[2]	--[2]	CA	--[1]
	4	CA	CA	CA	CA	n/a			
	5	CA	CA	CA	CA				
SV = 80 km/h POV = 20 km/h	1	CA	CA	CA	CA	CA	CA	28.5	--[1]
	2	CA	CA	CA	CA	CA	CA	26.4	--[1]
	3	CA	CA	CA	CA	--[2]	--[2]	--[1]	--[1]
	4	CA	CA	CA	CA	n/a			
	5	CA	CA	CA	CA				

[1]Test not performed due to previously observed SV-to-POV contact.

[2]No contact was observed during the first two test trials, so a third trial was not performed.

[3]SV deceleration did not meet or exceed 0.25g during this trial.

CA = Crash Avoidance.

Table 15. 50 km/h LVD Crash Avoidance and Relative Impact Speed Summary (Motorcycle POV; 50% Overlap)

Test Conditions	Trial #	2024 Subaru Crosstrek		2023 Toyota Corolla Hybrid		2024 Cadillac Lyriq		2024 Tesla Model 3	
		4a	ABD	4a	ABD	4a	ABD	4a	ABD
SV = 50 km/h POV = 50 km/h POV decel = 0.3g SV-to-POV headway = 12 m	1	8.3	9.7	CA	9.3	CA	3.4	CA	CA
	2	11.1	9.8	CA	21.8	CA	CA	CA	CA
	3	9.0	8.9	CA	CA	--[2]	CA	--[2]	--[2]
	4	--[1]	--[1]	CA	8.6	n/a			
	5	--[1]	--[1]	CA	--[1]				
SV = 50 km/h POV = 50 km/h POV decel = 0.5g SV-to-POV headway = 12 m	1	--[1]	--[1]	CA	--[1]	15.8	24.7	13.6	16.6
	2	--[1]	--[1]	CA	--[1]	15.8	--[1]	20.7	10.7
	3	--[1]	--[1]	CA	--[1]	--[1]	--[1]	--[1]	--[1]
	4	--[1]	--[1]	CA	--[1]	n/a			
	5	--[1]	--[1]	CA	--[1]				
SV = 50 km/h POV = 50 km/h POV decel = 0.3g SV-to-POV headway = 40 m	1	CA	CA	CA	CA	CA	CA	14.6	32.9
	2	CA	CA	CA	CA	CA	CA	31.3	--[1]
	3	CA	CA	CA	CA	--[2]	--[2]	--[1]	--[1]
	4	CA	CA	CA	CA	n/a			
	5	CA	CA	CA	47.5[3]				
SV = 50 km/h POV = 50 km/h POV decel = 0.5g SV-to-POV headway = 40 m	1	CA	CA	CA	CA	CA	CA	--[1]	--[1]
	2	CA	CA	CA	CA	CA	CA	--[1]	--[1]
	3	CA	CA	CA	48.5[3]	--[2]	--[2]	--[1]	--[1]
	4	CA	CA	CA	47.8	n/a			
	5	CA	CA	CA	48.0[3]				

[1]Test not performed due to previously observed SV-to-POV contact.

[2]No contact was observed during the first two test trials, so a third trial was not performed.

[3]SV deceleration did not meet or exceed 0.25g during this trial.

CA = Crash Avoidance.

Table 16. 50 km/h LVD Crash Avoidance and Relative Impact Speed Summary (Motorcycle POV; 75% Overlap)

Test Conditions	Trial #	2024 Subaru Crosstrek		2023 Toyota Corolla Hybrid		2024 Cadillac Lyriq		2024 Tesla Model 3	
		4a	ABD	4a	ABD	4a	ABD	4a	ABD
SV = 50 km/h POV = 50 km/h POV decel = 0.3g SV-to-POV headway = 12 m	1	5.1	10.9	CA	CA	CA	CA	CA	CA
	2	4.8	CA	CA	CA	CA	CA	CA	CA
	3	9.4	10.9	CA	CA	--[2]	--[2]	--[2]	--[2]
	4	--[1]	12.7	CA	11.8	n/a			
	5	--[1]	--[1]	CA	28.4[3]				
SV = 50 km/h POV = 50 km/h POV decel = 0.5g SV-to-POV headway = 12 m	1	--[1]	--[1]	CA	37.9[3]	17.5	18.2	26.0	0.3
	2	--[1]	--[1]	8.6	--[1]	15.8	18.5	--[1]	12.5
	3	--[1]	--[1]	CA	--[1]	--[1]	--[1]	--[1]	--[1]
	4	--[1]	--[1]	CA	--[1]	n/a			
	5	--[1]	--[1]	CA	--[1]				
SV = 50 km/h POV = 50 km/h POV decel = 0.3g SV-to-POV headway = 40 m	1	CA	CA	CA	CA	CA	CA	38.1	36.9
	2	CA	CA	CA	CA	CA	CA	--[1]	--[1]
	3	CA	CA	CA	CA	--[2]	--[2]	--[1]	--[1]
	4	CA	CA	CA	CA	n/a			
	5	CA	CA	CA	CA				
SV = 50 km/h POV = 50 km/h POV decel = 0.5g SV-to-POV headway = 40 m	1	CA	CA	CA	49.4	CA	CA	--[1]	--[1]
	2	CA	CA	CA	--[1]	CA	CA	--[1]	--[1]
	3	CA	CA	CA	--[1]	--[2]	--[2]	--[1]	--[1]
	4	CA	CA	CA	--[1]	n/a			
	5	CA	CA	CA	--[1]				

[1]Test not performed due to previously observed SV-to-POV contact.

[2]No contact was observed during the first two test trials, so a third trial was not performed.

[3]SV deceleration did not meet or exceed 0.25g during this trial.

CA = Crash Avoidance.

Table 17. 80 km/h LVD Crash Avoidance and Relative Impact Speed Summary (Motorcycle POV; 50% Overlap)

Test Conditions	Trial #	2024 Subaru Crosstrek		2023 Toyota Corolla Hybrid		2024 Cadillac Lyriq		2024 Tesla Model 3	
		4a	ABD	4a	ABD	4a	ABD	4a	ABD
SV = 80 km/h POV = 80 km/h POV decel = 0.3g SV-to-POV headway = 12 m	1	13.9	10.4	CA	9.5	CA	CA	11.2	11.3
	2	CA	15.5	CA	16.3	CA	CA	--[1]	--[1]
	3	CA	15.0	CA	6.3	--[2]	--[2]	--[1]	--[1]
	4	CA	--[1]	15.6	--[1]	n/a			
	5	CA	--[1]	CA	--[1]				
SV = 80 km/h POV = 80 km/h POV decel = 0.5g SV-to-POV headway = 12 m	1	17.6	--[1]	CA	--[1]	11.8	14.2	--[1]	--[1]
	2	14.4	--[1]	CA	--[1]	--[1]	--[1]	--[1]	--[1]
	3	16.7	--[1]	CA	--[1]	--[1]	--[1]	--[1]	--[1]
	4	--[1]	--[1]	CA	--[1]	n/a			
	5	--[1]	--[1]	2.7	--[1]				
SV = 80 km/h POV = 80 km/h POV decel = 0.3g SV-to-POV headway = 40 m	1	CA	10.0	CA	CA	CA	CA	CA	21.3
	2	11.0	17.4	CA	23.1	CA	CA	27.0	--[1]
	3	10.5	3.9	CA	CA	--[2]	--[2]	26.2	--[1]
	4	CA	--[1]	CA	18.8	n/a			
	5	CA	--[1]	CA	6.4				
SV = 80 km/h POV = 80 km/h POV decel = 0.5g SV-to-POV headway = 40 m	1	24.4	--[1]	28.3	--[1]	CA	CA	--[1]	--[1]
	2	27.2	--[1]	17.5	--[1]	CA	2.4	--[1]	--[1]
	3	22.7	--[1]	21.6	--[1]	--[2]	5.7	--[1]	--[1]
	4	--[1]	--[1]	--[1]	--[1]	n/a			
	5	--[1]	--[1]	--[1]	--[1]				

[1]Test not performed due to previously observed SV-to-POV contact.

[2]No contact was observed during the first two test trials, so a third trial was not performed.

CA = Crash Avoidance.

Table 18. 80 km/h LVD Crash Avoidance and Relative Impact Speed Summary (Motorcycle POV; 75% Overlap)

Test Conditions	Trial #	2024 Subaru Crosstrek		2023 Toyota Corolla Hybrid		2024 Cadillac Lyriq		2024 Tesla Model 3	
		4a	ABD	4a	ABD	4a	ABD	4a	ABD
SV = 80 km/h POV = 80 km/h POV decel = 0.3g SV-to-POV headway = 12 m	1	CA	14.7	CA	14.3[4]	CA	CA	CA	CA
	2	15.3	--[1]	CA	5.1[4]	CA	CA	CA	CA
	3	CA	--[1]	CA	--[1]	--[2]	--[2]	--[2]	--[2]
	4	12.4	--[1]	CA	--[1]	n/a			
	5	13.6	--[1]	CA	--[1]				
SV = 80 km/h POV = 80 km/h POV decel = 0.5g SV-to-POV headway = 12 m	1	--[1]	--[1]	4.3	--[1]	14.6	18.5	17.3	13.2
	2	--[1]	--[1]	CA	--[1]	--[1]	--[1]	--[1]	--[1]
	3	--[1]	--[1]	3.4	--[1]	--[1]	--[1]	--[1]	--[1]
	4	--[1]	--[1]	4.6	--[1]	n/a			
	5	--[1]	--[1]	--[1]	--[1]				
SV = 80 km/h POV = 80 km/h POV decel = 0.3g SV-to-POV headway = 40 m	1	3.7	10.4	CA	CA	CA	CA	18.0	5.2
	2	CA	8.4	CA	CA	CA	CA	CA	22.9
	3	CA	9.3	CA	--[4]	--[2]	--[2]	3.1	--[1]
	4	6.8	--[1]	CA	--[4]	n/a			
	5	14.9	--[1]	CA	--[4]				
SV = 80 km/h POV = 80 km/h POV decel = 0.5g SV-to-POV headway = 40 m	1	--[1]	--[1]	26.2	26.4	CA	CA	--[1]	--[1]
	2	--[1]	--[1]	35.4	69.7[3]	CA	CA	--[1]	--[1]
	3	--[1]	--[1]	25.6	--[1]	--[2]	--[2]	--[1]	--[1]
	4	--[1]	--[1]	--[1]	--[1]	n/a			
	5	--[1]	--[1]	--[1]	--[1]				

[1]Test not performed due to previously observed SV-to-POV contact.

[2]No contact was observed during the first two test trials, so a third trial was not performed.

[3]SV deceleration did not meet or exceed 0.25g during this trial.

[4]Only two repeated trials were performed (rather than 3) due to a testing oversight.

CA = Crash Avoidance.

Effect of Test Surrogate

For the four vehicles evaluated in this study, there was no consistent indication that the ability of an SV to avoid contact with the POV depended on what motorcycle surrogate make was used. This was also true for the two vehicles evaluated with both bicycle surrogate makes. Rather, when differences were observed, they appeared to relate to specific combinations of SV and test condition for unknown reasons. The following sections highlight some of these differences.

Bicycle POV

4a and ABD bicycles were used for tests performed with the Cadillac Lyric and Tesla Model 3. The Subaru Crosstrek and Toyota Corolla were only evaluated with the 4a bicycle.

The largest difference in avoidance performance was observed during LVS tests performed with a 50-percent overlap and the Tesla Model 3. When the ABD bicycle was used, no contact occurred during each trial performed with test speeds from 10 to 40 km/h. However, with the 4a bicycle, contact occurred during two of three tests performed with the 20 km/h test speed, after which no additional trials were performed.

Conversely, when the LVS tests were performed with the 25-percent overlap and Tesla Model 3, contact with two of three 10 km/h tests occurred with the ABD bicycle, but not for the 4a bicycle. Moving to the 20 km/h test speed produced contact during both trials performed with the 4a bicycle, but only during one of three trials performed with the ABD bicycle.

During LVM testing performed with a 50-percent overlap, the Tesla Model 3 avoided contact with the ABD bicycle during each trial performed with SV test speeds from 40 to 70 km/h. Contact was made during both trials performed with an SV test speed of 80 km/h. Using the 4a bicycle, Tesla Model 3 avoided contact during each trial performed with SV test speeds from 40 to 60 km/h. Contact was made during both trials performed with an SV test speed of 70 km/h.

For the LVD scenario tests performed with the Tesla Model 3, two of the three trials using a 20 km/h test speed, 12 m headway, and a 0.3g POV deceleration struck the ABD bicycle, but no contact was observed during the same tests using a 4a bicycle.

Conversely, for the LVD scenario tests performed with the Cadillac Lyric, two of the three trials using a 30 km/h test speed, 12 m headway, and a 0.3g POV deceleration struck the 4a bicycle, but no contact was observed during the same tests using a ABD bicycle.

Motorcycle POV

The 4a and ABD motorcycles were used for tests performed with each SV. In the LVS test condition, some SVs experienced more impacts with the 4a versus ABD motorcycle. Some notable examples include the following:

- With the Subaru Crosstrek, three instances of contact were observed during tests performed from 10 km/h using and a 75-percent overlap, but no impacts were observed with the ABD motorcycle. However, this trend was not observed during tests performed with a 50-percent overlap the same test speed, where no contact with either motorcycle surrogate make occurred.
- With the combination of an 80 km/h test speed and a 50-percent overlap, the Toyota Corolla struck the 4a motorcycle three times versus once with the ABD motorcycle.

That said, two of the impacts with the 4a motorcycle occurred at low speeds (2.3 and 6.2 km/h, or 1.4 and 3.9 mph), and the impact speed associated with single instance of contact made with the ABD motorcycle was significantly greater (22.4 km/h or 13.9 mph). Given the similarity of the test outcomes and range of impact speeds, it is not possible to determine if the surrogate make was responsible for the number of impacts observed per surrogate, or if the result was due to a combination of test-to-test variability (with unknown origin) and a small sample size. Furthermore, with the combination of an 80 km/h test speed and a 75-percent overlap, the Toyota Corolla struck each surrogate make three times and the range of impact speeds observed for tests performed with the 4a motorcycle was completely within the range of impact speeds observed for tests performed with the ABD motorcycle.

However, for some other combinations of SV and test condition more frequent and/or consistent impacts were observed with the ABD versus 4a motorcycle.

- Contact occurred during both LVS trials performed with the Tesla Model 3, a 30 km/h test speed and the ABD motorcycle, for both overlaps. For these test conditions, some instances of crash avoidance occurred during trials performed with the 4a motorcycle, and in the case of the 50-percent overlap, this allowed for conduct of the next test speed increment to 40 km/h; a test speed not used with the 75-percent overlap.
- A similar phenomenon occurred during Tesla Model 3 LVM tests performed with the 75-percent overlap; since two of the three trials performed with the 4a motorcycle and an SV speed of 70 km/h resulted in no contact, tests with the next test speed increment of 80 km/h were performed.
- For the Toyota Corolla, no contact was observed during all LVD tests performed with a test speed of 50 km/h, a headway of 40m, both POV deceleration magnitudes, both overlaps, and the 4a motorcycle. This was not always the case for trials performed with the ABD motorcycle, and when contact occurred, the impact speeds were high (between 47.5 to 49.4 km/h, or 29.5 to 30.7 mph). One exception was the 50 km/h LVD test condition with a 40 m headway, a 0.3g POV deceleration magnitude, and the 75-percent overlap which had no contact in all tests performed.
- Similar trends were observed during LVD tests performed with a test speed of 50 km/h but with a 12 m headway, where the Toyota Corolla avoided contact with the 4a motorcycle during all tests performed except one trial using a 75-percent overlap and 0.5g POV deceleration, where an impact speed of 8.6 km/h (5.3 mph) occurred. Again, this was not the case when the ABD motorcycle was used, where contact was made during two of the five trials when the POV deceleration was 0.3g (impact speeds were 11.8 and 28.4 km/h, or 7.3 to 17.6 mph), and during the single trial performed with a POV deceleration of 0.5g (where the impact speed was 37.9 km/h or 23.5 mph). Additionally, the SV deceleration observed during the trials with impact speeds of 28.4 and 37.9 km/h was less than 0.25g, indicating minimal AEB braking occurred during these tests.
- When the LVD test speed was 80 km/h, the Toyota Corolla struck the ABD motorcycle during teach trial performed with the 12m headway and 0.3g POV deceleration, regardless of overlap. However, Toyota Corolla generally avoided

contact with the 4a motorcycle in the same condition, which in-turn allowed for additional tests to be performed using a higher POV deceleration of 0.5g. Differences were also observed during 80 km/h LVD trials performed with a 40 m headway, 0.3g POV deceleration, and a 50-percent overlap where Toyota Corolla avoided contact with the 4a motorcycle during each of the five trials performed, but struck the ABD motorcycle during three of five tests.

- With the Subaru Crosstrek, contact with the ABD motorcycle occurred during each LVD trial performed with an 80 km/h test speed and a POV deceleration of 0.3g. This was not always the case for tests performed with the 4a motorcycle, where no contact was observed during multiple, but not all, trials in the same test conditions. Furthermore, since only one or two impacts were observed during the 80 km/h LVD trials performed with a POV deceleration of 0.3g, a 50-percent overlap, and the 4a motorcycle, additional tests were performed using a higher POV deceleration of 0.5g.

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Conclusion

The LVS, LVM, and LVD test scenarios used for this study were based on those developed for FMVSS No. 127. However, motorcycle- or bicycle-based surrogates were used as the POVs. Additionally, two within-lane lateral overlaps per POV were used and some POV speed and deceleration parameters were varied. This study has demonstrated that these tests can be accurately and constantly performed by satisfying test validity criteria generally aligned with those defined for FMVSS No. 127.

RCS Measurements

The radar return characteristics of the motorcycle and bicycle surrogates used in this study were measured at the test track using a DRI ScanR equipped with two automotive grade radar sensors. Each test surrogate was in new condition for these measurements. To assess RCS consistency, three radar measurement sets were performed with one example of each bicycle and motorcycle surrogate used in this study. For each test surrogate, this involved performing the first scan, removing the test surrogate from its robotic platform, disassembling the test surrogate, reassembling the test surrogate, reinstalling the test surrogate onto the robotic platform, then repeating the measurement process. Each of the three repeated measurement sets performed for a given test surrogate occurred on the same day to maximize the consistency of the ambient test conditions.

The RCS values of the 4a and ABD motorcycle surrogates were generally both found to be within the applicable boundaries described in ISO 19206-5:2025. Whether a boundary was exceeded depended on the combination of measurement type (fixed viewing angle, variable range or fixed range, variable viewing angle), radar sensor (Bosch or Continental), and motorcycle surrogate make (4a or ABD). However, the measurements taken multiple times with the same motorcycle surrogate on the same day show that how these boundaries may be exceeded can vary.

Overall, the percentage of RCS values within the boundaries recommended in ISO 19206-5:2025 was satisfied for each of the three ABD motorcycles evaluated regardless of which radar sensor was used. For the three 4a motorcycles, this was also true when measurements were performed with the Continental sensor. However, this was not the case for all measurements performed with the Bosch sensor. With the Bosch sensor and the 4a motorcycle, the percentage of RCS values within the fixed viewing angle, variable range boundaries were exceeded during two of the three measurements taken with the same motorcycle surrogate on the same day. Similarly, the percentage of RCS values within the fixed range, variable viewing angle boundaries was exceeded for two of the three 4a motorcycles with the Bosch sensor.

As previously mentioned in S3.2.1, although ISO 19206-4:2020 provides boundaries for which to compare bicycle surrogate RCS values against, they are only applicable to fixed viewing angle, variable range measurements performed with specific viewing angles, and the number of measurements required to be within bounds is not specified. Therefore, to provide an objective criterion for assessment of whether a bicycle RCS was acceptable (suitable for testing) or not acceptable (unsuitable for testing) for this research, the ISO 19206-3:2021 and ISO 19206-5:2025 recommendation that at least 92% of the fixed viewing angle, variable range measurements should be within the applicable boundaries was used.

The RCS values of the 4a and ABD bicycle surrogates were generally both found to be within the applicable boundaries shown in ISO 19206-4:2020. As was the case for the motorcycle surrogates, whether an upper or lower boundary condition was exceeded depended on which combination of radar sensor and bicycle surrogate make is considered. However, the measurements taken multiple times with the same bicycle surrogate on the same day show that how these boundaries may be exceeded can vary.

Overall, the percentage of RCS values within the upper and lower boundaries shown in ISO 19206-4:2020 was at least 92 percent for each of the three 4a bicycles when measurements were performed with the Bosch sensor. However, this was not the case for all measurements performed with the Continental sensor. For one ABD bicycle all RCS values were within the boundaries shown in ISO 19206-4:2020, regardless of which radar was used. However, for the second ABD bicycle, the percentage of RCS values within the upper and lower boundaries shown in ISO 19206-4:2020 was below 92 percent for during one of the three repeated test sets for each radar sensor, and the test set during which this occurred differed between the two sensors.

FCW and AEB Brake Onset Timing

An FCW alert was presented during each test trial performed in this study. This was not always the case for AEB brake activation. The similarity of the FCW alert and AEB brake onset TTCs observed for surrogate types (bicycles or motorcycles) varied as a function of what combination of SV, scenario, speed, overlap, and surrogate was used.

- Example 1: The summary of LVM tests performed with motorcycle surrogates previously shown in Figure 16 indicates the Subaru Crosstrek FCW onset TTCs produced during trials performed with each motorcycle surrogate were generally in good agreement both within and across the two overlap conditions. Conversely, while the same comparison made with responses from the Cadillac Lyriq also demonstrates FCW onset TTC consistency between overlaps for each test surrogate, there was a significant difference between the values observed for the 4a versus ABD motorcycles for the same test speed. However, despite the differences seen for Cadillac Lyriq FCW onset TTCs, the AEB onset TTCs for the same comparisons are quite comparable.
- Example 2: If results from LVD trials performed with a 12 m headway, a 0.3 g POV deceleration, and the same SVs and motorcycle surrogates used in Example 1 are considered (previously shown in Figure 17), the FCW onset and AEB onset TTCs produced during comparable tests generally were in agreement both within and across the two overlap conditions for each SV. For the Cadillac Lyriq, this is a much different result for the FCW onset TTC comparison despite the use of equivalent test surrogates.
- Example 3: The FCW onset TTCs observed during Tesla Model 3 LVD tests using an initial headway of 40 m depended on what combination of motorcycle surrogate and surrogate overlap is considered. The FCW onset TTC produced during trials performed with the ABD motorcycle and a 50-percent overlap (previously shown in Figure 18) remained nearly equivalent as the test speed was increased from 50 to 80 km/h. The same comparison made for trials performed with the 4a motorcycle resulted in an increase in FCW onset TTC. Conversely, the FCW onset TTC

produced during trials performed with the ABD motorcycle and a 75-percent overlap decreased markedly as the test speed was increased from 50 to 80 km/h but remained nearly equivalent for the same comparison made for trials performed with the 4a motorcycle.

Tables 19 and 20 present a summary of trials where the SV deceleration was less than 0.25g and SV-to-POV contact was observed. When tests were performed with a bicycle surrogate, the only instances occurred during two of three LVS trials performed with the Tesla Model 3, a test speed of 10 km/h, a 25-percent overlap, and the ABD bicycle.

Table 19. Test Trials With SV Deceleration <0.25 g and SV-to-POV Contact (Bicycle POV)

Subject Vehicle	Test Scenario	Test Speeds and Conditions	Bicycle Test Surrogate	
			4a	ABD
Tesla Model 3	LVS (25% Overlap)	SV = 10 km/h POV = 0 km/h	n/a (0 of 2 trials)	**2 of 3 trials**

When tests were performed with a motorcycle surrogate, two SVs experienced at least one test condition where SV deceleration was less than 0.25g and SV-to-POV contact was observed. For the Subaru Crosstrek, this was observed for each of the three LVS trials performed with a test speed of 10 km/h, a 75-percent overlap, and the 4a motorcycle. For the Toyota Corolla, this occurred during three LVD test conditions; generally during trials performed with a 50 km/h test speed (but inclusive of both overlaps, POV decelerations, and initial headways), but also during one of the two trials performed with an 80 km/h test speed, a POV deceleration of 0.5g, and an SV-to-POV headway of 40 m.

Table 20. Test Trials With SV Deceleration <0.25 g and SV-to-POV Contact (Motorcycle POV)

Subject Vehicle	Test Scenario	Test Speeds and Conditions	Motorcycle Test Surrogate	
			4a	ABD
Subaru Crosstrek	LVS (75% Overlap)	SV = 10 km/h POV = 0 km/h	**3 of 3 trials**	n/a (0 of 5 trials)
Toyota Corolla	LVD (50% Overlap)	SV = 50 km/h POV = 50 km/h POV decel = 0.3g SV-to-POV headway = 40 m	n/a (0 of 5 trials)	**1 of 5 trials**
		SV = 50 km/h POV = 50 km/h POV decel = 0.5g SV-to-POV headway = 40 m	n/a (0 of 5 trials)	**2 of 5 trials**
Toyota Corolla	LVD (75% Overlap)	SV = 50 km/h POV = 50 km/h POV decel = 0.3g SV-to-POV headway = 12 m	n/a (0 of 5 trials)	**1 of 5 trials**
		SV = 50 km/h POV = 50 km/h POV decel = 0.5g SV-to-POV headway = 12 m	n/a (0 of 5 trials)	**1 of 1 trial**
Toyota Corolla	LVD (75% Overlap)	SV = 80 km/h POV = 80 km/h POV decel = 0.5g SV-to-POV headway = 40 m	n/a (0 of 3 trials)	**1 of 2 trials**

Crash Avoidance Performance

An SV's ability to avoid contact with the POV was observed to vary as a function of testing conditions; what combination of SV, scenario, speed, overlap, and surrogate was used. None of the SVs tested were able to avoid contact with a motorcycle or bicycle POV during each individual test trial defined in the nominal test matrix.

For the vehicles evaluated in this study, there was no consistent indication that the ability of an SV to avoid contact with the POV depended on surrogate make. Rather, when differences were observed, they were related to specific combinations of SV and test condition. For example, although the outcome of some LVS tests performed with the Subaru Crosstrek and Toyota Corolla indicated a higher propensity for an impact to occur if the 4a motorcycle was used (versus the ABD motorcycle), the opposite was true if LVD results from tests performed at 50 km/h (Toyota Corolla) and 80 km/h (Subaru Crosstrek and Toyota Corolla) are considered (i.e., a higher propensity for an impact to occur was observed when the ABD motorcycle was used versus the 4a motorcycle).

A similar observation was made for SV responses to the bicycle surrogates. For example, whereas LVS tests performed with a 50-percent overlap and the Tesla Model 3 indicated a higher impact propensity if the 4a bicycle versus the ABD bicycle was used, the oppose was true if LVD results from tests performed at 20 km/h (with a 12 m headway and 0.3g POV deceleration) are considered. Conversely, while LVS tests performed with a 50-percent overlap and the Cadillac Lyriq indicated a higher impact propensity if the ABD bicycle versus the 4a bicycle was used, the opposite was true if LVD results from tests performed at 30 km/h (with a 12 m headway and 0.3g POV deceleration) are considered.

Motorcycle and Bicycle Surrogate Use Considerations

Insight into the operation and durability of the test surrogates was gained throughout the testing timeline. Both bicycle and motorcycle surrogates were successful utilized for the tests requiring their use. When SV-to-POV impacts occurred, little-to-no damage to the SVs was typically observed. Generally speaking, the extent to which test surrogate damage was realized depended on the impact severity and frequently.

Damage incurred by the bicycle surrogates was most frequently isolated to the wheel spokes and the rear wheels. In some cases, low-speed impacts resulted in damage requiring repairs or replacement of individual components. Some high-speed impacts resulted in damage to the lower frame tabs or strut braces and, in some instances, required replacement of the entire surrogate.

The motorcycle surrogates most frequently incurred damage to the rear wheels. However, high-speed impacts often resulted in damage to the rear swingarm, strut mounts, wheel attachment points, and/or the mounting base, and sometimes required replacement of the entire surrogate.

In some operating conditions, problems with test surrogate stability adversely affected testing efficiency (e.g., required trials to be rerun until all test validity conditions were satisfied). Such conditions include operating at the highest test speeds or when wind speed was at the upper end of the permissible range, and examples of stability issues include remaining vertically aligned within the test validity period and remaining securely attached to the robotic platform. Of all test conditions, LVD trials performed with an 80 km/h test speed and a motorcycle surrogate were the most challenging, requiring a significant number of trials to be terminated before or within the test validity period.

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Appendix A: Supplemental Tables

Test parameters, acceptable ranges, and assessment ranges are described in Table A-1.

The subject vehicle front and rear axle weight ratings (GAWR), gross vehicle weight ratings (GVWR), and as-tested weights are shown in Table A-2.

A description of the test equipment, its location in the SV and POV, and respective weight are described in Table A-3.

Sensor descriptions and specifications of the instrumentation used to perform the tests described in this report is described in Table A-4.

Table A-1. Vehicle Test Parameter Tolerances

Parameter	Acceptable Range	Assessment Interval (For Valid Test Conduct)	Scenario		
			LVS	LVM	LVD
SV speed	Nominal ± 1.6 km/h	From TTC = 5.0 seconds to FCW onset	✓	✓	✓
POV speed	Nominal ± 1.6 km/h	From TTC = 5.0 seconds until POV deceleration = 0.05g		✓	✓
SV yaw rate	± 1 degree	From TTC = 5.0 seconds to FCW onset	✓	✓	✓
SV path deviation	± 0.3 meters	From TTC = 5.0 seconds to FCW onset	✓	✓	✓
POV placement	± 0.3 meters	From TTC = 5.0 seconds to EOT*	✓		
POV path deviation	± 0.3 meters	From TTC = 5.0 seconds to EOT*		✓	✓
SV-to-POV path deviation	± 0.3 meters from nominal overlap	From TTC = 5.0 seconds to FCW onset	✓	✓	✓
POV brake onset threshold	POV deceleration = 0.05g	≥ 3 seconds after test validity assessment is initiated			✓
POV deceleration onset	Nominal ± 10%	Within 1.5 seconds after POV brake onset			✓
POV average deceleration magnitude	Nominal ± 10%	From 1.5 seconds after POV brake onset until (1) impact or (2) 250 ms before the POV has stopped			✓
SV accelerator release threshold	Accelerator position ≤ 5%	From FCW onset + 0.5 seconds to EOT*	✓	✓	✓
SV initial brake temperature (front axle)	65 to 100 deg Celsius	At the instant the SV begins to accelerate from rest to the desired test speed	✓	✓	✓

*EOT = end of test. For the LVS and LVD scenarios, this occurs when either (1) the SV impacts the POV, or (2) the SV has stopped. For the LVM scenario, this occurs when either (1) the SV impacts the POV, or (2) when the SV speed first falls below that of the POV.

Table A-2. Subject Vehicle Weight Information

Vehicle	GAWR		GVWR	Weight As Tested[1]		Total Weight As Tested[1]
	Front	Rear		Front	Rear	
2024 Cadillac Lyriq AWD; EV SUV	1550 kg (3417 lbs.)	1700 kg (3747 lbs.)	3175 kg (7000 lbs.)	1393 kg (3071 lbs.)	1440 kg (3175 lbs.)	2833 kg (6246 lbs.)
2024 Subaru Crosstrek AWD 5-dr hatchback	1165 kg (2568 lbs.)	1130 kg (2491 lbs.)	2185 kg (4817 lbs.)	959 kg (2114 lbs.)	759 kg (1674 lbs.)	1718 kg (3788 lbs.)
2024 Tesla Model 3 AWD; EV sedan	1110 kg (2447 lbs.)	1250 kg (2778 lbs.)	2247 kg (4954 lbs.)	980 kg (2160 lbs.)	1060 kg (2338 lbs.)	2040 kg (4498 lbs.)
2023 Toyota Corolla Hybrid XLE Sedan	1050 kg (2315 lbs.)	971 kg (2140 lbs.)	1844 kg (4065 lbs.)	892 kg (1966 lbs.)	677 kg (1492 lbs.)	1569 kg (3458 lbs.)

[1]Fully fueled, instrumentation, driver, in-vehicle experimenter(s).

Table A-3. Test Equipment Description, Location, Weight

Equipment Description	Equipment Used	Typical Location	Approximate Weight
Data Acquisition System (DAS)	Internally developed comprised of a NUC, PEAK modules, ethernet switch, laptop, and power converters	SV rear cargo area (e.g., trunk)	DAS ≈ 15 kg (32 lbs.) External batteries ≈ 23 to 29 kg (50 to 64 lbs.)
Integrated Inertial Measurement Unit and GPS (SV)	Oxford Technical Solutions (OxTS) RT 3000 series, NovAtel high precision antenna, FreeWave industrial radio and antenna	Antennas mounted to the roof of the SV. IMU/GPS securely positioned in the SV rear cargo area. GPS acquisition and ancillary equipment installed/secured in the SV rear cargo area.	RT 3000 ≈ 4 kg (8 lbs.) FreeWave ≈ 1 kg (3 lbs.)
Integrated Inertial Measurement Unit and GPS (POV)	OxTS RT 3000 series and antenna	Antenna mounted to the POV. IMU/GPS securely positioned within the POV near the center of the unit. GPS acquisition and ancillary equipment securely positioned within the POV.	≈ 4 kg (8 lbs.)
Programmable Driving Robot	AB Dynamics (ABD) SR15 steering robot, electronics box, battery box, and network antenna.	Antenna mounted to the roof of the SV. Driving robot is connected to the steering wheel and windshield. The robot controller electronics box and batteries are typically secured in the SV rear cargo area.	Steering robot ≈ 5 kg (11 lbs.) Robot controller electronics box ≈ 12 kg (27 lbs.) Battery box ≈ 18 kg (39 lbs.) Network antenna ≈ 4 kg (8 lbs.)
Sound Acquisition System	DBX equalizer, Xenyx mixing console, and microphone	Equalizer and mixing board positioned in the SV near the center of the vehicle, just behind the front seats. Microphone positioned near alert speakers.	≈ 5 kg (11 lbs.)
Vehicle-to-vehicle range receiver *(wireless communication between the SV and POV)*	OxTS RT Range, network antenna, driver displays	Antenna mounted to the roof of the SV. Ancillary equipment secured in the SV rear cargo area.	RT Range ≈ 2 kg (4 lbs.) Display boxes ≈ 2 kg (4 lbs.)
Vehicle-to-vehicle range transmitter *(wireless communication between the SV and POV)*	Network antenna	Antenna mounted to the POV. Ancillary equipment secured within the POV.	≈ 0.5 kg (1 lb.)

Table A-4. Sensor Descriptions and Specifications

Type	Output	Range	Resolution	Accuracy
Longitudinal Speed Sensor	SV and POV longitudinal speed	0.1 – 241 km/h (0.1 – 150 mph)	0.05 km/h (0.031 mph)	± 0.25% of full scale range
Rate Sensor	SV yaw rate	± 100 deg/s	0.01 deg/s	± 0.05% of full scale range
SR Torque	SV steering controller torque	0 – 15 N-m (0 – 11 lb-ft)	1.5 N-m (± 1.1 lb-ft)	± 1.5 N-m (± 1.1 lb-ft)
Accelerometer	SV and POV longitudinal deceleration	± 10g	0.01g	± 0.01% of full scale range
Position Sensor (String Potentiometer)	SV brake pedal position	0 – 20.3 cm (0 – 8 in.)	0.03 mm (0.001 in.)	± 0.3 mm (± 0.01 in.)
Position Sensor (String Potentiometer)	SV throttle position	0 – 100 percent (normalized)	0.1 percent	± 0.1 percent
Differential GPS	Longitudinal position of SV and POV	N/A	1 mm (0.04 in.)	± 10 mm (± 0.4 in.)
Vehicle Dimensional Measurements	Location of SV and POV GPS antennas; SV and POV centerlines; front-most SV bumper position; rear-most POV bumper position.	N/A	1 mm (0.04 in)	± 1 mm (± 0.04 in)
SV-to-POV Static Range	Distance between POV and rear-most POV bumper position.	N/A	1 mm (0.04 in.)	± 10 mm (± 0.4 in.)
Microphone	Frequency and Intensity of FCW alert	20 Hz – 20 kHz; 0 – 112 dB	-33 dB at 1 kHz	N/A
FARO	SV and POV dimensional measurements	N/A	1,200,000 points per second	± 0.065 mm (± 0.003 in)

Appendix B: Forward Collision Warning Onset Times

FCW onset TTCs are shown in Tables B-1 to B-14.

For all tables in Appendix B, trials where crash avoidance was observed are highlighted in green whereas trials highlighted in red indicate an SV-to-POV contact was observed.

Table B-1. LVS FCW Onset TTC Summary (Bicycle POV; 50% Overlap)

Test Conditions	Trial #	2024 Subaru Crosstrek		2023 Toyota Corolla Hybrid		2024 Cadillac Lyriq		2024 Tesla Model 3	
		4a	ABD	4a	ABD	4a	ABD	4a	ABD
SV = 10 km/h POV = 0 km/h	1	1.432	n/a	2.030	n/a	1.364	1.259	0.779	0.928
	2	1.501	n/a	1.826	n/a	1.368	1.022	0.833	0.838
	3	1.477	n/a	1.905	n/a	--[2]	--[2]	--[2]	--[2]
	4	1.443	n/a	1.784	n/a	n/a			
	5	1.479	n/a	1.767	n/a				
SV = 20 km/h POV = 0 km/h	1	1.794	n/a	1.904	n/a	1.519	1.457	1.102	1.418
	2	1.770	n/a	1.918	n/a	1.298	1.272	1.129	1.439
	3	1.847	n/a	2.078	n/a	--[2]	--[2]	1.082	--[2]
	4	1.766	n/a	1.876	n/a	n/a			
	5	1.853	n/a	1.910	n/a				
SV = 30 km/h POV = 0 km/h	1	1.997	n/a	2.078	n/a	1.891	1.856	--[1]	1.582
	2	2.012	n/a	2.135	n/a	1.865	1.791	--[1]	1.671
	3	2.075	n/a	2.155	n/a	--[2]	--[2]	--[1]	--[1]
	4	1.997	n/a	2.218	n/a	--[2]			
	5	2.055	n/a	2.122	n/a				
SV = 40 km/h POV = 0 km/h	1	2.346	n/a	2.199	n/a	2.296	2.197	--[1]	1.916
	2	2.304	n/a	2.224	n/a	2.241	2.180	--[1]	1.818
	3	2.306	n/a	2.219	n/a	--[2]	--[2]	--[1]	--[1]
	4	2.358	n/a	2.205	n/a	n/a			
	5	2.316	n/a	2.239	n/a				
SV = 50 km/h POV = 0 km/h	1	2.676	n/a	2.209	n/a	2.938	2.117	--[1]	1.857
	2	2.589	n/a	2.210	n/a	2.055	3.000	--[1]	--[1]
	3	2.635	n/a	2.207	n/a	--[2]	--[2]	--[1]	--[1]
	4	2.736	n/a	2.230	n/a	n/a			
	5	2.715	n/a	2.146	n/a				
SV = 60 km/h POV = 0 km/h	1	2.954	n/a	2.154	n/a	1.995	2.795	--[1]	--[1]
	2	3.163	n/a	2.165	n/a	2.291	1.518	--[1]	--[1]
	3	3.149	n/a	2.172	n/a	--[2]	1.766	--[1]	--[1]
	4	3.206	n/a	2.202	n/a	n/a			
	5	3.195	n/a	2.197	n/a				
SV = 70 km/h POV = 0 km/h	1	2.744	n/a	2.121	n/a	1.836	--[1]	--[1]	--[1]
	2	2.647	n/a	2.176	n/a	1.608	--[1]	--[1]	--[1]
	3	2.681	n/a	2.097	n/a	--[1]	--[1]	--[1]	--[1]
	4	2.681	n/a	2.105	n/a	n/a			
	5	2.661	n/a	2.157	n/a				
SV = 80 km/h POV = 0 km/h	1	2.279	n/a	1.740	n/a	--[1]	--[1]	--[1]	--[1]
	2	2.446	n/a	2.167	n/a	--[1]	--[1]	--[1]	--[1]
	3	2.235	n/a	2.165	n/a	--[1]	--[1]	--[1]	--[1]
	4	--[1]	n/a	2.139	n/a	n/a			
	5	--[1]	n/a	1.942	n/a				

[1]Test not performed due to previously observed SV-to-POV contact.
[2]No contact was observed during the first two test trials, so a third trial was not performed.
Green cells = crash avoidance; red cells = SV-to-POV contact occurred.

Table B-2. LVS FCW Onset TTC Summary (Bicycle POV; 25% Overlap)

Test Conditions	Trial #	2024 Subaru Crosstrek		2023 Toyota Corolla Hybrid		2024 Cadillac Lyriq		2024 Tesla Model 3	
		4a	ABD	4a	ABD	4a	ABD	4a	ABD
SV = 10 km/h POV = 0 km/h	1	1.534	n/a	1.253	n/a	1.301	1.185	0.726	1.266
	2	1.554	n/a	1.349	n/a	1.715	1.184	0.806	0.933
	3	1.441	n/a	1.754	n/a	--[2]	--[2]	--[2]	1.216
	4	1.497	n/a	1.729	n/a	n/a			
	5	1.422	n/a	1.970	n/a				
SV = 20 km/h POV = 0 km/h	1	1.370	n/a	2.011	n/a	1.588	1.438	1.106	1.253
	2	1.530	n/a	2.080	n/a	1.484	1.536	1.031	1.162
	3	1.345	n/a	1.997	n/a	--[2]	--[2]	--[1]	1.209
	4	1.484	n/a	1.952	n/a	n/a			
	5	1.483	n/a	1.942	n/a				
SV = 30 km/h POV = 0 km/h	1	2.057	n/a	2.199	n/a	1.908	1.848	--[1]	1.185
	2	1.985	n/a	2.147	n/a	1.915	1.851	--[1]	--[1]
	3	1.971	n/a	2.061	n/a	--[2]	--[2]	--[1]	--[1]
	4	1.949	n/a	2.179	n/a	n/a			
	5	2.056	n/a	2.107	n/a				
SV = 40 km/h POV = 0 km/h	1	2.286	n/a	2.218	n/a	2.302	2.567	--[1]	--[1]
	2	2.332	n/a	2.176	n/a	2.088	2.392	--[1]	--[1]
	3	2.304	n/a	2.104	n/a	--[2]	--[2]	--[1]	--[1]
	4	2.302	n/a	2.191	n/a	n/a			
	5	2.313	n/a	2.148	n/a				
SV = 50 km/h POV = 0 km/h	1	2.702	n/a	2.196	n/a	2.707	2.136	--[1]	--[1]
	2	2.502	n/a	2.176	n/a	2.976	2.112	--[1]	--[1]
	3	2.638	n/a	2.202	n/a	--[2]	--[2]	--[1]	--[1]
	4	2.528	n/a	2.226	n/a	--[2]			
	5	2.728	n/a	2.176	n/a				
SV = 60 km/h POV = 0 km/h	1	2.865	n/a	1.774	n/a	2.427	1.854	--[1]	--[1]
	2	3.191	n/a	2.208	n/a	1.930	1.728	--[1]	--[1]
	3	2.919	n/a	2.187	n/a	--[2]	--[2]	--[1]	--[1]
	4	3.251	n/a	2.206	n/a	n/a			
	5	3.240	n/a	2.209	n/a				
SV = 70 km/h POV = 0 km/h	1	2.902	n/a	2.084	n/a	1.708	1.801	--[1]	--[1]
	2	2.933	n/a	2.137	n/a	2.890	1.859	--[1]	--[1]
	3	2.676	n/a	1.580	n/a	2.358	--[2]	--[1]	--[1]
	4	2.881	n/a	2.195	n/a	n/a			
	5	2.681	n/a	1.700	n/a				
SV = 80 km/h POV = 0 km/h	1	2.417	n/a	1.907	n/a	1.807	1.982	--[1]	--[1]
	2	2.540	n/a	2.107	n/a	--[1]	--[1]	--[1]	--[1]
	3	2.406	n/a	1.889	n/a	--[1]	--[1]	--[1]	--[1]
	4	--[1]	n/a	1.811	n/a	n/a			
	5	--[1]	n/a	1.810	n/a				

[1]Test not performed due to previously observed SV-to-POV contact.

[2]No contact was observed during the first two test trials, so a third trial was not performed.

Green cells = crash avoidance; red cells = SV-to-POV contact occurred.

Table B-3. LVM FCW Onset TTC Summary (Bicycle POV; 50% Overlap)

Test Conditions	Trial #	2024 Subaru Crosstrek		2023 Toyota Corolla Hybrid		2024 Cadillac Lyriq		2024 Tesla Model 3	
		4a	ABD	4a	ABD	4a	ABD	4a	ABD
SV = 40 km/h POV = 20 km/h	1	1.555	n/a	2.019	n/a	2.285	2.256	3.101	2.905
	2	2.106	n/a	2.002	n/a	2.365	2.389	3.675	3.297
	3	2.155	n/a	1.991	n/a	--[2]	--[2]	--[2]	--[2]
	4	2.101	n/a	2.015	n/a	n/a			
	5	2.051	n/a	2.006	n/a				
SV = 50 km/h POV = 20 km/h	1	2.214	n/a	2.180	n/a	2.849	2.631	3.381	3.337
	2	2.258	n/a	2.158	n/a	2.776	2.685	2.670	3.470
	3	2.191	n/a	2.136	n/a	--[2]	--[2]	--[2]	--[2]
	4	2.315	n/a	2.195	n/a	n/a			
	5	2.103	n/a	2.120	n/a				
SV = 60 km/h POV = 20 km/h	1	2.520	n/a	2.186	n/a	2.911	2.967	2.854	3.403
	2	2.285	n/a	2.256	n/a	2.981	2.622	3.093	3.405
	3	2.472	n/a	2.200	n/a	--[2]	--[2]	--[2]	--[2]
	4	2.477	n/a	2.180	n/a	n/a			
	5	2.275	n/a	2.233	n/a				
SV = 70 km/h POV = 20 km/h	1	2.604	n/a	2.188	n/a	3.118	3.013	2.829	3.202
	2	2.737	n/a	2.233	n/a	2.998	2.851	2.651	3.141
	3	2.635	n/a	2.189	n/a	--[2]	--[2]	--[1]	--[2]
	4	2.517	n/a	2.124	n/a	n/a			
	5	2.652	n/a	2.185	n/a				
SV = 80 km/h POV = 20 km/h	1	2.964	n/a	2.208	n/a	3.098	2.786	--[1]	2.904
	2	2.999	n/a	2.119	n/a	3.044	2.520	--[1]	2.901
	3	2.977	n/a	2.177	n/a	--[2]	--[2]	--[1]	--[1]
	4	3.029	n/a	2.231	n/a	n/a			
	5	2.856	n/a	2.216	n/a				

[1]Test not performed due to previously observed SV-to-POV contact.

[2]No contact was observed during the first two test trials, so a third trial was not performed.

Green cells = crash avoidance; red cells = SV-to-POV contact occurred.

Table B-4. LVM FCW Onset TTC Summary (Bicycle POV; 25% Overlap)

Test Conditions	Trial #	2024 Subaru Crosstrek		2023 Toyota Corolla Hybrid		2024 Cadillac Lyriq		2024 Tesla Model 3	
		4a	ABD	4a	ABD	4a	ABD	4a	ABD
SV = 40 km/h POV = 20 km/h	1	2.135	n/a	2.023	n/a	2.294	2.249	3.100	2.613
	2	2.103	n/a	2.026	n/a	2.420	2.348	3.742	4.751
	3	2.051	n/a	2.003	n/a	--[2]	--[2]	--[2]	--[2]
	4	1.933	n/a	2.029	n/a	n/a			
	5	1.983	n/a	1.988	n/a				
SV = 50 km/h POV = 20 km/h	1	2.216	n/a	2.066	n/a	2.770	2.827	2.825	3.141
	2	2.292	n/a	2.162	n/a	2.779	2.637	3.085	4.698
	3	2.321	n/a	2.105	n/a	--[2]	--[2]	--[2]	--[2]
	4	2.254	n/a	2.251	n/a	n/a			
	5	2.272	n/a	2.130	n/a				
SV = 60 km/h POV = 20 km/h	1	2.343	n/a	2.190	n/a	3.113	2.882	2.821	2.750
	2	2.434	n/a	2.172	n/a	2.972	2.936	2.706	4.878
	3	2.328	n/a	2.151	n/a	--[2]	--[2]	--[2]	--[2]
	4	2.412	n/a	2.119	n/a	n/a			
	5	2.402	n/a	2.127	n/a				
SV = 70 km/h POV = 20 km/h	1	2.528	n/a	2.191	n/a	3.068	2.868	2.491	2.894
	2	2.433	n/a	2.164	n/a	3.177	2.851	2.232	2.924
	3	2.643	n/a	2.224	n/a	--[2]	--[2]	--[1]	--[1]
	4	2.654	n/a	2.026	n/a	n/a			
	5	2.436	n/a	2.204	n/a				
SV = 80 km/h POV = 20 km/h	1	3.020	n/a	2.261	n/a	2.958	2.131	--[1]	--[1]
	2	2.879	n/a	2.128	n/a	2.961	3.057	--[1]	--[1]
	3	2.971	n/a	2.044	n/a	--[2]	--[2]	--[1]	--[1]
	4	3.033	n/a	2.167	n/a	n/a			
	5	3.123	n/a	2.171	n/a				

[1]Test not performed due to previously observed SV-to-POV contact.

[2]No contact was observed during the first two test trials, so a third trial was not performed.

Green cells = crash avoidance; red cells = SV-to-POV contact occurred.

Table B-5. LVD FCW Onset TTC Summary (Bicycle POV; 50% Overlap)

Test Conditions	Trial #	2024 Subaru Crosstrek		2023 Toyota Corolla Hybrid		2024 Cadillac Lyriq		2024 Tesla Model 3	
		4a	ABD	4a	ABD	4a	ABD	4a	ABD
SV = 20 km/h POV = 20 km/h POV decel = 0.3g SV-to-POV headway = 12 m	1	1.203	n/a	1.611	n/a	1.445	1.594	0.990	1.285
	2	1.250	n/a	1.670	n/a	1.610	1.514	1.001	1.138
	3	1.099	n/a	1.595	n/a	--[2]	--[2]	--[2]	1.059
	4	1.251	n/a	1.596	n/a	n/a			
	5	1.218	n/a	1.613	n/a				
SV = 30 km/h POV = 30 km/h POV decel = 0.3g SV-to-POV headway = 12 m	1	1.607	n/a	1.755	n/a	1.686	1.816	1.842	1.606
	2	1.530	n/a	1.715	n/a	1.790	1.642	2.036	2.316
	3	1.393	n/a	1.828	n/a	1.640	--[2]	--[2]	--[2]
	4	1.633	n/a	1.609	n/a	n/a			
	5	1.459	n/a	1.802	n/a				
SV = 20 km/h POV = 20 km/h POV decel = 0.3g SV-to-POV headway = 40 m	1	1.791	n/a	1.952	n/a	1.418	1.618	1.392	1.261
	2	1.919	n/a	1.964	n/a	1.458	1.689	1.337	1.297
	3	1.875	n/a	1.959	n/a	--[2]	--[2]	--[2]	--[2]
	4	1.808	n/a	1.903	n/a	n/a			
	5	1.859	n/a	1.915	n/a				
SV = 30 km/h POV = 30 km/h POV decel = 0.3g SV-to-POV headway = 40 m	1	2.075	n/a	2.152	n/a	2.215	2.736	1.767	1.732
	2	2.102	n/a	2.146	n/a	1.965	2.508	1.795	1.720
	3	2.145	n/a	2.051	n/a	--[2]	--[2]	--[2]	--[2]
	4	2.065	n/a	2.084	n/a	n/a			
	5	2.063	n/a	2.095	n/a				

[1]Test not performed due to previously observed SV-to-POV contact.

[2]No contact was observed during the first two test trials, so a third trial was not performed.

Green cells = crash avoidance; red cells = SV-to-POV contact occurred.

Table B-6. LVD FCW Onset TTC Summary (Bicycle POV; 25% Overlap)

Test Conditions	Trial #	2024 Subaru Crosstrek		2023 Toyota Corolla Hybrid		2024 Cadillac Lyriq		2024 Tesla Model 3	
		4a	ABD	4a	ABD	4a	ABD	4a	ABD
SV = 20 km/h POV = 20 km/h POV decel = 0.3g SV-to-POV headway = 12 m	1	0.944	n/a	1.630	n/a	1.397	1.531	0.961	0.995
	2	1.112	n/a	1.673	n/a	1.663	1.554	0.978	0.994
	3	1.037	n/a	1.635	n/a	--[2]	--[2]	--[1]	--[1]
	4	0.944	n/a	1.518	n/a	n/a			
	5	1.115	n/a	1.600	n/a				
SV = 30 km/h POV = 30 km/h POV decel = 0.3g SV-to-POV headway = 12 m	1	1.485	n/a	1.779	n/a	1.652	1.691	1.542	1.597
	2	1.534	n/a	1.790	n/a	1.726	1.740	1.512	1.793
	3	1.489	n/a	1.797	n/a	1.821	--[2]	--[2]	--[2]
	4	1.483	n/a	1.714	n/a	n/a			
	5	1.481	n/a	1.827	n/a				
SV = 20 km/h POV = 20 km/h POV decel = 0.3g SV-to-POV headway = 40 m	1	1.682	n/a	2.100	n/a	1.488	1.541	1.442	1.414
	2	1.677	n/a	2.094	n/a	1.446	1.393	1.529	1.382
	3	1.774	n/a	2.097	n/a	--[2]	--[2]	--[2]	--[2]
	4	1.711	n/a	2.169	n/a	n/a			
	5	1.722	n/a	2.130	n/a				
SV = 30 km/h POV = 30 km/h POV decel = 0.3g SV-to-POV headway = 40 m	1	2.006	n/a	1.937	n/a	1.893	1.854	1.511	1.847
	2	2.015	n/a	1.938	n/a	1.892	2.632	1.492	1.704
	3	2.016	n/a	1.915	n/a	--[2]	--[2]	--[2]	--[2]
	4	2.063	n/a	1.947	n/a	n/a			
	5	2.141	n/a	1.934	n/a				

[1]Test not performed due to previously observed SV-to-POV contact.

[2]No contact was observed during the first two test trials, so a third trial was not performed.

Green cells = crash avoidance; red cells = SV-to-POV contact occurred.

Table B-7. LVS FCW Onset TTC Summary (Motorcycle POV; 50% Overlap)

Test Conditions	Trial #	2024 Subaru Crosstrek		2023 Toyota Corolla Hybrid		2024 Cadillac Lyriq		2024 Tesla Model 3	
		4a	ABD	4a	ABD	4a	ABD	4a	ABD
SV = 10 km/h POV = 0 km/h	1	1.453	1.508	1.680	1.977	1.447	1.369	1.054	1.057
	2	1.481	1.579	1.911	2.110	1.359	1.318	1.315	1.412
	3	1.660	1.486	2.027	2.095	--[2]	1.362	--[2]	--[2]
	4	1.551	1.681	1.857	1.980	n/a			
	5	1.458	1.480	1.979	2.114				
SV = 20 km/h POV = 0 km/h	1	1.864	1.907	1.949	2.012	0.977	1.357	1.240	1.248
	2	1.902	1.837	1.918	2.111	1.351	1.094	1.689	1.745
	3	1.852	1.833	2.030	2.007	--[2]	--[2]	--[2]	--[2]
	4	1.844	1.868	1.967	2.103	n/a			
	5	1.831	1.797	1.936	2.053				
SV = 30 km/h POV = 0 km/h	1	2.050	2.075	2.058	2.216	1.596	1.396	1.975	1.701
	2	2.031	2.078	1.966	2.225	1.519	1.681	1.670	1.694
	3	1.952	2.079	2.061	2.162	--[2]	--[2]	1.687	--[1]
	4	2.072	2.032	2.139	2.201	n/a			
	5	1.965	2.075	2.067	2.212				
SV = 40 km/h POV = 0 km/h	1	2.322	2.354	2.208	2.287	1.610	1.937	2.474	--[1]
	2	2.435	2.359	2.208	2.271	1.588	1.829	1.919	--[1]
	3	2.383	2.403	2.229	2.289	--[2]	--[2]	--[1]	--[1]
	4	2.383	2.330	2.219	2.254	n/a			
	5	2.336	2.374	2.170	2.192				
SV = 50 km/h POV = 0 km/h	1	2.636	2.635	2.166	2.234	1.914	1.860	--[1]	--[1]
	2	2.434	2.736	2.167	2.219	1.880	1.883	--[1]	--[1]
	3	2.620	2.721	2.205	2.245	--[2]	--[2]	--[1]	--[1]
	4	2.577	2.729	2.214	2.186	n/a			
	5	2.595	2.668	2.213	2.236				
SV = 60 km/h POV = 0 km/h	1	3.129	3.109	2.163	2.210	1.766	2.065	--[1]	--[1]
	2	3.174	3.036	2.111	1.914	2.148	2.088	--[1]	--[1]
	3	3.187	3.000	2.213	2.217	--[2]	--[2]	--[1]	--[1]
	4	2.976	3.032	2.208	2.182	n/a			
	5	3.014	3.128	2.137	2.128				
SV = 70 km/h POV = 0 km/h	1	2.582	2.813	2.125	1.725	3.653	1.913	--[1]	--[1]
	2	2.626	2.922	2.159	1.317	2.547	2.681	--[1]	--[1]
	3	2.591	2.840	2.121	1.887	--[2]	--[2]	--[1]	--[1]
	4	2.693	--[1]	2.197	2.210	n/a			
	5	--[1]	--[1]	2.159	1.349				
SV = 80 km/h POV = 0 km/h	1	--[1]	--[1]	1.940	1.297	2.421	2.655	--[1]	--[1]
	2	--[1]	--[1]	1.304	1.883	1.918	2.243	--[1]	--[1]
	3	--[1]	--[1]	2.094	1.519	2.629	--[2]	--[1]	--[1]
	4	--[1]	--[1]	1.605	2.045	n/a			
	5	--[1]	--[1]	--[1]	1.892				

[1]Test not performed due to previously observed SV-to-POV contact.

[2]No contact was observed during the first two test trials, so a third trial was not performed.

Green cells = crash avoidance; red cells = SV-to-POV contact occurred.

Table B-8. LVS FCW Onset TTC Summary (Motorcycle POV; 75% Overlap)

Test Conditions	Trial #	2024 Subaru Crosstrek		2023 Toyota Corolla Hybrid		2024 Cadillac Lyriq		2024 Tesla Model 3	
		4a	ABD	4a	ABD	4a	ABD	4a	ABD
SV = 10 km/h POV = 0 km/h	1	1.175	1.688	1.905	2.041	1.405	1.473	1.358	1.361
	2	1.176	1.337	1.962	2.038	1.438	1.351	1.563	1.010
	3	1.174	1.626	1.877	2.012	--[2]	--[2]	--[2]	--[2]
	4	--[1]	1.124	1.930	2.050	n/a			
	5	--[1]	1.645	1.865	2.013				
SV = 20 km/h POV = 0 km/h	1	1.620	1.657	1.982	2.067	1.397	1.359	1.225	1.128
	2	1.761	1.577	2.014	2.106	1.303	1.250	1.195	1.180
	3	1.661	1.643	1.958	2.151	--[2]	--[2]	--[2]	--[2]
	4	1.624	1.615	1.954	2.017	n/a			
	5	1.687	1.611	1.989	2.089				
SV = 30 km/h POV = 0 km/h	1	2.048	1.911	2.077	2.187	1.580	1.568	1.519	1.539
	2	1.990	1.920	2.156	2.206	1.540	1.449	1.486	1.516
	3	2.011	2.001	2.137	2.205	--[2]	--[2]	1.515	--[1]
	4	1.970	1.883	2.091	2.126	n/a			
	5	1.834	2.146	2.102	2.171				
SV = 40 km/h POV = 0 km/h	1	2.322	2.391	2.218	2.114	1.825	1.606	--[1]	--[1]
	2	2.413	2.409	2.139	2.092	1.855	1.612	--[1]	--[1]
	3	2.182	2.342	2.137	2.169	--[2]	--[2]	--[1]	--[1]
	4	2.312	2.349	2.103	2.142	n/a			
	5	2.215	2.268	2.136	2.184				
SV = 50 km/h POV = 0 km/h	1	2.622	2.621	2.168	2.176	1.847	1.854	--[1]	--[1]
	2	2.504	2.592	2.191	2.175	1.790	1.919	--[1]	--[1]
	3	2.592	2.537	2.075	2.143	--[2]	--[2]	--[1]	--[1]
	4	2.558	2.631	2.143	2.115	n/a			
	5	2.648	2.616	2.150	2.134				
SV = 60 km/h POV = 0 km/h	1	2.979	2.998	2.097	2.082	1.818	2.120	--[1]	--[1]
	2	3.039	2.895	2.069	2.059	2.143	2.095	--[1]	--[1]
	3	3.077	2.842	2.159	2.176	2.134	--[2]	--[1]	--[1]
	4	3.094	3.090	2.171	2.129	n/a			
	5	3.009	2.969	2.150	2.083				
SV = 70 km/h POV = 0 km/h	1	2.641	2.719	2.104	1.981	2.239	2.032	--[1]	--[1]
	2	2.713	2.705	2.162	2.171	1.745	2.555	--[1]	--[1]
	3	2.629	2.613	2.185	2.133	2.267	--[2]	--[1]	--[1]
	4	--[1]	--[1]	2.145	2.156	n/a			
	5	--[1]	--[1]	2.012	1.972				
SV = 80 km/h POV = 0 km/h	1	--[1]	--[1]	2.123	2.128	3.165	2.743	--[1]	--[1]
	2	--[1]	--[1]	2.102	2.091	3.185	2.333	--[1]	--[1]
	3	--[1]	--[1]	2.165	2.056	3.133	2.788	--[1]	--[1]
	4	--[1]	--[1]	--[1]	--[1]	n/a			
	5	--[1]	--[1]	--[1]	--[1]				

[1]Test not performed due to previously observed SV-to-POV contact.

[2]No contact was observed during the first two test trials, so a third trial was not performed. Green cells = crash avoidance; red cells = SV-to-POV contact occurred.

Table B-9. LVM FCW Onset TTC Summary (Motorcycle POV; 50% Overlap)

Test Conditions	Trial #	2024 Subaru Crosstrek		2023 Toyota Corolla Hybrid		2024 Cadillac Lyriq		2024 Tesla Model 3	
		4a	ABD	4a	ABD	4a	ABD	4a	ABD
SV = 40 km/h POV = 20 km/h	1	1.955	2.035	2.019	2.030	1.911	1.735	3.055	2.248
	2	2.020	2.009	2.002	2.072	1.926	1.888	2.157	3.522
	3	2.020	2.010	1.991	2.035	--[2]	--[2]	--[2]	--[2]
	4	2.031	2.089	2.015	1.981	n/a			
	5	2.008	2.005	2.006	2.411				
SV = 50 km/h POV = 20 km/h	1	2.197	2.358	2.180	2.224	1.916	1.915	2.129	3.499
	2	2.242	2.318	2.158	2.193	2.043	1.845	1.535	2.357
	3	2.190	2.277	2.136	2.206	--[2]	--[2]	--[2]	--[2]
	4	2.222	2.213	2.195	2.186	n/a			
	5	2.135	2.195	2.120	2.165				
SV = 60 km/h POV = 20 km/h	1	2.417	2.610	2.186	2.116	2.066	2.061	1.977	2.161
	2	2.395	2.316	2.256	2.276	2.111	2.158	2.055	2.229
	3	2.379	2.573	2.200	2.302	--[2]	--[2]	--[2]	--[2]
	4	2.344	2.305	2.180	2.228	n/a			
	5	2.344	2.365	2.233	2.252				
SV = 70 km/h POV = 20 km/h	1	2.538	2.514	2.188	2.258	2.193	2.259	2.025	2.209
	2	2.686	2.665	2.233	2.272	2.234	2.286	1.737	2.267
	3	2.615	2.856	2.189	2.230	--[2]	--[2]	--[1]	2.281
	4	2.463	2.608	2.124	2.196	n/a			
	5	2.794	2.487	2.185	2.257				
SV = 80 km/h POV = 20 km/h	1	2.983	2.747	2.208	2.147	2.335	2.351	--[1]	--[1]
	2	3.214	2.485	2.119	2.279	2.310	2.312	--[1]	--[1]
	3	3.205	2.876	2.177	2.318	--[2]	--[2]	--[1]	--[1]
	4	3.160	3.055	2.231	2.232	n/a			
	5	3.286	2.669	2.216	2.239				

[1]Test not performed due to previously observed SV-to-POV contact.

[2]No contact was observed during the first two test trials, so a third trial was not performed.

Green cells = crash avoidance; red cells = SV-to-POV contact occurred.

Table B-10. LVM FCW Onset TTC Summary (Motorcycle POV; 75% Overlap)

Test Conditions	Trial #	2024 Subaru Crosstrek		2023 Toyota Corolla Hybrid		2024 Cadillac Lyriq		2024 Tesla Model 3	
		4a	ABD	4a	ABD	4a	ABD	4a	ABD
SV = 40 km/h POV = 20 km/h	1	2.051	1.949	2.023	2.118	1.845	1.831	2.846	2.283
	2	2.123	2.106	2.026	2.057	1.796	1.507	2.843	2.253
	3	2.050	1.947	2.003	1.998	--[2]	--[2]	--[2]	--[2]
	4	2.098	1.965	2.029	2.087	n/a			
	5	1.976	1.929	1.988	2.067				
SV = 50 km/h POV = 20 km/h	1	2.180	2.302	2.066	2.128	1.957	1.938	2.340	2.377
	2	2.299	2.221	2.162	2.171	1.933	1.901	2.223	2.266
	3	2.314	2.262	2.105	2.077	--[2]	--[2]	--[2]	--[2]
	4	2.256	2.286	2.251	2.257	n/a			
	5	2.201	2.222	2.130	2.183				
SV = 60 km/h POV = 20 km/h	1	2.337	2.277	2.190	2.125	2.068	2.055	2.088	3.324
	2	2.442	2.378	2.172	2.247	2.112	2.027	2.003	2.134
	3	2.262	2.526	2.151	2.236	--[2]	--[2]	--[2]	--[2]
	4	2.553	2.236	2.119	2.131	n/a			
	5	2.433	2.349	2.127	2.273				
SV = 70 km/h POV = 20 km/h	1	2.427	2.572	2.191	2.183	2.212	2.268	1.658	2.070
	2	2.497	2.664	2.164	2.174	2.293	2.300	1.900	2.140
	3	2.504	2.447	2.224	2.126	--[2]	--[2]	1.958	--[1]
	4	2.480	2.634	2.026	2.160	n/a			
	5	2.566	2.528	2.204	2.146				
SV = 80 km/h POV = 20 km/h	1	2.961	2.870	2.261	2.167	2.326	2.321	1.818	--[1]
	2	2.914	2.657	2.128	2.151	2.340	2.396	1.973	--[1]
	3	2.971	2.878	2.044	2.104	--[2]	--[2]	--[1]	--[1]
	4	2.782	3.224	2.167	2.154	n/a			
	5	2.895	3.040	2.171	2.237				

[1]Test not performed due to previously observed SV-to-POV contact.

[2]No contact was observed during the first two test trials, so a third trial was not performed.

Green cells = crash avoidance; red cells = SV-to-POV contact occurred.

Table B-11. 50 km/h LVD FCW Onset TTC Summary (Motorcycle POV; 50% Overlap)

Test Conditions	Trial #	2024 Subaru Crosstrek		2023 Toyota Corolla Hybrid		2024 Cadillac Lyriq		2024 Tesla Model 3	
		4a	ABD	4a	ABD	4a	ABD	4a	ABD
SV = 50 km/h POV = 50 km/h POV decel = 0.3g SV-to-POV headway = 12 m	1	1.686	2.000	1.775	1.726	1.702	1.714	1.388	1.486
	2	1.794	1.803	1.803	1.855	1.580	1.655	1.182	1.552
	3	1.835	1.903	1.823	1.731	--[2]	1.770	--[2]	--[2]
	4	--[1]	--[1]	1.834	1.655	n/a			
	5	--[1]	--[1]	1.804	--[1]				
SV = 50 km/h POV = 50 km/h POV decel = 0.5g SV-to-POV headway = 12 m	1	--[1]	--[1]	1.409	--[1]	1.209	1.139	0.980	0.636
	2	--[1]	--[1]	1.319	--[1]	1.258	--[1]	0.974	0.993
	3	--[1]	--[1]	1.387	--[1]	--[1]	--[1]	--[1]	--[1]
	4	--[1]	--[1]	1.397	--[1]	n/a			
	5	--[1]	--[1]	1.372	--[1]				
SV = 50 km/h POV = 50 km/h POV decel = 0.3g SV-to-POV headway = 40 m	1	1.881	1.931	2.081	2.202	1.873	1.823	1.667	1.695
	2	1.912	2.021	2.008	2.131	1.852	1.852	1.596	--[1]
	3	1.965	1.904	2.081	2.144	--[2]	--[2]	--[1]	--[1]
	4	1.887	1.973	2.144	2.125	n/a			
	5	1.938	1.995	2.149	2.178				
SV = 50 km/h POV = 50 km/h POV decel = 0.5g SV-to-POV headway = 40 m	1	1.650	1.856	1.857	1.227	1.942	1.995	--[1]	--[1]
	2	1.719	1.804	1.967	1.939	1.863	1.955	--[1]	--[1]
	3	1.633	1.722	1.892	1.973	--[2]	--[2]	--[1]	--[1]
	4	1.732	1.862	1.922	0.942	n/a			
	5	1.676	1.803	1.904	1.951				

[1]Test not performed due to previously observed SV-to-POV contact.

[2]No contact was observed during the first two test trials, so a third trial was not performed.

Green cells = crash avoidance; red cells = SV-to-POV contact occurred.

Table B-12. 50 km/h LVD FCW Onset TTC Summary (Motorcycle POV; 75% Overlap)

Test Conditions	Trial #	2024 Subaru Crosstrek		2023 Toyota Corolla Hybrid		2024 Cadillac Lyriq		2024 Tesla Model 3	
		4a	ABD	4a	ABD	4a	ABD	4a	ABD
SV = 50 km/h POV = 50 km/h POV decel = 0.3g SV-to-POV headway = 12 m	1	1.835	1.928	1.771	1.782	1.715	1.740	1.405	1.396
	2	1.842	1.922	1.832	1.671	1.656	1.650	1.020	1.505
	3	1.865	1.927	1.809	1.807	--[2]	--[2]	--[2]	--[2]
	4	--[1]	1.883	1.839	0.978	n/a			
	5	--[1]	--[1]	1.777	1.776				
SV = 50 km/h POV = 50 km/h POV decel = 0.5g SV-to-POV headway = 12 m	1	--[1]	--[1]	1.365	1.350	1.286	1.188	0.745	0.956
	2	--[1]	--[1]	1.311	--[1]	1.214	1.210	--[1]	0.947
	3	--[1]	--[1]	1.385	--[1]	--[1]	--[1]	--[1]	--[1]
	4	--[1]	--[1]	1.263	--[1]	n/a			
	5	--[1]	--[1]	1.342	--[1]				
SV = 50 km/h POV = 50 km/h POV decel = 0.3g SV-to-POV headway = 40 m	1	1.950	1.775	1.939	2.121	1.909	1.772	1.294	1.565
	2	2.010	1.819	1.864	2.075	1.887	1.811	--[1]	--[1]
	3	1.933	1.981	2.059	2.067	--[2]	--[2]	--[1]	--[1]
	4	1.862	1.930	2.081	2.058	n/a			
	5	1.965	2.013	2.104	2.167				
SV = 50 km/h POV = 50 km/h POV decel = 0.5g SV-to-POV headway = 40 m	1	1.688	1.781	1.808	0.647	2.044	2.156	--[1]	--[1]
	2	1.789	1.594	1.908	--[1]	1.993	1.905	--[1]	--[1]
	3	1.651	1.687	1.912	--[1]	--[2]	--[2]	--[1]	--[1]
	4	1.696	1.727	1.837	--[1]	n/a			
	5	1.662	1.717	1.781	--[1]				

[1]Test not performed due to previously observed SV-to-POV contact.

[2]No contact was observed during the first two test trials, so a third trial was not performed.

Green cells = crash avoidance; red cells = SV-to-POV contact occurred.

Table B-13. 80 km/h LVD FCW Onset TTC Summary (Motorcycle POV; 50% Overlap)

Test Conditions	Trial #	2024 Subaru Crosstrek		2023 Toyota Corolla Hybrid		2024 Cadillac Lyriq		2024 Tesla Model 3	
		4a	ABD	4a	ABD	4a	ABD	4a	ABD
SV = 80 km/h POV = 80 km/h POV decel = 0.3g SV-to-POV headway = 12 m	1	1.952	1.948	1.810	1.716	1.817	1.822	0.973	0.991
	2	1.927	1.907	1.804	1.830	1.889	1.870	--[1]	--[1]
	3	1.955	1.917	1.793	1.714	--[2]	--[2]	--[1]	--[1]
	4	1.947	--[1]	1.704	--[1]	n/a			
	5	1.889	--[1]	1.827	--[1]				
SV = 80 km/h POV = 80 km/h POV decel = 0.5g SV-to-POV headway = 12 m	1	1.344	--[1]	1.217	--[1]	1.390	1.289	--[1]	--[1]
	2	1.355	--[1]	1.367	--[1]	--[1]	--[1]	--[1]	--[1]
	3	1.388	--[1]	1.343	--[1]	--[1]	--[1]	--[1]	--[1]
	4	--[1]	--[1]	1.398	--[1]	n/a			
	5	--[1]	--[1]	1.370	--[1]				
SV = 80 km/h POV = 80 km/h POV decel = 0.3g SV-to-POV headway = 40 m	1	2.657	2.377	2.088	2.165	2.354	2.297	2.036	1.6263
	2	2.799	2.770	2.091	1.041	2.237	2.248	1.911	--[1]
	3	2.315	2.600	2.123	2.152	--[2]	--[2]	1.843	--[1]
	4	2.186	--[1]	2.228	1.257	n/a			
	5	2.752	--[1]	2.182	2.111				
SV = 80 km/h POV = 80 km/h POV decel = 0.5g SV-to-POV headway = 40 m	1	2.101	--[1]	2.143	--[1]	2.220	2.229	--[1]	--[1]
	2	2.008	--[1]	2.170	--[1]	2.384	2.124	--[1]	--[1]
	3	2.264	--[1]	2.038	--[1]	--[2]	2.437	--[1]	--[1]
	4	--[1]	--[1]	--[1]	--[1]	n/a			
	5	--[1]	--[1]	--[1]	--[1]				

[1]Test not performed due to previously observed SV-to-POV contact.

[2]No contact was observed during the first two test trials, so a third trial was not performed.

Green cells = crash avoidance; red cells = SV-to-POV contact occurred.

Table B-14. 80 km/h LVD FCW Onset TTC Summary (Motorcycle POV; 75% Overlap)

Test Conditions	Trial #	2024 Subaru Crosstrek		2023 Toyota Corolla Hybrid		2024 Cadillac Lyriq		2024 Tesla Model 3	
		4a	ABD	4a	ABD	4a	ABD	4a	ABD
SV = 80 km/h POV = 80 km/h POV decel = 0.3g SV-to-POV headway = 12 m	1	1.879	1.887	1.774	1.844	1.852	1.665	1.123	1.102
	2	1.956	--[1]	1.785	1.699[3]	1.782	1.817	1.189	1.242
	3	1.937	--[1]	1.793	--[1]	--[2]	--[2]	--[2]	--[2]
	4	1.973	--[1]	1.830	--[1]	n/a			
	5	1.928	--[1]	1.833	--[1]				
SV = 80 km/h POV = 80 km/h POV decel = 0.5g SV-to-POV headway = 12 m	1	--[1]	--[1]	1.412	--[1]	1.301	1.348	0.645	0.780
	2	--[1]	--[1]	1.355	--[1]	--[1]	--[1]	--[1]	--[1]
	3	--[1]	--[1]	1.373	--[1]	--[1]	--[1]	--[1]	--[1]
	4	--[1]	--[1]	1.303	--[1]	n/a			
	5	--[1]	--[1]	--[1]	--[1]				
SV = 80 km/h POV = 80 km/h POV decel = 0.3g SV-to-POV headway = 40 m	1	2.208	2.183	2.147	2.003	2.225	2.412	1.351	1.127
	2	2.227	2.154	2.120	2.048	2.305	2.338	1.310	1.034
	3	2.385	2.546	2.139	--[3]	--[2]	--[2]	1.260	--[1]
	4	2.167	--[1]	1.982	--[3]	n/a			
	5	2.263	--[1]	2.080	--[3]				
SV = 80 km/h POV = 80 km/h POV decel = 0.5g SV-to-POV headway = 40 m	1	--[1]	--[1]	2.027	1.550	2.310	2.251	--[1]	--[1]
	2	--[1]	--[1]	2.180	1.701	2.353	2.233	--[1]	--[1]
	3	--[1]	--[1]	1.965	--[1]	--[2]	--[2]	--[1]	--[1]
	4	--[1]	--[1]	--[1]	--[1]	n/a			
	5	--[1]	--[1]	--[1]	--[1]				

[1]Test not performed due to previously observed SV-to-POV contact.

[2]No contact was observed during the first two test trials, so a third trial was not performed.

[3]Only two repeated trials were performed (rather than 3) due to a testing oversight.

Green cells = crash avoidance; red cells = SV-to-POV contact occurred.

Appendix C: Automatic Emergency Braking Onset Times

AEB brake onset TTCs are shown in Tables C-1 to C-14. Here, the AEB brake onset is taken to be the instant the SV longitudinal deceleration is ≥ 0.25g.

For all tables in Appendix C, trials where crash avoidance was observed are highlighted in green whereas trials highlighted in red indicate an SV-to-POV contact was observed.

Table C-1. LVS AEB Brake Onset TTC Summary (Bicycle POV; 50% Overlap)

Test Conditions	Trial #	2024 Subaru Crosstrek		2023 Toyota Corolla Hybrid		2024 Cadillac Lyriq		2024 Tesla Model 3	
		4a	ABD	4a	ABD	4a	ABD	4a	ABD
SV = 10 km/h POV = 0 km/h	1	0.310	n/a	0.809	n/a	0.658	0.653	0.174	0.240
	2	0.326	n/a	0.726	n/a	0.750	0.672	0.209	0.339
	3	0.294	n/a	0.788	n/a	--[2]	--[2]	--[2]	--[2]
	4	0.326	n/a	0.749	n/a	n/a			
	5	0.283	n/a	0.625	n/a				
SV = 20 km/h POV = 0 km/h	1	0.572	n/a	0.653	n/a	0.655	0.553	0.360	0.636
	2	0.600	n/a	0.604	n/a	0.565	0.634	0.334	0.543
	3	0.580	n/a	0.636	n/a	--[2]	--[2]	0.310	--[2]
	4	0.570	n/a	0.675	n/a	n/a			
	5	0.682	n/a	0.602	n/a				
SV = 30 km/h POV = 0 km/h	1	0.814	n/a	0.906	n/a	0.645	0.601	--[1]	0.659
	2	0.883	n/a	0.913	n/a	0.572	0.635	--[1]	0.703
	3	0.852	n/a	0.933	n/a	--[2]	--[2]	--[1]	--[1]
	4	0.885	n/a	0.963	n/a	n/a			
	5	0.855	n/a	0.974	n/a				
SV = 40 km/h POV = 0 km/h	1	0.978	n/a	1.020	n/a	0.775	0.768	--[1]	0.609
	2	0.984	n/a	1.008	n/a	0.797	0.802	--[1]	0.647
	3	0.989	n/a	1.005	n/a	--[2]	--[2]	--[1]	--[1]
	4	1.001	n/a	1.013	n/a	n/a			
	5	0.994	n/a	1.062	n/a				
SV = 50 km/h POV = 0 km/h	1	1.037	n/a	1.085	n/a	1.079	0.961	--[1]	0.477
	2	1.069	n/a	1.121	n/a	1.063	1.073	--[1]	--[1]
	3	1.051	n/a	1.136	n/a	--[2]	--[2]	--[1]	--[1]
	4	1.085	n/a	1.101	n/a	n/a			
	5	1.089	n/a	1.139	n/a				
SV = 60 km/h POV = 0 km/h	1	1.146	n/a	1.292	n/a	1.384	1.259	--[1]	--[1]
	2	1.113	n/a	1.264	n/a	1.038	1.040	--[1]	--[1]
	3	1.182	n/a	1.273	n/a	--[2]	1.052	--[1]	--[1]
	4	1.166	n/a	1.297	n/a	n/a			
	5	1.169	n/a	1.291	n/a				
SV = 70 km/h POV = 0 km/h	1	1.177	n/a	1.455	n/a	1.002	--[1]	--[1]	--[1]
	2	1.109	n/a	1.430	n/a	1.189	--[1]	--[1]	--[1]
	3	1.161	n/a	1.519	n/a	--[1]	--[1]	--[1]	--[1]
	4	1.254	n/a	1.501	n/a	n/a			
	5	1.131	n/a	1.453	n/a				
SV = 80 km/h POV = 0 km/h	1	1.191	n/a	1.579	n/a	--[1]	--[1]	--[1]	--[1]
	2	1.180	n/a	1.643	n/a	--[1]	--[1]	--[1]	--[1]
	3	1.198	n/a	1.605	n/a	--[1]	--[1]	--[1]	--[1]
	4	--[1]	n/a	1.616	n/a	n/a			
	5	--[1]	n/a	1.608	n/a				

[1]Test not performed due to previously observed SV-to-POV contact.

[2]No contact was observed during the first two test trials, so a third trial was not performed.

Green cells = crash avoidance; red cells = SV-to-POV contact occurred.

Table C-2. LVS AEB Brake Onset TTC Summary (Bicycle POV; 25% Overlap)

Test Conditions	Trial #	2024 Subaru Crosstrek		2023 Toyota Corolla Hybrid		2024 Cadillac Lyriq		2024 Tesla Model 3	
		4a	ABD	4a	ABD	4a	ABD	4a	ABD
SV = 10 km/h POV = 0 km/h	1	0.389	n/a	0.765	n/a	0.649	0.753	0.195	0.891
	2	0.316	n/a	0.825	n/a	0.626	0.527	0.739	NA
	3	0.367	n/a	0.762	n/a	--[2]	--[2]	--[2]	NA
	4	0.368	n/a	0.829	n/a	n/a			
	5	0.346	n/a	0.727	n/a				
SV = 20 km/h POV = 0 km/h	1	0.696	n/a	0.669	n/a	0.625	0.582	0.278	0.333
	2	0.556	n/a	0.699	n/a	0.569	0.526	0.242	0.302
	3	0.575	n/a	0.694	n/a	--[2]	--[2]	--[1]	0.301
	4	0.557	n/a	0.734	n/a	n/a			
	5	0.745	n/a	0.665	n/a				
SV = 30 km/h POV = 0 km/h	1	0.732	n/a	1.002	n/a	0.593	0.508	--[1]	0.307
	2	0.884	n/a	0.914	n/a	0.629	0.550	--[1]	--[1]
	3	0.853	n/a	0.957	n/a	--[2]	--[2]	--[1]	--[1]
	4	0.873	n/a	0.944	n/a	n/a			
	5	0.888	n/a	0.984	n/a				
SV = 40 km/h POV = 0 km/h	1	0.987	n/a	1.053	n/a	0.874	0.754	--[1]	--[1]
	2	0.959	n/a	1.067	n/a	0.885	0.832	--[1]	--[1]
	3	0.977	n/a	1.049	n/a	--[2]	--[2]	--[1]	--[1]
	4	0.939	n/a	1.045	n/a	n/a			
	5	0.967	n/a	1.063	n/a				
SV = 50 km/h POV = 0 km/h	1	1.059	n/a	1.129	n/a	1.079	1.103	--[1]	--[1]
	2	1.075	n/a	1.146	n/a	0.990	1.064	--[1]	--[1]
	3	1.070	n/a	1.146	n/a	--[2]	--[2]	--[1]	--[1]
	4	1.047	n/a	1.136	n/a	--[2]			
	5	1.092	n/a	1.125	n/a				
SV = 60 km/h POV = 0 km/h	1	1.120	n/a	1.331	n/a	1.211	1.360	--[1]	--[1]
	2	1.104	n/a	1.309	n/a	1.285	1.318	--[1]	--[1]
	3	1.176	n/a	1.286	n/a	--[2]	--[2]	--[1]	--[1]
	4	1.158	n/a	1.275	n/a	n/a			
	5	1.162	n/a	1.282	n/a				
SV = 70 km/h POV = 0 km/h	1	1.215	n/a	1.464	n/a	1.219	1.411	--[1]	--[1]
	2	1.136	n/a	1.471	n/a	1.232	1.761	--[1]	--[1]
	3	1.179	n/a	1.446	n/a	1.616	--[2]	--[1]	--[1]
	4	1.205	n/a	1.439	n/a	n/a			
	5	1.119	n/a	1.498	n/a				
SV = 80 km/h POV = 0 km/h	1	1.172	n/a	1.566	n/a	0.891	1.009	--[1]	--[1]
	2	1.225	n/a	1.466	n/a	--[1]	--[1]	--[1]	--[1]
	3	1.129	n/a	1.648	n/a	--[1]	--[1]	--[1]	--[1]
	4	--[1]	n/a	1.599	n/a	n/a			
	5	--[1]	n/a	1.629	n/a				

[1]Test not performed due to previously observed SV-to-POV contact.

[2]No contact was observed during the first two test trials, so a third trial was not performed.

Green cells = crash avoidance; red cells = SV-to-POV contact occurred.

Table C-3. LVM AEB Brake Onset TTC Summary (Bicycle POV; 50% Overlap)

Test Conditions	Trial #	2024 Subaru Crosstrek		2023 Toyota Corolla Hybrid		2024 Cadillac Lyriq		2024 Tesla Model 3	
		4a	ABD	4a	ABD	4a	ABD	4a	ABD
SV = 40 km/h POV = 20 km/h	1	0.603	n/a	0.585	n/a	0.943	0.909	2.457	2.654
	2	0.627	n/a	0.547	n/a	0.933	0.963	NA[3]	NA[3]
	3	0.596	n/a	0.551	n/a	--[2]	--[2]	--[2]	--[2]
	4	0.702	n/a	0.557	n/a	n/a			
	5	0.633	n/a	0.577	n/a				
SV = 50 km/h POV = 20 km/h	1	0.909	n/a	0.839	n/a	1.162	1.223	4.439	2.185
	2	0.878	n/a	0.743	n/a	1.117	1.139	1.032	3.236
	3	0.867	n/a	0.938	n/a	--[2]	--[2]	--[2]	--[2]
	4	0.877	n/a	0.930	n/a	n/a			
	5	0.829	n/a	0.874	n/a				
SV = 60 km/h POV = 20 km/h	1	0.966	n/a	1.017	n/a	1.225	1.219	1.060	1.442
	2	0.972	n/a	1.007	n/a	1.151	1.118	0.940	1.425
	3	1.025	n/a	1.068	n/a	--[2]	--[2]	--[2]	--[2]
	4	1.020	n/a	1.019	n/a	n/a			
	5	1.023	n/a	0.998	n/a				
SV = 70 km/h POV = 20 km/h	1	1.111	n/a	1.125	n/a	1.289	1.210	0.568	1.051
	2	1.079	n/a	1.114	n/a	1.148	1.174	0.681	0.976
	3	1.087	n/a	1.164	n/a	--[2]	--[2]	--[1]	--[2]
	4	1.096	n/a	1.160	n/a	n/a			
	5	1.071	n/a	1.210	n/a				
SV = 80 km/h POV = 20 km/h	1	1.122	n/a	1.034	n/a	1.345	1.253	--[1]	0.717
	2	1.163	n/a	1.041	n/a	1.300	1.338	--[1]	0.666
	3	1.174	n/a	1.233	n/a	--[2]	--[2]	--[1]	--[1]
	4	1.143	n/a	1.312	n/a	n/a			
	5	1.162	n/a	0.928	n/a				

[1]Test not performed due to previously observed SV-to-POV contact.

[2]No contact was observed during the first two test trials, so a third trial was not performed.

[3]SV deceleration did not meet or exceed 0.25g during this trial.

Green cells = crash avoidance; red cells = SV-to-POV contact occurred.

Table C-4. LVM AEB Brake Onset TTC Summary (Bicycle POV; 25% Overlap)

Test Conditions	Trial #	2024 Subaru Crosstrek		2023 Toyota Corolla Hybrid		2024 Cadillac Lyriq		2024 Tesla Model 3	
		4a	ABD	4a	ABD	4a	ABD	4a	ABD
SV = 40 km/h POV = 20 km/h	1	0.608	n/a	0.646	n/a	0.937	0.924	2.570	1.447
	2	0.590	n/a	0.599	n/a	0.860	0.821	NA[3]	NA[3]
	3	0.606	n/a	0.665	n/a	--[2]	--[2]	--[2]	--[2]
	4	0.784	n/a	0.543	n/a	n/a			
	5	0.619	n/a	0.652	n/a				
SV = 50 km/h POV = 20 km/h	1	0.893	n/a	0.975	n/a	1.201	1.201	1.189	1.835
	2	0.837	n/a	0.921	n/a	1.136	1.150	1.759	NA[3]
	3	0.828	n/a	0.942	n/a	--[2]	--[2]	--[2]	--[2]
	4	0.842	n/a	0.972	n/a	n/a			
	5	0.843	n/a	0.956	n/a				
SV = 60 km/h POV = 20 km/h	1	0.926	n/a	1.046	n/a	1.133	1.139	0.687	0.618
	2	1.002	n/a	1.049	n/a	1.160	1.199	0.665	NA[3]
	3	0.956	n/a	1.075	n/a	--[2]	--[2]	--[2]	--[2]
	4	0.995	n/a	1.047	n/a	n/a			
	5	0.961	n/a	1.036	n/a				
SV = 70 km/h POV = 20 km/h	1	1.033	n/a	1.134	n/a	1.164	1.147	0.542	0.591
	2	1.090	n/a	1.205	n/a	1.072	1.174	0.515	0.541
	3	1.125	n/a	1.135	n/a	--[2]	--[2]	--[1]	--[1]
	4	1.066	n/a	1.081	n/a	n/a			
	5	1.039	n/a	1.169	n/a				
SV = 80 km/h POV = 20 km/h	1	1.127	n/a	1.348	n/a	1.285	1.459	--[1]	--[1]
	2	1.157	n/a	1.299	n/a	1.274	1.314	--[1]	--[1]
	3	1.154	n/a	1.294	n/a	--[2]	--[2]	--[1]	--[1]
	4	1.092	n/a	1.287	n/a	n/a			
	5	1.094	n/a	1.369	n/a				

[1]Test not performed due to previously observed SV-to-POV contact.

[2]No contact was observed during the first two test trials, so a third trial was not performed.

[3]SV deceleration did not meet or exceed 0.25g during this trial.

Green cells = crash avoidance; red cells = SV-to-POV contact occurred.

Table C-5. LVD AEB Brake Onset TTC Summary (Bicycle POV; 50% Overlap)

Test Conditions	Trial #	2024 Subaru Crosstrek		2023 Toyota Corolla Hybrid		2024 Cadillac Lyriq		2024 Tesla Model 3	
		4a	ABD	4a	ABD	4a	ABD	4a	ABD
SV = 20 km/h POV = 20 km/h POV decel = 0.3g SV-to-POV headway = 12 m	1	0.757	n/a	0.852	n/a	0.801	0.777	0.433	0.401
	2	0.722	n/a	0.823	n/a	0.715	1.214	0.392	0.347
	3	0.815	n/a	0.782	n/a	--[2]	--[2]	--[2]	0.319
	4	0.765	n/a	0.972	n/a	n/a			
	5	0.779	n/a	0.943	n/a				
SV = 30 km/h POV = 30 km/h POV decel = 0.3g SV-to-POV headway = 12 m	1	0.721	n/a	0.953	n/a	0.859	0.860	1.567	2.020
	2	0.770	n/a	0.961	n/a	0.320	0.905	2.056	1.335
	3	0.832	n/a	0.961	n/a	0.339	--[2]	--[2]	--[2]
	4	0.779	n/a	0.977	n/a	n/a			
	5	0.749	n/a	0.970	n/a				
SV = 20 km/h POV = 20 km/h POV decel = 0.3g SV-to-POV headway = 40 m	1	0.691	n/a	0.671	n/a	0.698	0.632	0.963	0.764
	2	0.696	n/a	0.826	n/a	0.737	0.607	0.852	0.699
	3	0.883	n/a	0.703	n/a	--[2]	--[2]	--[2]	--[2]
	4	0.759	n/a	0.697	n/a	n/a			
	5	0.760	n/a	0.874	n/a				
SV = 30 km/h POV = 30 km/h POV decel = 0.3g SV-to-POV headway = 40 m	1	1.036	n/a	1.109	n/a	0.758	0.723	0.906	0.751
	2	0.998	n/a	1.124	n/a	0.653	0.665	0.939	0.775
	3	1.033	n/a	1.149	n/a	--[2]	--[2]	--[2]	--[2]
	4	1.093	n/a	1.135	n/a	n/a			
	5	1.043	n/a	1.103	n/a				

[1]Test not performed due to previously observed SV-to-POV contact.

[2]No contact was observed during the first two test trials, so a third trial was not performed.

Green cells = crash avoidance; red cells = SV-to-POV contact occurred.

Table C-6. LVD AEB Brake Onset TTC Summary (Bicycle POV; 25% Overlap)

Test Conditions	Trial #	2024 Subaru Crosstrek		2023 Toyota Corolla Hybrid		2024 Cadillac Lyriq		2024 Tesla Model 3	
		4a	ABD	4a	ABD	4a	ABD	4a	ABD
SV = 20 km/h POV = 20 km/h POV decel = 0.3g SV-to-POV headway = 12 m	1	0.740	n/a	0.969	n/a	0.824	2.001	0.327	0.231
	2	0.704	n/a	0.898	n/a	1.816	1.644	0.337	0.275
	3	0.752	n/a	0.966	n/a	--[2]	--[2]	--[1]	--[1]
	4	0.775	n/a	0.916	n/a	n/a			
	5	0.688	n/a	1.138	n/a				
SV = 30 km/h POV = 30 km/h POV decel = 0.3g SV-to-POV headway = 12 m	1	0.879	n/a	0.967	n/a	0.438	0.806	1.071	1.939
	2	0.752	n/a	1.008	n/a	0.536	0.726	1.420	1.489
	3	0.766	n/a	1.007	n/a	0.773	--[2]	--[2]	--[2]
	4	0.795	n/a	0.947	n/a	n/a			
	5	0.803	n/a	0.949	n/a				
SV = 20 km/h POV = 20 km/h POV decel = 0.3g SV-to-POV headway = 40 m	1	0.691	n/a	1.147	n/a	0.902	0.687	0.877	0.875
	2	0.696	n/a	1.140	n/a	0.734	0.790	0.965	0.794
	3	0.883	n/a	1.130	n/a	--[2]	--[2]	--[2]	--[2]
	4	0.759	n/a	1.121	n/a	n/a			
	5	0.760	n/a	1.142	n/a				
SV = 30 km/h POV = 30 km/h POV decel = 0.3g SV-to-POV headway = 40 m	1	1.036	n/a	0.775	n/a	0.679	0.781	0.898	0.720
	2	0.998	n/a	0.856	n/a	0.729	0.709	0.921	0.843
	3	1.033	n/a	0.750	n/a	--[2]	--[2]	--[2]	--[2]
	4	1.093	n/a	0.847	n/a	n/a			
	5	1.043	n/a	0.776	n/a				

[1]Test not performed due to previously observed SV-to-POV contact.

[2]No contact was observed during the first two test trials, so a third trial was not performed.

Green cells = crash avoidance; red cells = SV-to-POV contact occurred.

Table C-7. LVS AEB Brake Onset TTC Summary (Motorcycle POV; 50% Overlap)

Test Conditions	Trial #	2024 Subaru Crosstrek		2023 Toyota Corolla Hybrid		2024 Cadillac Lyriq		2024 Tesla Model 3	
		4a	ABD	4a	ABD	4a	ABD	4a	ABD
SV = 10 km/h POV = 0 km/h	1	0.423	0.411	0.684	0.881	0.761	0.373	0.258	0.405
	2	0.514	0.359	0.713	0.868	0.623	0.690	0.220	0.543
	3	0.428	0.384	0.698	0.856	--[2]	0.307	--[2]	--[2]
	4	0.480	0.367	0.690	0.854	n/a			
	5	0.454	0.400	0.678	0.878				
SV = 20 km/h POV = 0 km/h	1	0.839	0.756	0.652	0.699	0.365	0.626	0.523	0.475
	2	0.741	0.828	0.644	0.736	0.585	0.496	0.544	0.511
	3	0.611	0.795	0.624	0.723	--[2]	--[2]	--[2]	--[2]
	4	0.669	0.794	0.702	0.748	n/a			
	5	0.659	0.784	0.674	0.776				
SV = 30 km/h POV = 0 km/h	1	0.882	0.911	0.941	0.900	0.739	0.584	0.523	0.399
	2	0.848	0.888	0.814	1.045	0.654	0.703	0.544	0.401
	3	0.880	0.883	0.958	1.031	--[2]	--[2]	0.463	--[1]
	4	0.865	0.903	0.810	0.998	n/a			
	5	0.856	0.847	0.987	1.011				
SV = 40 km/h POV = 0 km/h	1	0.972	1.013	1.018	1.092	0.821	0.956	0.460	--[1]
	2	0.941	1.066	1.042	1.094	1.122	0.837	0.441	--[1]
	3	0.959	1.036	1.052	1.093	--[2]	--[2]	--[1]	--[1]
	4	1.025	0.989	1.014	1.102	n/a			
	5	1.005	0.997	1.009	1.085				
SV = 50 km/h POV = 0 km/h	1	1.073	1.119	1.142	1.154	0.821	1.054	--[1]	--[1]
	2	1.108	1.067	1.146	1.174	1.067	1.081	--[1]	--[1]
	3	1.110	1.104	1.142	1.206	--[2]	--[2]	--[1]	--[1]
	4	1.063	1.070	1.145	1.192	n/a			
	5	1.082	1.092	1.139	1.170				
SV = 60 km/h POV = 0 km/h	1	1.213	1.141	1.315	1.525	1.351	1.329	--[1]	--[1]
	2	1.182	1.151	1.283	1.374	1.266	1.309	--[1]	--[1]
	3	1.137	1.161	1.321	1.316	--[2]	--[2]	--[1]	--[1]
	4	1.122	1.240	1.267	1.271	n/a			
	5	1.177	1.202	1.326	1.281				
SV = 70 km/h POV = 0 km/h	1	1.160	1.121	1.494	1.364	1.288	1.406	--[1]	--[1]
	2	1.141	1.115	1.496	1.060	1.370	1.328	--[1]	--[1]
	3	1.163	1.141	1.479	1.534	--[2]	--[2]	--[1]	--[1]
	4	1.137	--[1]	1.420	1.444	n/a			
	5	--[1]	--[1]	1.489	1.186				
SV = 80 km/h POV = 0 km/h	1	--[1]	--[1]	1.605	1.118	1.273	1.655	--[1]	--[1]
	2	--[1]	--[1]	1.070	1.601	1.610	1.648	--[1]	--[1]
	3	--[1]	--[1]	1.541	1.313	1.390	--[2]	--[1]	--[1]
	4	--[1]	--[1]	1.433	1.583	n/a			
	5	--[1]	--[1]	--[1]	1.630				

[1]Test not performed due to previously observed SV-to-POV contact.

[2]No contact was observed during the first two test trials, so a third trial was not performed. Green cells = crash avoidance; red cells = SV-to-POV contact occurred.

Table C-8. LVS AEB Brake Onset TTC Summary (Motorcycle POV; 75% Overlap)

Test Conditions	Trial #	2024 Subaru Crosstrek		2023 Toyota Corolla Hybrid		2024 Cadillac Lyriq		2024 Tesla Model 3	
		4a	ABD	4a	ABD	4a	ABD	4a	ABD
SV = 10 km/h POV = 0 km/h	1	NA	0.450	0.718	0.844	0.722	0.735	0.619	0.708
	2	NA	0.312	0.710	0.843	0.734	0.695	0.899	0.604
	3	NA	0.457	0.745	0.790	--[2]	--[2]	--[2]	--[2]
	4	--[1]	0.366	0.737	0.804	n/a			
	5	--[1]	0.441	0.717	0.868				
SV = 20 km/h POV = 0 km/h	1	0.755	0.578	0.643	0.757	0.679	0.605	0.627	0.449
	2	0.758	0.669	0.605	0.769	0.663	0.661	0.615	0.421
	3	0.569	0.849	0.672	0.698	--[2]	--[2]	--[2]	--[2]
	4	0.797	0.585	0.634	0.789	n/a			
	5	0.818	0.836	0.639	0.708				
SV = 30 km/h POV = 0 km/h	1	0.846	0.853	0.973	1.043	0.702	0.708	0.514	0.328
	2	0.886	0.874	0.996	1.045	0.732	0.688	0.371	0.360
	3	0.870	0.871	0.967	1.017	--[2]	--[2]	0.492	--[1]
	4	0.855	0.867	0.970	1.036	n/a			
	5	0.827	0.912	0.994	0.944				
SV = 40 km/h POV = 0 km/h	1	0.998	1.010	1.058	1.050	0.831	0.849	--[1]	--[1]
	2	0.975	1.025	1.035	1.063	0.778	0.835	--[1]	--[1]
	3	1.017	0.889	1.058	1.030	--[2]	--[2]	--[1]	--[1]
	4	0.991	1.021	1.041	1.023	n/a			
	5	0.993	1.001	1.038	1.078				
SV = 50 km/h POV = 0 km/h	1	1.099	1.126	1.176	1.180	1.094	1.107	--[1]	--[1]
	2	1.046	1.069	1.149	1.199	1.078	1.139	--[1]	--[1]
	3	1.082	1.076	1.188	1.211	--[2]	--[2]	--[1]	--[1]
	4	1.086	1.034	1.163	1.208	n/a			
	5	1.131	1.043	1.163	1.160				
SV = 60 km/h POV = 0 km/h	1	1.136	1.114	1.267	1.291	1.051	1.311	--[1]	--[1]
	2	1.123	1.115	1.290	1.277	1.327	1.287	--[1]	--[1]
	3	1.126	1.122	1.244	1.275	1.303	--[2]	--[1]	--[1]
	4	1.187	1.097	1.281	1.305	n/a			
	5	1.171	1.160	1.267	1.272				
SV = 70 km/h POV = 0 km/h	1	1.097	1.138	1.497	1.520	1.288	1.335	--[1]	--[1]
	2	1.131	1.181	1.448	1.479	1.056	1.479	--[1]	--[1]
	3	1.097	1.168	1.461	1.498	1.263	--[2]	--[1]	--[1]
	4	--[1]	--[1]	1.487	1.453	n/a			
	5	--[1]	--[1]	1.498	1.500				
SV = 80 km/h POV = 0 km/h	1	--[1]	--[1]	1.590	1.584	1.280	1.713	--[1]	--[1]
	2	--[1]	--[1]	1.555	1.659	2.234	1.417	--[1]	--[1]
	3	--[1]	--[1]	1.623	1.573	1.351	1.959	--[1]	--[1]
	4	--[1]	--[1]	--[1]	--[1]	n/a			
	5	--[1]	--[1]	--[1]	--[1]				

[1]Test not performed due to previously observed SV-to-POV contact.

[2]No contact was observed during the first two test trials, so a third trial was not performed. Green cells = crash avoidance; red cells = SV-to-POV contact occurred.

Table C-9. LVM AEB Brake Onset TTC Summary (Motorcycle POV; 50% Overlap)

Test Conditions	Trial #	2024 Subaru Crosstrek		2023 Toyota Corolla Hybrid		2024 Cadillac Lyriq		2024 Tesla Model 3	
		4a	ABD	4a	ABD	4a	ABD	4a	ABD
SV = 40 km/h POV = 20 km/h	1	0.617	0.665	0.683	0.713	0.997	0.954	NA[3]	1.619
	2	0.649	0.673	0.611	0.731	0.987	0.993	1.850	NA[3]
	3	0.571	0.684	0.666	0.763	--[2]	--[2]	--[2]	--[2]
	4	0.628	0.635	0.668	0.740	n/a			
	5	0.669	0.572	0.658	0.736				
SV = 50 km/h POV = 20 km/h	1	0.841	0.908	0.934	0.946	1.271	1.243	1.169	NA[3]
	2	0.942	0.916	0.806	0.980	1.203	1.155	1.221	1.198
	3	0.887	0.887	0.771	0.832	--[2]	--[2]	--[2]	--[2]
	4	0.870	0.910	0.821	0.857	n/a			
	5	0.906	0.889	0.818	0.819				
SV = 60 km/h POV = 20 km/h	1	0.992	1.000	1.020	1.064	1.175	1.254	0.751	0.940
	2	0.981	1.015	1.065	1.108	1.192	1.083	0.763	0.924
	3	1.020	1.029	1.012	1.053	--[2]	--[2]	--[2]	--[2]
	4	1.022	1.056	1.055	1.067	n/a			
	5	1.004	1.028	1.089	1.055				
SV = 70 km/h POV = 20 km/h	1	1.064	1.072	1.188	1.152	1.286	1.196	0.768	0.662
	2	1.076	1.104	1.156	1.164	1.267	1.162	0.617	0.811
	3	1.109	1.069	1.175	1.193	--[2]	--[2]	--[1]	0.767
	4	1.052	1.099	1.157	1.166	n/a			
	5	1.054	1.119	1.189	1.208				
SV = 80 km/h POV = 20 km/h	1	1.197	1.163	1.375	1.234	1.313	1.365	--[1]	--[1]
	2	1.122	1.138	1.348	1.265	1.253	1.316	--[1]	--[1]
	3	1.134	1.127	1.309	1.347	--[2]	--[2]	--[1]	--[1]
	4	1.127	1.135	1.317	1.350	n/a			
	5	1.115	1.119	1.354	1.313				

[1]Test not performed due to previously observed SV-to-POV contact.

[2]No contact was observed during the first two test trials, so a third trial was not performed.

[3]SV deceleration did not meet or exceed 0.25g during this trial.

Green cells = crash avoidance; red cells = SV-to-POV contact occurred.

Table C-10. LVM AEB Brake Onset TTC Summary (Motorcycle POV; 75% Overlap)

Test Conditions	Trial #	2024 Subaru Crosstrek		2023 Toyota Corolla Hybrid		2024 Cadillac Lyriq		2024 Tesla Model 3	
		4a	ABD	4a	ABD	4a	ABD	4a	ABD
SV = 40 km/h POV = 20 km/h	1	0.652	0.561	0.859	0.506	1.012	0.907	NA[3]	2.150
	2	0.641	0.615	0.789	0.763	0.963	0.871	NA[3]	2.155
	3	0.646	0.631	0.788	0.650	--[2]	--[2]	--[2]	--[2]
	4	0.622	0.585	0.851	0.615	n/a			
	5	0.629	0.589	0.669	0.522				
SV = 50 km/h POV = 20 km/h	1	0.892	0.875	0.932	0.991	1.209	1.132	1.093	1.365
	2	0.900	0.798	0.970	0.962	1.170	1.150	1.254	1.267
	3	0.830	0.812	0.926	0.959	--[2]	--[2]	--[2]	--[2]
	4	0.722	0.882	0.949	0.870	n/a			
	5	0.867	0.849	0.968	0.952				
SV = 60 km/h POV = 20 km/h	1	0.862	1.013	1.018	1.059	1.192	1.143	0.930	1.309
	2	0.855	0.994	1.022	1.063	1.198	1.110	0.872	0.788
	3	0.898	1.037	1.035	1.117	--[2]	--[2]	--[2]	--[2]
	4	0.868	1.019	1.034	1.075	n/a			
	5	0.868	0.989	1.022	1.063				
SV = 70 km/h POV = 20 km/h	1	1.056	1.090	1.120	1.229	1.199	1.191	1.191	0.692
	2	1.070	1.104	1.186	1.147	1.289	1.219	0.732	0.609
	3	1.058	1.043	1.182	1.294	--[2]	--[2]	0.825	--[1]
	4	1.105	1.034	1.208	1.208	n/a			
	5	1.118	1.064	1.199	1.224				
SV = 80 km/h POV = 20 km/h	1	1.109	1.113	1.285	1.260	1.330	1.322	0.659	--[1]
	2	1.042	1.127	1.361	1.383	1.302	1.295	0.701	--[1]
	3	1.128	1.185	1.335	1.321	--[2]	--[2]	--[1]	--[1]
	4	1.082	1.148	1.284	1.377	n/a			
	5	1.122	1.103	1.338	1.340				

[1]Test not performed due to previously observed SV-to-POV contact.

[2]No contact was observed during the first two test trials, so a third trial was not performed.

[3]SV deceleration did not meet or exceed 0.25g during this trial.

Green cells = crash avoidance; red cells = SV-to-POV contact occurred.

Table C-11. 50 km/h LVD AEB Brake Onset TTC Summary (Motorcycle POV; 50% Overlap)

Test Conditions	Trial #	2024 Subaru Crosstrek		2023 Toyota Corolla Hybrid		2024 Cadillac Lyriq		2024 Tesla Model 3	
		4a	ABD	4a	ABD	4a	ABD	4a	ABD
SV = 50 km/h POV = 50 km/h POV decel = 0.3g SV-to-POV headway = 12 m	1	1.088	0.996	0.968	0.973	1.147	1.276	1.208	1.411
	2	0.980	1.045	0.993	0.247	1.037	1.199	0.808	1.238
	3	0.972	1.004	0.992	0.816	--[2]	0.982	--[2]	--[2]
	4	--[1]	--[1]	0.956	1.012	n/a			
	5	--[1]	--[1]	0.976	--[1]				
SV = 50 km/h POV = 50 km/h POV decel = 0.5g SV-to-POV headway = 12 m	1	--[1]	--[1]	1.056	--[1]	0.817	0.615	0.670	0.636
	2	--[1]	--[1]	1.000	--[1]	0.797	--[1]	0.531	0.818
	3	--[1]	--[1]	0.988	--[1]	--[1]	--[1]	--[1]	--[1]
	4	--[1]	--[1]	0.977	--[1]	n/a			
	5	--[1]	--[1]	1.049	--[1]				
SV = 50 km/h POV = 50 km/h POV decel = 0.3g SV-to-POV headway = 40 m	1	0.976	0.955	1.136	1.194	1.292	1.283	0.703	0.384
	2	0.927	0.929	1.141	1.215	1.257	1.219	0.446	--[1]
	3	1.003	1.040	1.171	1.209	--[2]	--[2]	--[1]	--[1]
	4	0.983	1.023	1.161	1.031	n/a			
	5	0.985	0.946	1.118	NA[3]				
SV = 50 km/h POV = 50 km/h POV decel = 0.5g SV-to-POV headway = 40 m	1	1.145	1.294	1.305	1.259	1.460	1.401	--[1]	--[1]
	2	1.113	1.083	1.322	1.335	1.552	1.392	--[1]	--[1]
	3	1.137	1.087	1.329	NA[3]	--[2]	--[2]	--[1]	--[1]
	4	1.083	1.135	1.265	0.296	n/a			
	5	1.140	1.087	1.297	NA[3]				

[1]Test not performed due to previously observed SV-to-POV contact.

[2]No contact was observed during the first two test trials, so a third trial was not performed.

[3]SV deceleration did not meet or exceed 0.25g during this trial.

Green cells = crash avoidance; red cells = SV-to-POV contact occurred.

Table C-12. 50 km/h LVD AEB Brake Onset TTC Summary (Motorcycle POV; 75% Overlap)

Test Conditions	Trial #	2024 Subaru Crosstrek		2023 Toyota Corolla Hybrid		2024 Cadillac Lyriq		2024 Tesla Model 3	
		4a	ABD	4a	ABD	4a	ABD	4a	ABD
SV = 50 km/h POV = 50 km/h POV decel = 0.3g SV-to-POV headway = 12 m	1	0.954	0.996	0.969	0.968	1.298	1.014	1.179	1.454
	2	0.915	0.892	1.003	1.025	1.122	1.012	1.098	1.106
	3	0.953	0.966	0.950	1.008	--[2]	--[2]	--[2]	--[2]
	4	--[1]	1.025	1.015	0.490	n/a			
	5	--[1]	--[1]	1.008	NA[3]				
SV = 50 km/h POV = 50 km/h POV decel = 0.5g SV-to-POV headway = 12 m	1	--[1]	--[1]	1.012	NA[3]	0.778	0.795	0.430	0.774
	2	--[1]	--[1]	0.994	--[1]	0.794	0.755	--[1]	0.748
	3	--[1]	--[1]	1.004	--[1]	--[1]	--[1]	--[1]	--[1]
	4	--[1]	--[1]	0.964	--[1]	n/a			
	5	--[1]	--[1]	0.969	--[1]				
SV = 50 km/h POV = 50 km/h POV decel = 0.3g SV-to-POV headway = 40 m	1	0.985	0.976	1.047	1.109	1.342	1.313	0.304	0.270
	2	0.962	1.005	1.075	1.119	1.362	1.251	--[1]	--[1]
	3	0.918	0.995	1.110	1.043	--[2]	--[2]	--[1]	--[1]
	4	1.006	1.139	1.077	1.055	n/a			
	5	0.982	0.954	1.079	1.086				
SV = 50 km/h POV = 50 km/h POV decel = 0.5g SV-to-POV headway = 40 m	1	1.076	1.017	1.376	0.027	1.487	1.418	--[1]	--[1]
	2	1.103	1.103	1.360	--[1]	1.418	1.436	--[1]	--[1]
	3	1.136	1.180	1.341	--[1]	--[2]	--[2]	--[1]	--[1]
	4	1.194	1.147	1.337	--[1]	n/a			
	5	1.121	1.085	1.394	--[1]				

[1]Test not performed due to previously observed SV-to-POV contact.

[2]No contact was observed during the first two test trials, so a third trial was not performed.

[3]SV deceleration did not meet or exceed 0.25g during this trial.

Green cells = crash avoidance; red cells = SV-to-POV contact occurred.

Table C-13. 80 km/h LVD AEB Brake Onset TTC Summary (Motorcycle POV; 50% Overlap)

Test Conditions	Trial #	2024 Subaru Crosstrek		2023 Toyota Corolla Hybrid		2024 Cadillac Lyriq		2024 Tesla Model 3	
		4a	ABD	4a	ABD	4a	ABD	4a	ABD
SV = 80 km/h POV = 80 km/h POV decel = 0.3g SV-to-POV headway = 12 m	1	1.043	0.992	0.985	1.070	1.389	1.160	0.743	0.787
	2	1.073	1.091	1.026	0.969	1.554	1.074	--[1]	--[1]
	3	0.881	1.016	0.974	0.557	--[2]	--[2]	--[1]	--[1]
	4	1.006	--[1]	1.025	--[1]	n/a			
	5	0.984	--[1]	1.038	--[1]				
SV = 80 km/h POV = 80 km/h POV decel = 0.5g SV-to-POV headway = 12 m	1	1.110	--[1]	1.055	--[1]	0.867	0.845	--[1]	--[1]
	2	1.055	--[1]	1.025	--[1]	--[1]	--[1]	--[1]	--[1]
	3	1.097	--[1]	1.002	--[1]	--[1]	--[1]	--[1]	--[1]
	4	--[1]	--[1]	1.051	--[1]	n/a			
	5	--[1]	--[1]	1.068	--[1]				
SV = 80 km/h POV = 80 km/h POV decel = 0.3g SV-to-POV headway = 40 m	1	1.051	0.985	1.175	1.154	1.465	1.331	2.125	0.817
	2	1.001	0.917	1.168	0.783	1.334	1.316	0.740	--[1]
	3	0.958	1.097	1.186	1.174	--[2]	--[2]	0.716	--[1]
	4	1.020	--[1]	1.180	0.834	n/a			
	5	1.029	--[1]	1.156	1.188				
SV = 80 km/h POV = 80 km/h POV decel = 0.5g SV-to-POV headway = 40 m	1	1.110	--[1]	1.070	--[1]	1.576	1.525	--[1]	--[1]
	2	1.169	--[1]	1.159	--[1]	1.585	1.538	--[1]	--[1]
	3	1.163	--[1]	1.140	--[1]	--[2]	1.520	--[1]	--[1]
	4	--[1]	--[1]	--[1]	--[1]	n/a			
	5	--[1]	--[1]	--[1]	--[1]				

[1]Test not performed due to previously observed SV-to-POV contact.

[2]No contact was observed during the first two test trials, so a third trial was not performed.

Green cells = crash avoidance; red cells = SV-to-POV contact occurred.

Table C-14. 80 km/h LVD AEB Brake Onset TTC Summary (Motorcycle POV; 75% Overlap)

Test Conditions	Trial #	2024 Subaru Crosstrek		2023 Toyota Corolla Hybrid		2024 Cadillac Lyriq		2024 Tesla Model 3	
		4a	ABD	4a	ABD	4a	ABD	4a	ABD
SV = 80 km/h POV = 80 km/h POV decel = 0.3g SV-to-POV headway = 12 m	1	0.999	1.049	0.935	1.061	1.392	1.180	0.971	1.033
	2	1.043	--[1]	1.029	0.994[4]	1.333	1.272	1.251	1.050
	3	0.980	--[1]	0.967	--[1]	--[2]	--[2]	--[2]	--[2]
	4	0.802	--[1]	0.975	--[1]	n/a			
	5	0.923	--[1]	0.997	--[1]				
SV = 80 km/h POV = 80 km/h POV decel = 0.5g SV-to-POV headway = 12 m	1	--[1]	--[1]	0.970	--[1]	0.832	0.754	0.609	0.726
	2	--[1]	--[1]	0.997	--[1]	--[1]	--[1]	--[1]	--[1]
	3	--[1]	--[1]	0.988	--[1]	--[1]	--[1]	--[1]	--[1]
	4	--[1]	--[1]	0.916	--[1]	n/a			
	5	--[1]	--[1]	--[1]	--[1]				
SV = 80 km/h POV = 80 km/h POV decel = 0.3g SV-to-POV headway = 40 m	1	1.001	0.963	1.054	1.074	1.390	1.265	0.996	0.974
	2	0.993	1.010	1.027	1.109	1.437	1.303	1.145	0.835
	3	1.047	0.951	1.021	--[4]	--[2]	--[2]	1.200	--[1]
	4	0.995	--[1]	1.045	--[4]	n/a			
	5	0.935	--[1]	1.038	--[4]				
SV = 80 km/h POV = 80 km/h POV decel = 0.5g SV-to-POV headway = 40 m	1	--[1]	--[1]	1.053	1.066	1.523	1.497	--[1]	--[1]
	2	--[1]	--[1]	1.026	NA[3]	1.487	1.523	--[1]	--[1]
	3	--[1]	--[1]	1.078	--[1]	--[2]	--[2]	--[1]	--[1]
	4	--[1]	--[1]	--[1]	--[1]	n/a			
	5	--[1]	--[1]	--[1]	--[1]				

[1]Test not performed due to previously observed SV-to-POV contact.

[2]No contact was observed during the first two test trials, so a third trial was not performed.

[3]SV deceleration did not meet or exceed 0.25g during this trial.

[4]Only two repeated trials were performed due to a testing oversight.

Green cells = crash avoidance; red cells = SV-to-POV contact occurred.

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