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2022 Light Vehicle Pedestrian Automatic Emergency Braking Test Summary

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List of Acronyms

EV	Electric Vehicle
GPS	Global Positioning System
IC	Internal Combustion
NHTSA	National Highway Traffic Safety Administration
PAEB	Pedestrian Automatic Emergency Braking
PTM	Pedestrian Test Mannequin
SV	Subject Vehicles
TTC	Time-to-Collision

1. Introduction

In 2022, NHTSA performed test track evaluations for Pedestrian Automatic Emergency Braking (PAEB) systems on 12 light vehicles in different lighting conditions. In 2019, NHTSA published a draft PAEB test procedure¹ that provides methods and specifications for collecting performance data on PAEB systems for light vehicles. NHTSA’s PAEB test procedures were developed to assess the two most frequent crash scenarios involving pedestrians in the United States². They include the scenario in which the pedestrian crosses the road in front of the vehicle known as scenario S1, and the scenario in which the pedestrian walks along the road in the path of the vehicle known as scenario S4. This report describes the subject vehicles, test tools, test matrix, procedures, and results of the test track evaluations performed. Tests were conducted following NHTSA’s draft test procedure; however, some test parameters were adjusted, and new parameters evaluated.

Objectives

The main objective for this testing is to:

- Assess longitudinal crash avoidance capabilities for PAEB systems during daylight and darkness light conditions of 12 light vehicles (subject vehicle incremental increase in speed from 10 km/h to 60 km/h)

Subject Vehicles

The following 12 light vehicles were used to perform PAEB testing. **Error! Reference source not found.** lists the vehicles in the order they were tested. From left to right, model year, make/model, propulsion type (internal combustion (IC) or electric vehicle (EV)), sensor type, AEB nomenclature, and the owner’s manual stated speed range.

Table 1-1 Subject Vehicles for PAEB Testing

Model Year	Make/Model	Type	Sensors	AEB Nomenclature	Manual Stated Speed Range (km/h)
2021	Mercedes S580	IC	Camera and Radar	Active Brake Assist	7-120
2022	Subaru Outback	IC	Camera	Pre-Collision Braking System	1-160
2022	Toyota Camry	IC	Camera and Radar	Pre-Collision System (PCS)	10-80

¹ National Highway Traffic Safety Administration (2019, September). *Pedestrian Automatic Emergency Brake System Confirmation Test (working draft)*. Washington, DC: Author. Available at <https://www.regulations.gov/document/NHTSA-2019-0102-0005>

² Yanagisawa, M., Swanson, E., Azeredo, P., & Najm, W. G. (2017, April). *Estimation of potential safety benefits for pedestrian crash avoidance/mitigation systems*. (Report No. DOT HS 812 400). Washington, DC: National Highway Traffic Safety Administration.

2022	Nissan Rouge	IC	Camera and Radar	Automatic Emergency Braking (AEB) with Pedestrian Detection	10-60
2022	Dodge Ram 1500	IC	Camera and Radar	Forward Collision Warning with Mitigation	5-52
2022	Hyundai Tucson	IC	Vision	Forward Collision-Avoidance Assist (FCA)	10-60
2022	Ford Mustang Mach E	EV	Camera and Radar	Pre-Collision Assist	5-80
2022	Tesla Model 3 Dual Motor; firmware v11.0 (2022.3.101.1)	EV	Camera	Collision Avoidance Assist	5-150
2022	Honda Odyssey	IC	Camera and Radar	Collision Mitigation Braking System (CMBS)	5-100
2022	Jeep Grand Cherokee	IC	Camera and Radar	Forward Collision Warning with Mitigation	5-62
2022	Honda Civic EX Sedan	IC	Camera	Collision Mitigation Braking System (CMBS)	5-100
2022	Ford F150	IC	Camera and Radar	Pre-Collision Assist	5-80

Instrumentation and Test Tools

Instrumentation in each subject vehicle included a steering robot, inertial and position measurement sensor, pedal movement sensors, brake thermocouples, sound detection hardware, and a data acquisition system for logging data. An external battery is installed for powering the test equipment. Adult and child surrogate pedestrian mannequins developed for testing vehicles equipped with PAEB technology are used during testing. A low-profile robotic platform was used to support the mannequins in tests that require the mannequin to follow a path or be stationary during testing. To measure and document ambient lighting conditions during day and nighttime testing, a light meter was used. Wind speed and temperature were monitored. All testing was conducted on a dry surface with no precipitation.

Steering Control Hardware

A steering robot³ is installed in each subject vehicle to maintain an accurate and consistent path within the specified tolerance. The steering robot system includes the actuator installed on the steering wheel, controller box for signal processing, and a power pack. The controller box receives position updates from the inertial measurement and position hardware. An experimenter is seated, and safety belted in the driver's seat as a monitor of how the steering robot is operating during test conduct. The experimenter can abort the steering robot operation and take over manual steering control of the SV for any reason during the test. Figure 1.1 is an example of an installed steering robot.



Figure 1.1 SV Installed Steering Robot

³ Anthony Best Dynamics Ltd. (n.a.) Steering Robots SR15 Orbit (Web page). Wiltshire, England: Author. Available at <https://www.abdynamics.com/en/products/track-testing/driving-robots/steering-robots>

Video

Video was collected for each test. Subject vehicles forward path, dash, and external view of the test were captured. Figure 1.2 are camera views internal and external to the subject vehicle.



Figure 1.2 Subject Vehicle Camera Views (Forward, Dash, and External)

Mannequin Test Devices

Adult and child mannequins⁴ are used for conducting PAEB testing. Mannequins used for testing described in this report were developed specifically for testing vehicles equipped with PAEB vision and radar sensing technologies. Figure 1.3 are the adult and child mannequins. A composite clear pole extends down from the torso and is the primary mounting point to the platform. The adult and child mannequin legs articulate from motorized hip joints. The knees are a passive joint that bend during leg articulation. The legs of the mannequins are magnetically coupled at the hips and will separate if impacted by the SV. The arms are fixed and can be posed, but do not move during testing. The head is fixed to the torso and cannot rotate. The clothing has vision and radar specific features, and the internal structure of the mannequin is tuned for radar only. The internal structure is a foam material that is impactable and will maintain shape for a range of impact speeds.



Figure 1.3 Adult and Child Test Mannequins

The mannequin support pole is barely visible during daylight testing; however, darkness testing headlamp reflections were observed. As a precaution, the support pole was covered during darkness testing to prevent headlamp reflection. Figure 1.4 below, shows the support pole not covered on the left and covered on the right.

⁴ 4activeSystems GmbH. (n.a.). 4activePA pedestrian adult and child articulated (Web page). Traboch, Austria: Author. Available at <https://www.4activesystems.at/4activepa>



Figure 1.4 Mannequin Support Pole (not covered (left) versus covered (right))

For more detailed specifications, reference ISO 19206-2:2018(E)⁵. Figure 1.5 represents the vehicle's forward views of the mannequin for S1 and S4 scenario test conditions. Shown from top to bottom are S1a-b-c, S1d, S4a, S4b, and S4c views. Views in this figure are not to be considered the start position of the mannequin before testing begins.

⁵ ISO 19206-2:2018(E), Road vehicles – Test devices for target vehicles, vulnerable road users and other objects, for assessment of active safety functions – Part 2: Requirements for pedestrian targets

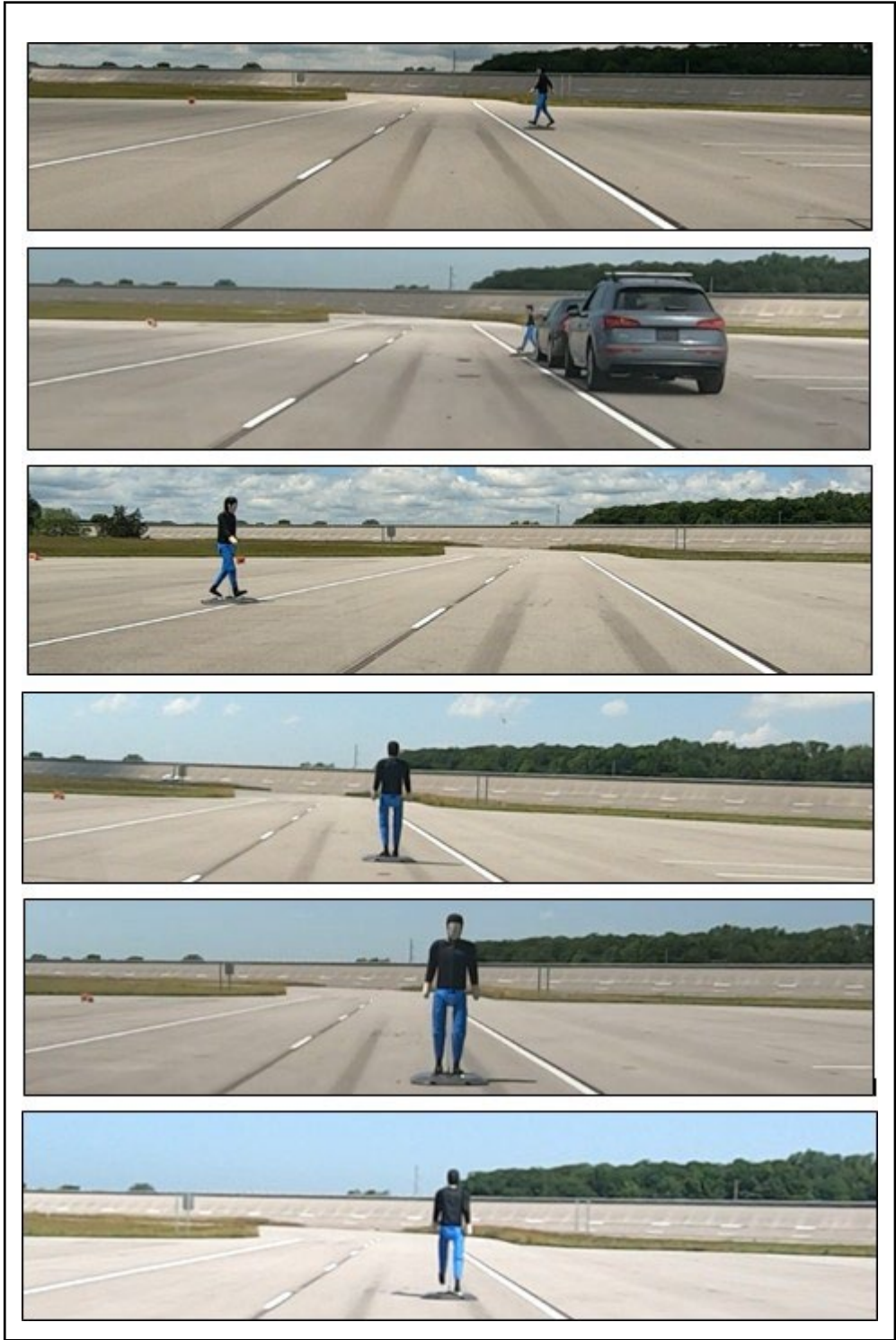


Figure 1.5 Mannequin Pose for S1/S4 Test Conditions

Robotic Platform

The platform⁶ shown in Figure 1.6 is used to support and maneuver the surrogate adult and child mannequins during testing. The internal components of the platform include drive motors, controllers, global positioning system (GPS), radios, and rechargeable batteries. Inertial measurement and position information of the platform are shared in real-time with the subject vehicle steering controller to create closed loop control for synchronizing the movement between the subject vehicle and the mannequin. The top side of the platform has antennas for wireless communication and position tracking along with attachment points for the mannequins or other types of test devices. The main attachment point for the mannequins is strong enough to support the mannequin during test conduct but will allow the mannequin to decouple from the platform if contacted by the subject vehicle. The main attachment hardware can be rotated on the platform for different types of testing. Tethers can be attached to the mannequins and magnetically couple to the platform to reduce swaying of the mannequin which can occur when the platform is not at a steady state velocity or during higher wind speeds. The sloped sides of the platform reduce RADAR response and the matte finish reduces headlamp reflection during darkness testing.



Figure 1.6 Robotic Platform

Track Support Vehicle

A track support vehicle shown in Figure 1.7 was parked at the test location and positioned for viewing during testing. The purpose of the track support vehicle is for a safety operator to monitor the steering robot and platform operation during testing. The support vehicle has hardware that can disable both robots for safety reasons. Prior to test conduct the mannequin platform is initialized from the track support vehicle and manually driven to its start position. During testing, the platform and steering robot follow a preprogrammed path.

⁶ Anthony Best Dynamics Ltd. (n.a.) Compact VRU test platform LaunchPad 50/60 (Web page). Wiltshire, England: Author. Available at <https://www.abdynamics.com/resources/files/AB-Dynamics-LaunchPad-50-60-Product>



Figure 1.7 Track Support Vehicle

Obstructed Vehicles

The following vehicles shown in Figure 1.8 were used when conducting the child obstructed scenario. A 2010 Ford Fusion and 2020 Audi Q5 shown in the top photo and a 2018 Buick Regal and 2018 Audi Q5 shown in the bottom picture.



Figure 1.8 Obstruction Vehicles

2. Test Methods

Tests were performed following the NHTSA Pedestrian Automatic Emergency Braking System Confirmation Test draft test procedures; however, some test parameters were adjusted, and new parameters were evaluated for this testing. The two types of scenarios involve a pedestrian crossing the road in front of a subject vehicle (S1) and a pedestrian that is walking or standing along the side of the road in the path of a subject vehicle (S4).

Crash Avoidance Testing

Tests were performed for a range of subject vehicle test speeds from 10-60 km/h for all S1 and S4a-b test conditions and 10-65 km/h for S1c test condition. The following criteria were followed depending on the outcome of the first trial. These criteria maximized the collection of PAEB system performance while reducing unnecessary testing and potential damage to the test devices and vehicles.

1. If the subject vehicle avoided contact with the mannequin on the first trial, speed of the subject vehicle was increased by 10 km/h and the test was repeated.
2. If the subject vehicle contacted the mannequin the first trial, and the subject vehicle's speed at impact was less than 50 percent of its initial speed up to four additional trials were performed at the same initial subject vehicle speed.
3. If three of the four additional trials resulted in crash avoidance, subject vehicle speed was increased, and the test was repeated.
4. If two of the four additional trials contacted the mannequin regardless of the subject vehicle speed reduction, testing was complete for that test condition.

Crossing Scenario (S1)

Figure 2.1 Illustration of S1 Scenario illustrates the crossing path test scenario performed. For tests S1a-b-c-d, the pedestrian mannequin is positioned 4.0 m (13.1 ft) from the SV centerline on the nearside, oriented perpendicular to the SV centerline. For tests S1e the mannequin is positioned 6.0 m (19.6 ft) from the subject vehicle's centerline on the offside, oriented perpendicular to the subject vehicle's centerline.

Figure 2.1 illustrates crossing scenario test conditions for S1a-b-c-d-e.

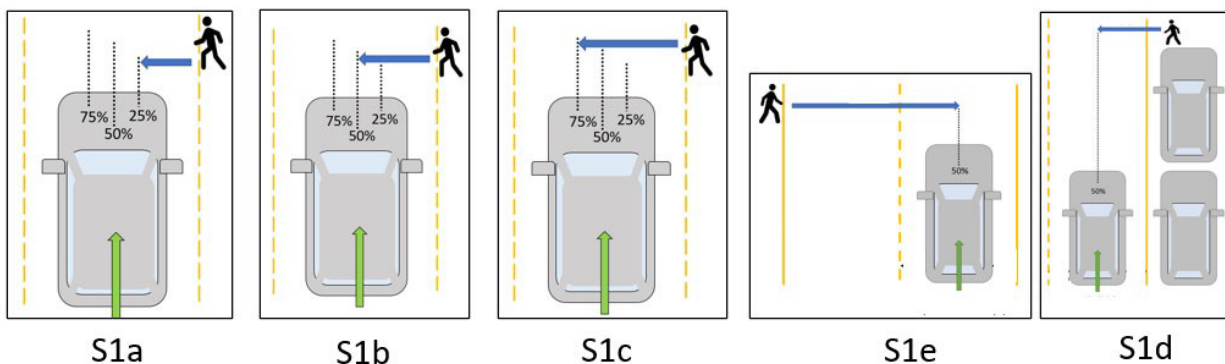


Figure 2.1 Illustration of S1 Scenario Test Conditions

- S1a-b-c: These tests evaluate the ability of the subject vehicle’s PAEB system to detect and respond to a crossing adult pedestrian walking into the subject vehicle’s path from the right side.
- S1d: This test evaluates the ability of the subject vehicle’s PAEB system to detect and respond to a crossing child pedestrian running into the subject vehicle’s path from behind parked vehicles from the right side
- S1e: This test evaluates the ability of the subject’s vehicle’s PAEB system to detect and respond to a crossing adult pedestrian running into the subject’s vehicle path from the left side.

To ensure the desired subject vehicle to mannequin choreography is achieved, time-to-collision is constantly monitored by the robotic platform’s software. When the forward motion is triggered the legs of the mannequin also begin to articulate. Trigger timing for the S1 test conditions assumes that the subject approaches the crossing mannequin with no PAEB system intervention, and the mannequin will continue to move at a steady state speed along its path. The following trigger timing was setup for the SV to collide with the mannequin at the following subject vehicle overlaps shown in Figure 2.1.

- S1a overlap is set up so that the mannequin would contact the front of the SV at 25 percent of the SV width
- S1b-d-e overlaps are set up so that the PTM would contact the front of the SV at 50 percent of the SV width which is also the center of the SV
- S1c overlap is set up so that the PTM would contact on the front of the SV at 75 percent of the SV width

Table 2-1 shown below describes the test matrix followed for conducting crossing scenario tests. Shown from left to right the scenario, mannequin size, path origin, overlap, obstruction SV speed, mannequin forward speed, mannequin movement classification, and lighting condition. Testing was performed during daylight and darkness lighting conditions. All testing for the S1 scenarios was performed during daylight and darkness with lower beam headlamps. Scenario S1b was also performed during darkness with upper beams.

Table 2-1 S1 Scenario Test Matrix

Scenario	Size	Path Origin	Overlap (%)	Obstruction	SV Speed (km/h)	Mannequin Speed (km/h)	Movement Classification	Light Condition
S1a	Adult	Right	25	No	10-60	5	Walk	Daylight
S1a	Adult	Right	25	No	10-60	5	Walk	Darkness - Lower Beam
S1b	Adult	Right	50	No	10-60	5	Walk	Daylight
S1b	Adult	Right	50	No	10-60	5	Walk	Darkness - Lower Beam
S1b	Adult	Right	50	No	10-60	5	Walk	Darkness - Upper Beam
S1c	Adult	Right	75	No	10-60	5	Walk	Daylight

S1c	Adult	Right	75	No	10-60	5	Walk	Darkness - Lower Beam
S1d	Child	Right	50	Yes	10-60	5	Run	Daylight
S1d	Child	Right	50	Yes	10-60	5	Run	Darkness - Lower Beam
S1e	Adult	Left	50	No	10-60	8	Run	Daylight
S1e	Adult	Left	50	No	10-60	8	Run	Darkness - Lower Beam

In Path Scenario (S4)

Figure 2.2 S4 Scenario illustrates the in-path test conditions performed. For tests S4a, S4b, and S4c the mannequin is positioned in the direct path of the SV at a 25 percent overlap on the right side. The orientation of the mannequin is either facing toward or away from the SV and is either stationary or moving for the duration of the tests.

No trigger time is needed for S4a and S4b. The mannequin remains stationary for the duration of the test. Trigger timing for the S4c test is set up so that the mannequin will be moving and reach steady state speed for a TTC of 7 seconds before SV-to-PTM contact would occur if there was no PAEB system intervention.

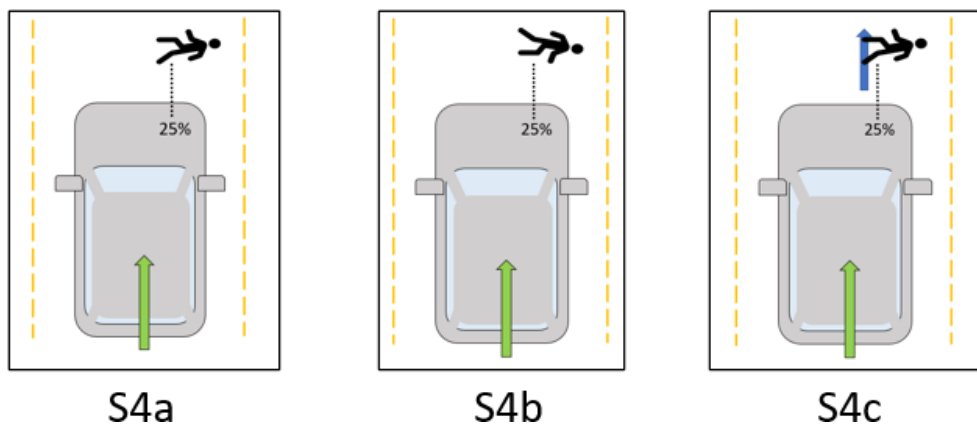


Figure 2.2 S4 Scenario

- S4a: Subject vehicle encounters an adult pedestrian standing in front of the vehicle on the nearside (right side), at 25 percent overlap, facing away from the vehicle.
- S4b: Subject vehicle encounters an adult pedestrian standing in front of the vehicle on the nearside, at 25 percent overlap, facing towards the vehicle.
- S4c: Subject vehicle encounters an adult pedestrian walking in front of the vehicle on the nearside, at 25 percent overlap, facing away from the vehicle.

Table 2-2 below, describes the test matrix for conducting in-path, S4 scenario, tests. Shown from left to right are the scenario, mannequin size, path origin, overlap, obstruction SV speed, mannequin forward speed, mannequin movement classification, and lighting condition specifications. Testing was performed during daylight and darkness lighting conditions. All S4 scenarios were tested during daylight and darkness with lower beam headlamps. S4a and S4c scenarios were also tested with upper beams.

Table 2-2 S4 Scenario Test Matrix

Scenario	Size	Path Origin	Overlap (%)	Obstruction	SV Speed (km/h)	Mannequin Speed (km/h)	Movement Classification	Light Condition
S4a	Adult Facing Away	Right	25	No	10-60	0	Stationary	Daylight
S4a	Adult Facing Away	Right	25	No	10-60	0	Stationary	Darkness - Lower Beams
S4a	Adult Facing Away	Right	25	No	10-60	0	Stationary	Darkness - Upper Beams
S4b	Adult Facing Towards	Right	25	No	10-60	0	Stationary	Daylight
S4b	Adult Facing Towards	Right	25	No	10-60	0	Stationary	Darkness - Lower Beams
S4c	Adult Facing Away	Right	25	No	10-60,65	5	Walk	Daylight
S4c	Adult Facing Away	Right	25	No	10-60,65	5	Walk	Darkness - Lower Beams
S4c	Adult Facing Away	Right	25	No	10-60,65	5	Walk	Darkness - Upper Beams

Daylight Testing

Daylight testing was monitored with a light meter. Testing was performed at a light measurement of 2000 lux or more.

Darkness Testing

Ambient light was also measured during darkness testing. Testing was conducted when the measured ambient illuminance of 0.2 lux⁷ or less was observed. Prior to performing darkness testing, headlamp aim was checked and adjusted if necessary, according to the vehicle manufacturer's instructions.

SV headlamps were adjusted following SAE J599 headlamp aiming procedures unless the manufacturer specified a different procedure. SAE J599 specifies that the driver be present in the vehicle during aiming; however, in this case weights were used to represent the driver. SV instrumentation as would be present during testing was also in the vehicle during the aiming procedure. The SV was positioned on a level surface 25 feet away from a vertical wall containing a dimensioned grid. The headlamps' aim was visually assessed and adjusted to meet the vehicle manufacturer's stated specifications. The aim was assessed in the appropriate region based on its optical design of either visually optical left or visually optical right.

⁷ Mazzae, E. N., Baldwin, G. H. S., Satterfield, K., Browning, D. A., & Andrella, A. T. (2022, October). *Adaptive driving beam headlighting systems rulemaking support testing* (Report No. DOT HS 813 267). National Highway Traffic Safety Administration.

Table 2-3 describes whether the headlight's aim needed to be adjusted to meet the manufacturers' specification. "Yes" means the aim was adjusted and "No" means the aim was not adjusted. The vehicles are listed in the order they were tested. Headlamp aim was not checked for the first three vehicles.

Table 2-3 SV Headlamp Aiming

MY	Make/Model	Driver Side	Passenger Side	Notes
2021	Mercedes S580	No	No	Headlamp aiming was not performed.
2022	Subaru Outback	No	No	
2022	Toyota Camry	No	No	
2022	Nissan Rouge	Yes	Yes	Alignment check and adjusted.
2022	Dodge Ram 1500	Yes	Yes	Alignment check and adjusted.
2022	Hyundai Tucson	Yes	Yes	Alignment check and adjusted.
2022	Ford Mustang Mach E	Yes	Yes	Alignment check and adjusted.
2022	Tesla Model 3	Yes	Yes	Alignment check and adjusted.
2022	Honda Odyssey	No	No	The manufacturer checked alignment.
2022	Jeep Grand Cherokee	Yes	Yes	Alignment check and adjusted.
2022	Honda Civic EX Sedan	Yes	Yes	The manufacturer check alignment and adjusted.
2022	Ford F150	Yes	Yes	Alignment check and adjusted.

3. Test Protocol

Testing was generally performed following the 2019 draft Pedestrian Automatic Emergency Brake System Confirmation Test. In some cases, parameters or test conditions were not specified in the draft procedure and in other cases, a parameter or test condition range was adjusted to better suit the testing matrix. Table 3-1 highlights key adjustments or additions to testing.

Table 3-1 Summary of Test Conditions and Parameters

Test Parameters and Conditions	2019 Draft PAEB Confirmation Test Reference	2022 PAEB
Ambient Temperature	7°C (45°F) to 40°C (104°F)	0°C (32°F) to 40° C (104°F)
Ambient Lighting - Daylight	Not Specified	>= 2,000 lux
Ambient Lighting - Darkness	Not Specified	<= 0.2 lux
Headlamp State (darkness testing)	Not Specified	Lower and upper Beams

Forward Collision Warning	Not Specified	Setting - near or closest warning
Regenerative Braking	Not Specified	Setting - produces the lowest deceleration
SV Speed	25 km/h (10 mph) and 40 km/h (25 mph)	10-65 km/h (6.2-40.3 mph)
Mannequin Start Distance S1a-b-c-d	3.5 ± 0.025 m (11.4 ft)	4.0 ± 0.1 m (13.1 ft)
Mannequin Start Distance S1e	5.5 ± 0.025 m (18.0 ft)	6.0 ± 0.1 m (19.6 ft)
Mannequin Acceleration Distance S1a-b-c-d	5 km/h (3.1 mph) = acceleration distance 0.5 m (1.64 ft)	acceleration distance 1.5 m (4.9 ft)
Mannequin Acceleration Distance S1e	8 km/h (4.9 mph) = acceleration distance 1.0 m (3.28 ft)	acceleration distance 1.5 m (4.9 ft)

4. Results

Test results shown in section 4 represent crash avoidance results, ambient light conditions, test conditions, and subject vehicle initial speed for each scenario. Each test result resulted in one of the five outcomes listed below.

1. If the subject vehicle performed crash avoidance on the first trial, speed of the subject vehicle was increased by 10 km/h and the test was repeated.
2. If the subject vehicle performed crash avoidance, throughout the tested speed range, on the first trial, testing was complete.
3. If the subject contacted the mannequin for the first trial, and the subject vehicle's relative speed reduction was greater than 50 percent of the subject vehicle's entrance speed, up to four additional trials were performed at the current subject vehicle's speed.
4. If three of the four additional trails resulted in crash avoidance, subject vehicle's speed was increased, and the test was repeated.
5. If two of the four additional trails resulted in contact with the mannequin regardless of the subject vehicle's relative speed reduction, testing was complete.

Results shown in Table 4-1, Table 4-2, Table 4-3, and Table 4-4 display scenario, lighting, test conditions, and entrance speed for each test performed. Vehicles are listed in the order they were tested. Each cell is color coded to describe how the vehicle performed. Appendix B contains the speed reduction data for each vehicle.

- Green cells represent crash avoidance for the first trial
- Yellow cells represent mannequin contact for the first trial when subject vehicle's speed reduction was greater than 50 percent of the subject vehicle's initial speed. Three out of four retrials resulted in crash avoidance. This indicates testing continued to the next subject vehicle's speed increment.
- Orange cells represent mannequin contact for the first trial when subject vehicle's speed reduction was greater than 50 percent of the subject vehicle's initial speed. Less than three of the four trials resulted in crash avoidance. This indicates testing did not proceed to the next subject vehicle speed increment and the series was completed. Orange cells with a number indicate the number of retrials that resulted in crash avoidance.
- Red cells represent mannequin contact for the first trial when subject vehicle's speed reduction was less than 50 percent of the subject vehicle's entrance speed. This indicates no retrials were conducted and testing did not proceed to the next subject vehicle speed increment and the series was completed. The one exception to this outcome is for tests performed at 10 km/h. For the 10 km/h test, speed was incremented regardless of the outcome. Harm to the subject vehicles or test equipment was minimal at this speed.
- Gray cells represent no testing was performed.

S1 Daylight Test Results Summary

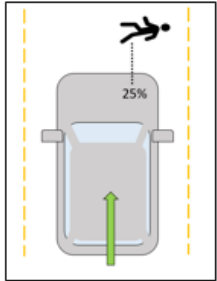
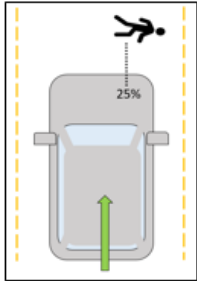
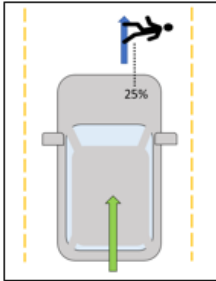
Table 4-1 S1 Daylight Crash Avoidance Testing Summary

		S1 Crossing – Daylight Test Conditions																													
		S1a - 25						S1b - 50						S1c - 75						S1e - 50						S1d - 50					
SV Speed (kph)		10	20	30	40	50	60	10	20	30	40	50	60	10	20	30	40	50	60	10	20	30	40	50	60	10	20	30	40	50	60
Mercedes S580																															
Subaru Outback																															
Toyota Camry																															
Nissan Rogue																															
Ram 1500																															
Hyundai Tucson																															
Mustang Mach E																															
Tesla Model 3																															
Honda Odyssey																															
Jeep Grand Cherokee																															
Honda Civic																															
Ford F150																															
First trial	Crash avoidance.																														
First trial	Contact with > 50% speed reduction. 3 of 4 retrials were crash avoidance.																														
First trial	Contact with > 50% speed reduction. Less than 3 of 4 retrials were crash avoidance. Testing complete.																														
First trial	Contact with < 50% speed reduction. Testing complete. Exception for 10 kph.																														
	Test was not performed.																														

*Orange cells that have numbers indicates crash avoidance for 2 or less retrials; however, less than 3 trials would be observed for that outcome. Orange cells with no number means there was no subsequent run with any crash avoidance

S4 Daylight Test Results Summary

Table 4-2 S4 Daylight Crash Avoidance Testing Summary

		S4 In Path – Daylight Test Conditions																		
		S4a - 25						S4b - 25						S4c - 25						
SV Speed (kph)		10	20	30	40	50	60	10	20	30	40	50	60	10	20	30	40	50	60	65
Mercedes S580		Red						Red												
Subaru Outback																				
Toyota Camry							Orange						Orange							
Nissan Rogue							Yellow							Red						1
Ram 1500							Red						Red						Red	
Hyundai Tucson																				Yellow
Mustang Mach E							Red						Orange	Red					Red	
Tesla Model 3				Orange		Grey	Grey					Orange	Grey					Orange	Grey	Grey
Honda Odyssey		Red					Orange													
Jeep Grand Cherokee																				Red
Honda Civic							Yellow													2
Ford F150							1						1	Red						1
First trial	Crash avoidance.																			
First trial	Contact with > 50% speed reduction. 3 of 4 retrials were crash avoidance.																			
First trial	Contact with > 50% speed reduction. Less than 3 of 4 retrials were crash avoidance Testing complete.																			
First trial	Contact with < 50% speed reduction. Testing complete. Exception for 10 kph.																			
	Test was not performed.																			

* Orange cells that have numbers indicates crash avoidance for 2 or less retrials; however, less than 3 trials would be observed for that outcome. Orange cells with no number means there was no subsequent run with any crash avoidance

S4 Dark Test Results Summary

Table 4-4 S4 Darkness Crash Avoidance Testing Summary

		S4 In Path – Darkness Test Conditions																																			
		S4a-25 Lower Beams						S4a-25 Upper Beams						S4b-25 Lower Beams						S4c-25 Lower Beams						S4c-25 Upper Beams											
		10	20	30	40	50	60	10	20	30	40	50	60	10	20	30	40	50	60	10	20	30	40	50	60	65	10	20	30	40	50	60	65				
Mercedes S580		Red						Red						Red						Red							Yellow	Red									
Subaru Outback		Red				Red	Grey							Red													Red	Grey	Grey	Red							
Toyota Camry							Orange																				Red								Orange		
Nissan Rogue							Orange																				Red								Orange		
Ram 1500				Red	Grey			Red		Red	Grey	Grey				Red	Grey	Grey									Red	Grey	Grey				Orange	Grey	Grey		
Hyundai Tucson						1																					Red								1		
Mustang Mach E						Red																					Red	Grey	Red								1
Tesla Model 3					Orange	Grey																					Red								Orange		
Honda Odyssey		Red			Red	Grey		Red	Red	Grey	Grey		Red													Red	Grey	Grey								Red	
Jeep Grand Cherokee							Orange																				Red	Red	Red								Orange
Honda Civic						Red																					Red	Red	Red				Red	Grey	Grey		Red
Ford F150							Red																				Red	Grey	Red								Orange
First trial	Crash avoidance																																				
First trial	Contact with > 50% speed reduction. 3 of 4 retrials were crash avoidance.																																				
First trial	Contact with > 50% speed reduction. Less than 3 of 4 retrials were crash avoidance. Testing complete.																																				
First trial	Contact with < 50% speed reduction. Less than 3 of 4 retrials were crash avoidance. Testing complete. Exception for 10 kph.																																				
	Test was not performed.																																				

* Orange cells that have numbers indicates crash avoidance for 2 or less retrials; however, less than 3 trials would be observed for that outcome. Orange cells with no number means there was no subsequent run with any crash avoidance

Validity Checks

The following test parameters shown in Table 4-5 were monitored for each trial.

Table 4-5 Test Conditions and Parameters Monitored During Testing

Test Conditions and Parameters	Range
Ambient Temperature	0°C (32°F) to 40° C (104°F)
Wind Speed	0.0 m/s to 6.7 m/s (15 mph)
Ambient Illumination Daylight	≥ 2,000 lux
Ambient Illumination Darkness	≤ 0.2 lux
Subject Vehicle Speed	±1.6 km/h (±1.0 mph)
Subject Vehicle Accelerator Pedal	within 500 milliseconds
Subject Vehicle Yaw Rate	±1.0 deg/s
Subject Vehicle Travel Path from Center	0.3 m (1.0 ft)
Subject Vehicle Overlap Tolerance	0.15 m (0.5 ft)
Subject Vehicle Brake Temperatures	65°C (149°F) to 100° C (212°F)
Mannequin Forward Speed	0.4 km/h (±0.2 mph)
Mannequin Start Distance S1a-b-c-d	4.0 ± 0.1 m (13.1 ft)
Mannequin Start Distance S1e	6.0 ± 0.1 m (19.6 ft)
Mannequin Acceleration Distance	acceleration distance 1.5 m (4.9 ft)

5. Conclusions

The following conclusions and observations were made from during testing and results.

- All vehicle's achieved crash avoidance for some test conditions.
- No single vehicle demonstrated crash avoidance for all tests conditions; however, some were close.
- No vehicle's demonstrated crash avoidance for S1d daylight and darkness lower beams at 60 km/h and darkness lower beams at 50 km/h.
- Test device damage was minor. Consumable parts were replaced for the mannequin and weekly maintenance was performed on the platform. Equipment failures did not cause down time.
- Minor subject vehicle damage occurred during test conduct. The most extensive repairs required were glass replacement and sensor alignment/calibration.

Appendix A: Research Testing Procedures

Crossing Pedestrian

Subject Vehicle Approach to a Crossing Pedestrian (S1)

For each test, the following test parameters were used:

- The mannequins start distance from the right S1a-b-c-d: 4.0 ± 0.1 m (13.1 ft)
- The mannequins start distance from the left S1e: 6.0 ± 0.1 m (19.6 ft)
- The mannequins speed for the S1a-b-c-d was 5 km/h (3.1 mph) and acceleration distance of 1.5 m (4.9 ft)
- The mannequins speed for the S1e was 8 km/h (4.9 mph) and acceleration distance of 1.5 m (4.9 ft)

SV Approach

For an individual test trial to be valid, the following held true throughout the test:

- A. The SV driver seatbelt was latched.
- B. The SV driver cycled the ignition.
- C. The SV was driven at the initial speed for each test.
 1. SV 10 km/h (6.2 mph)
 2. SV 20 km/h (12.4 mph)
 3. SV 30 km/h (18.6 mph)
 4. SV 40 km/h (24.8 mph)
 5. SV 50 km/h (31.0 mph)
 6. SV 60 km/h (37.2 mph)
- D. The test begins when the longitudinal Time-to-Collision (TTC) of the SV = 4.0 seconds.
- E. When the SV speed is 10-60 km/h, the TTC at 4.0 seconds will occur at the following distance.
 1. SV 10 km/h (6.2 mph): TTC = 4.0 seconds occurs at 11.1 m (36.4 ft)
 2. SV 20 km/h (12.4 mph): TTC = 4.0 seconds occurs at 22.2 m (72.9 ft)
 3. SV 30 km/h (18.6 mph): TTC = 4.0 seconds occurs at 33.3 m (109.3 ft)
 4. SV 40 km/h (24.8 mph): TTC = 4.0 seconds occurs at 44.4 m (144.8 ft)
 5. SV 50 km/h (31.0 mph): TTC = 4.0 seconds occurs at 55.5 m (182.2 ft)
 6. SV 60 km/h (37.2 mph): TTC = 4.0 seconds occurs at 66.6 m (218.7 ft)
- F. The SV maintained the center of the lane using the least amount of steering input necessary.
- G. The yaw rate of the SV was checked to be within ± 1.0 deg/s.
- H. The SV driver modulated the throttle, using smooth inputs, to maintain a constant SV speed.
- I. The SV driver was instructed not to apply any force to the brake pedal unless the mannequin is contacted, or the front of the SV has crossed the path of the mannequin.
- J. The instant the SV PAEB warning event is presented (visual, haptic, or audible) the SV throttle was fully released (within 500 msec). If no SV warning event is presented by the SV PAEB system, the SV driver was instructed to modulate the throttle to maintain a constant speed until either the onset of PAEB or, if the SV's PAEB does not activate, the end of the test occurs (i.e., contact with the mannequin).

Validity Period

- A. The valid test interval begins when the longitudinal TTC of the SV = 4.0 seconds.

- B. The test is over when any of the following occurs for scenario S1a-b-c-d-e:
 - 1. The SV contacts the mannequin; or
 - 2. The SV stops (through PAEB activation) before contacting the mannequin; or
 - 3. The mannequin clears the forward path of the SV.

End-of-Test Instructions

- A. After the test is complete, the SV driver manually applied force to the brake pedal, bringing the vehicle to a stop (if necessary), and placed the transmission in park (automatic transmission).
- B. The SV driver cycled the ignition.
- C. The test is complete.

Speed Reduction

The magnitude of the SV speed reduction attributable to PAEB intervention is calculated in one of two ways, depending on whether a test trial concludes with the SV colliding with the mannequin. For scenario S1a-b-c-d-e:

- A. If the SV contacts the mannequin during a test trial, the PAEB speed reduction is calculated by subtracting the SV speed at the time of contact (i.e., when longitudinal range becomes zero) from the SV speed calculated from $TTC = 4.0$ seconds.
- B. If the SV does not contact the mannequin during a test trial (i.e., PAEB intervention prevents the crash), the SV speed at the time of SV and mannequin contact is taken to be zero. The speed reduction is therefore equal to the SV speed at $TTC = 4.0$ seconds.

Pedestrian Walking or Stationery in SV Path

SV Approach to a In-Path pedestrian (S4)

For each test, the following test parameters were used:

- The mannequins speed for S4a (facing away from SV) and S4b (facing towards the SV) was 0 km/h (3.1 mph).
- The mannequin speed for S4c was 5 km/h (3.1 mph) and acceleration distance of 1.5 m (4.9 ft)

SV Approach

For an individual test trial to be valid, the following held true throughout the test:

- A. The SV driver seatbelt was latched.
- B. The SV driver cycled the ignition.
- C. The SV was driven at the initial speed for each test.
 1. SV 10 km/h (6.2 mph)
 2. SV 20 km/h (12.4 mph)
 3. SV 30 km/h (18.6 mph)
 4. SV 40 km/h (24.8 mph)
 5. SV 50 km/h (31.0 mph)
 6. SV 60 km/h (37.2 mph)
 7. SV 65 km/h (40.4 mph)
- A. For scenario S4c only, mannequin motion begins when the longitudinal TTC of the SV = 7.0 seconds.
 1. SV 10 km/h (6.2 mph): TTC = 7.0 seconds occurs at 19.4 m (63.7 ft)
 2. SV 20 km/h (12.4 mph): TTC = 7.0 seconds occurs at 38.8 m (127.5 ft)
 3. SV 30 km/h (18.6 mph): TTC = 7.0 seconds occurs at 58.3 m (191.3 ft)
 4. SV 40 km/h (24.8 mph): TTC = 7.0 seconds occurs at 77.7 m (255.1 ft)
 5. SV 50 km/h (31.0 mph): TTC = 7.0 seconds occurs at 97.2 m (318.9 ft)
 6. SV 60 km/h (37.2 mph): TTC = 7.0 seconds occurs at 116.6 m (382.7 ft)
 7. SV 65 km/h (40.4 mph): TTC = 7.0 seconds occurs at 126.3 m (414.6 ft)
- B. The test begins when the longitudinal TTC of the SV = 4.0 seconds.
 1. SV 10 km/h (6.2 mph): TTC = 4.0 seconds occurs at 11.1 m (36.4 ft)
 2. SV 20 km/h (12.4 mph): TTC = 4.0 seconds occurs at 22.2 m (72.9 ft)
 3. SV 30 km/h (18.6 mph): TTC = 4.0 seconds occurs at 33.3 m (109.3 ft)
 4. SV 40 km/h (24.8 mph): TTC = 4.0 seconds occurs at 44.4 m (144.8 ft)
 6. SV 50 km/h (31.0 mph): TTC = 4.0 seconds occurs at 55.5 m (182.2 ft)
 7. SV 60 km/h (37.2 mph): TTC = 4.0 seconds occurs at 66.6 m (218.7 ft)
 8. For S4c only, SV 65 km/h (40.4 mph): TTC = 4.0 seconds occurs at 72.2 m (237.0 ft)
- C. The SV maintained the center of the lane using the least amount of steering input necessary
- D. The yaw rate of the SV was checked to be within ± 1.0 deg/s.
- E. The SV driver modulated the throttle, using smooth inputs, to maintain a constant SV speed.
- F. The SV driver was instructed not to apply any force to the brake pedal unless the mannequin is contacted, or the SV has come to a complete stop (speed = 0) because the PAEB system has activated and prevented mannequin contact.
- G. The instant the SV PAEB warning event is presented (visual, haptic, or audible) the SV throttle was fully released (within 500 msec). If no SV warning event is presented by the SV PAEB

system, the SV driver was instructed to modulate the throttle to maintain a constant speed until either the onset of PAEB or, if the SV's PAEB does not activate, the end of the test occurs (i.e., contact with the mannequin).

Validity Period

- A. The valid test interval begins when the longitudinal TTC of the SV = 4.0 seconds.
- B. Test ends when any of the following occurs:
 - 1. Test Scenario S4a-b
 - i. The SV comes in contact with the mannequin; or
 - ii. The SV comes to a stop before making contact with the mannequin.
 - 2. Test Scenario S4c
 - i. The SV comes in contact with the mannequin; or
 - ii. One second after the velocity of the SV becomes less than or equal to that of the pedestrian mannequin.

End-of-Test Instructions

- A. After the test is complete, the SV driver shall manually apply force to the brake pedal, bring the vehicle to a stop (if necessary), and place the transmission in park (automatic transmission) or neutral (manual transmission).
- B. The test trial is complete.

Speed Reduction

The magnitude of the SV speed reduction attributable to PAEB intervention is calculated in one of three ways, depending on whether a test trial concludes with the SV colliding with the mannequin.

- A. For all S4: If the SV contacts the mannequin during a test trial, the PAEB speed reduction is calculated by subtracting the SV speed at the time of contact (i.e., when longitudinal range becomes zero) from the SV speed calculated from $TTC = 4.0$ seconds.
- B. For S4a-b: If the SV does not contact the mannequin during a test trial (i.e., PAEB intervention prevents the crash), the SV speed at the time of SV and mannequin contact is taken to be zero. The speed reduction is therefore equal to the SV speed at $TTC = 4.0$ seconds.
- C. For S4c: If the SV does not contact the mannequin during a test trial (i.e., PAEB intervention prevents the crash), the speed reduction is calculated by subtracting the SV speed at the minimum longitudinal SV to mannequin range during the validity period from the SV speed at $TTC = 4.0$ seconds.

Appendix B: Test Data

2021 Mercedes S580

Table B 1 S1a 2021 Mercedes S580 Crash Avoidance and Speed Reduction Results

2021 Mercedes S580					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S1a	Adult	5	Daylight	10	A
				20	A
				30	A
				40	A
				50	A
				60	A
			Darkness – Lower Beam	10	A
				20	A
				30	A
				40	A
				50	A
				60	A

Table B 2 S1b 2021 Mercedes S580 Crash Avoidance and Speed Reduction Results

2021 Mercedes S580					
Scenario	Stature	PTM Speed (kph)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S1b	Adult	5	Daylight	10	A
				20	A
				30	A
				40	A
				50	A
				60	A
			Darkness – Lower Beam	10	A
				20	A
				30	A
				40	A
				50	A
				60	A
			Darkness – Upper Beam	10	A
				20	A
				30	A
				40	A
				50	A
				60	A

Table B 3 S1c 2021 Mercedes S580 Crash Avoidance and Speed Reduction Results

2021 Mercedes S580					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S1c	Adult	5	Daylight	10	A
				20	A
				30	A
				40	A
				50	A
				60	A
			Darkness – Lower Beam	10	A
				20	A
				30	A
				40	A
				50	A
				60	A

Table B 4 S1d 2021 Mercedes S580 Crash Avoidance and Speed Reduction Results

2021 Mercedes S580					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S1d	Adult	5	Daylight	10	A
				20	A
				30	A
				40	A
				50	36.4
				50	34.7
				50	A
				50	A
				50	A
				60	30.9
				60	19.1
				60	24.8
			Darkness – Lower Beam	10	A
				20	A
				30	A
				40	24.9
				40	7.8
				40	17.5

Table B 5 S1e 2021 Mercedes S580 Crash Avoidance and Speed Reduction Results

2021 Mercedes S580					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S1e	Adult	5	Daylight	10	A
				20	A
				30	A
				40	A
				50	A
				60	A
			Darkness – Lower Beam	10	A
				20	A
				30	A
				40	A
				50	A
				60	A

Table B 6 S4a 2021 Mercedes S580 Crash Avoidance and Speed Reduction Results

2021 Mercedes S580					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S4a	Adult	0	Daylight	10	0.0
				20	A
				30	A
				40	A
				50	A
				60	A
			Darkness – Lower Beam	10	0.0
				20	A
				30	A
				40	A
				50	A
				60	A
			Darkness – Upper Beam	10	0.0
				20	A
				30	A
				40	A
				50	A
				60	A

Table B 7 S4b 2021 Mercedes S580 Crash Avoidance and Speed Reduction Results

2021 Mercedes S580					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S4b	Adult	0	Daylight	10	0.0
				20	A
				30	A
				40	A
				50	A
				60	A
			Darkness – Lower Beam	10	0.0
				20	A
				30	A
				40	A
				50	A
				60	A

Table B 8 S4c 2021 Mercedes S580 Crash Avoidance and Speed Reduction Results

2021 Mercedes S580					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S4c	Adult	5	Daylight	10	0.0
				20	A
				30	A
				40	A
				50	A
				60	A
				65	A
			Darkness – Lower Beam	10	0.0
				20	A
				30	A
				40	A
				50	A
				60	A
				65	33.0
				65	45.1
			Darkness – Upper Beam	65	A
				65	A
				65	A
				10	0.0
				20	A
				30	A
				40	A
			50	A	
			60	A	
65	A				

2022 Subaru Outback

Table B 9 S1a 2022 Subaru Outback Crash Avoidance and Speed Reduction Results

2022 Subaru Outback					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S1a	Adult	5.0	Daylight	10	0.0
				20	A
				30	A
				40	A
				50	A
				60	A
			Darkness – Lower Beam	10	0.0
				20	A
				30	A
				40	25.1
				40	A
				40	A
				40	A
				40	A
				50	A
				60	39.0
60	18.6				
60	27.3				

Table B 10 S1b 2022 Subaru Outback Crash Avoidance and Speed Reduction Results

2022 Subaru Outback					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S1b	Adult	5.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	A
				60	A
			Darkness – Lower Beam	10	A
				20	A
				30	A
				40	A
				50	A
				60	45.7
				60	A
				60	39.8
				60	A
			Darkness – Upper Beam	10	0.0
				20	A
				30	A
				40	A
				50	A
				60	A

Table B 11 S1c 2022 Subaru Outback Crash Avoidance and Speed Reduction Results

2022 Subaru Outback					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S1c	Adult	5.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	A
				60	A
			Darkness – Lower Beam	10	A
				20	A
				30	A
				40	A
				50	A
				60	A

Table B 12 S1d 2022 Subaru Outback Crash Avoidance and Speed Reduction Results

2022 Subaru Outback					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S1d	Adult	5.0	Daylight	10	0.0
				20	A
				30	A
				40	17.2
			Darkness – Lower Beam	10	0.0
				20	A
				30	18.4
				30	A
				30	A
				30	14.7
				30	A
				40	14.2

Table B 13 S1e 2022 Subaru Outback Crash Avoidance and Speed Reduction Results

2022 Subaru Outback					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S1e	Adult	5.0	Daylight	10	0.0
				20	0.0
			Darkness – Lower Beam	10	0.0
				20	0.0

Table B 14 S4a 2022 Subaru Outback Crash Avoidance and Speed Reduction Results

2022 Subaru Outback					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S4a	Adult	0.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	A
				60	A
			Darkness – Lower Beam	10	2.9
				20	A
				30	A
				40	A
				50	18.9
			Darkness – Upper Beam	10	A
				20	A
				30	A
				40	A
			50	20.9	

Table B 15 S4b 2022 Subaru Outback Crash Avoidance and Speed Reduction Results

2022 Subaru Outback					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S4b	Adult	0.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	A
				60	A
			Darkness – Lower Beam	10	1.5
				20	A
				30	A
				40	A
				50	A
				60	0.0

Table B 16 S4c 2022 Subaru Outback Crash Avoidance and Speed Reduction Results

2022 Subaru Outback					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S4c	Adult	5.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	A
				60	A
				65	A
			Darkness – Lower Beam	10	A
				20	A
				30	A
				40	A
				50	0.0
			Darkness – Upper Beam	10	5.1
				20	A
				30	A
				40	A
				50	A
				60	A
				65	A

2022 Toyota Camry

Table B 17 S1a 2022 Toyota Camry Crash Avoidance and Speed Reduction Results

2022 Toyota Camry					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S1a	Adult	5.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	A
				60	50.9
				60	A
				60	A
				60	A
				60	52.9
			Darkness – Lower Beam	10	0.0
				20	A
				30	A
				40	A
				50	A
				60	A

Table B 18 S1b 2022 Toyota Camry Crash Avoidance and Speed Reduction Results

2022 Toyota Camry					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S1b	Adult	5.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	A
				60	A
			Darkness – Lower Beam	10	A
				20	A
				30	A
				40	A
				50	A
				60	A
			Darkness – Upper Beam	10	A
				20	A
				30	A
				40	A
				50	A
				60	A

Table B 19 S1c 2022 Toyota Camry Crash Avoidance and Speed Reduction Results

2022 Toyota Camry					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S1c	Adult	5.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	A
				60	A
			Darkness – Lower Beam	10	A
				20	A
				30	A
				40	A
				50	A
				60	A

Table B 20 S1d 2022 Toyota Camry Crash Avoidance and Speed Reduction Results

2022 Toyota Camry					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S1d	Adult	5.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	A
				60	34.0
				60	33.8
			Darkness – Lower Beam	10	0.0
				20	0.0

Table B 21 Se 2022 Toyota Camry Crash Avoidance and Speed Reduction Results

2022 Toyota Camry					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S1e	Adult	5.0	Daylight	10	0.0
				20	A
				30	A
				40	A
				50	A
				60	23.6
			Darkness – Lower Beam	10	0.0
				20	A
				30	A
				40	A
				50	A
				60	26.2

Table B 22 S4a 2022 Toyota Camry Crash Avoidance and Speed Reduction Results

2022 Toyota Camry					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S4a	Adult	0.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	A
				60	43.5
				60	40.4
				60	38.9
			Darkness – Lower Beam	10	A
				20	A
				30	A
				40	A
				50	A
				60	48.2
				60	51.3
				60	20.7
			Darkness – Upper Beam	10	A
				20	A
				30	A
				40	A
				50	A
				60	50.2
				60	50.5
				60	46.1

Table B 23 S4b 2022 Toyota Camry Crash Avoidance and Speed Reduction Results

2022 Toyota Camry					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S4b	Adult	0.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	A
				60	37.9
				60	23.8
			Darkness – Lower Beam	60	23.4
				10	A
				20	A
				30	A
				40	A
				50	A
				60	49.3
60	48.7				
60	50.7				

Table B 24 S4c 2022 Toyota Camry Crash Avoidance and Speed Reduction Results

2022 Toyota Camry					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S4c	Adult	5.0	Daylight	10	0.0
				20	A
				30	A
				40	A
				50	A
				60	A
				65	38.6
				65	43.5
				65	38.0
			Darkness – Lower Beam	10	0.0
				20	A
				30	A
				40	A
				50	A
				60	A
				60	20.7
			Darkness – Upper Beam	10	0.0
				20	A
				30	A
				40	A
				50	A
				60	A
				65	46.7
				65	47.0
65	48.2				

2022 Nissan Rogue

Table B 25 S1a 2022 Nissan Rogue Crash Avoidance and Speed Reduction Results

2022 Nissan Rogue					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S1a	Adult	5.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	A
				60	A
			Darkness – Lower Beam	10	A
				20	A
				30	A
				40	A
				50	A
				60	A

Table B 26 S1b 2022 Nissan Rogue Crash Avoidance and Speed Reduction Results

2022 Nissan Rogue					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S1b	Adult	5.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	A
				60	44.7
				60	A
				60	34.6
				60	38.0
			Darkness – Lower Beam	10	A
				20	A
				30	A
				40	A
				50	A
				60	A
			Darkness – Upper Beam	10	A
				20	A
				30	A
				40	A
				50	A
				60	A

Table B 27 S1c 2022 Nissan Rogue Crash Avoidance and Speed Reduction Results

2022 Nissan Rogue					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S1c	Adult	5.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	A
				60	A
			Darkness – Lower Beam	10	A
				20	A
				30	A
				40	A
				50	A
				60	A

Table B 28 S1d 2022 Nissan Rogue Crash Avoidance and Speed Reduction Results

2022 Nissan Rogue					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S1d	Adult	5.0	Daylight	10	0.8
				20	A
				30	A
				40	32.1
				40	34.2
				40	A
				40	A
				40	27.9
			Darkness – Lower Beam	10	0.0
				20	A
				30	A
				40	10.8

Table B 29 S1e 2022 Nissan Rogue Crash Avoidance and Speed Reduction Results

2022 Nissan Rogue					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S1e	Adult	5.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	A
				60	A
			Darkness – Lower Beam	10	A
				20	A
				30	A
				40	A
				50	34.6
				50	A
				50	21.5
				50	A
50	A				
60	25.2				

Table B 30 S4a 2022 Nissan Rogue Crash Avoidance and Speed Reduction Results

2022 Nissan Rogue					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S4a	Adult	0.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	A
				60	52.5
				60	A
				60	A
				60	A
				60	A
			Darkness – Lower Beam	10	A
				20	A
				30	A
				40	A
				50	A
				60	38.3
				60	35.0
			Darkness – Upper Beam	60	32.5
				10	A
				20	A
				30	A
40	A				
60	A				

Table B 31 S4b 2022 Nissan Rogue Crash Avoidance and Speed Reduction Results

2022 Nissan Rogue					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S4b	Adult	0.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	A
				60	A
			Darkness – Lower Beam	10	A
				20	A
				30	A
				40	A
				50	A
				60	42.9
				60	A
				60	A
60	A				
60	A				

Table B 32 S4c 2022 Nissan Rogue Crash Avoidance and Speed Reduction Results

2022 Nissan Rogue					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S4c	Adult	5.0	Daylight	10	0.0
				20	A
				30	A
				40	A
				50	A
				60	41.7
				60	41.6
				60	A
				60	21.8
			Darkness – Lower Beam	10	2.3
				20	A
				30	A
				40	A
				50	A
				60	A
				65	35.9
				65	12.0
			Darkness – Upper Beam	65	47.4
				10	2.5
				20	A
				30	A
				40	A
				50	A
				60	A
65	A				

2022 Dodge Ram 1500

Table B 33 S1a 2022 Dodge Ram 1500 Crash Avoidance and Speed Reduction Results

2022 Dodge Ram 1500					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S1a	Adult	5.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	31.3
				50	40.3
				50	20.5
			Darkness – Lower Beam	10	1.6
				20	A
				30	14.5

Table B 34 S1b 2022 Dodge Ram 1500 Crash Avoidance and Speed Reduction Results

2022 Dodge Ram 1500					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S1b	Adult	5.0	Daylight	10	0.0
				20	A
				30	A
				40	A
				50	34.0
				50	A
				50	A
				50	A
				50	37.0
				60	2.0
			Darkness – Lower Beam	10	5.0
				20	A
				30	16.9
				30	15.7
				30	18.5
			Darkness – Upper Beam	10	6.9
				20	A
				30	17.3
				30	17.1
				30	13.4

Table B 35 S1c 2022 Dodge Ram 1500 Crash Avoidance and Speed Reduction Results

2022 Dodge Ram 1500					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S1c	Adult	5.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	A
			Darkness – Lower Beam	60	0.0
				10	0.0
				20	A
				30	16.6
				30	17.5
			30	0.0	

Table B 36 S1d 2022 Dodge Ram 1500 Crash Avoidance and Speed Reduction Results

2022 Dodge Ram 1500					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S1d	Adult	5.0	Daylight	10	2.3
				20	A
				30	A
				40	A
				50	20.6
			Darkness – Lower Beam	10	0.0
				20	0.0

Table B 37 S1e 2022 Dodge Ram 1500 Crash Avoidance and Speed Reduction Results

2022 Dodge Ram 1500					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S1e	Adult	5.0	Daylight	10	0.0
				20	A
				30	A
				40	23.2
				40	A
				40	28.8
				40	A
				40	A
				50	28.4
				50	24.9
			50	22.9	
			Darkness – Lower Beam	10	0.0
				20	A
				30	15.2
				30	12.2
				30	10.3

Table B 38 S4a 2022 Dodge Ram 1500 Crash Avoidance and Speed Reduction Results

2022 Dodge Ram 1500					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S4a	Adult	0.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	A
				60	2.2
			Darkness – Lower Beam	10	A
				20	A
				30	A
				40	13.2
			Darkness – Upper Beam	10	A
				20	A
				30	A
				40	A
				50	A
				60	2.2

Table B 39 S4b 2022 Dodge Ram 1500 Crash Avoidance and Speed Reduction Results

2022 Dodge Ram 1500					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S4b	Adult	0.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	A
				60	2.3
			Darkness – Lower Beam	10	A
				20	A
				30	11.5

Table B 40 S4c 2022 Dodge Ram 1500 Crash Avoidance and Speed Reduction Results

2022 Dodge Ram 1500					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S4c	Adult	5.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	A
				60	0.0
			Darkness – Lower Beam	10	0.0
				20	A
				30	A
				40	17.6
			Darkness – Upper Beam	10	0.0
				20	A
				30	A
				40	21.7
				40	26.6
				40	29.9

2022 Hyundai Tucson

Table B 41 S1a 2022 Hyundai Tucson Crash Avoidance and Speed Reduction Results

2022 Hyundai Tucson					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S1a	Adult	5.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	A
				60	35.9
				60	28.4
				60	24.7
			Darkness – Lower Beam	10	A
				20	A
				30	A
				40	A
				50	7.9

Table B 42 S1b 2022 Hyundai Tucson Crash Avoidance and Speed Reduction Results

2022 Hyundai Tucson					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S1b	Adult	5.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	A
				60	37.5
				60	39.0
				60	43.5
			Darkness – Lower Beam	10	A
				20	A
				30	A
				40	A
				50	38.2
				50	34.6
				50	A
				50	A
			Darkness – Upper Beam	50	A
				50	A
				60	22.8
				10	A
				20	A
				30	A
				40	A
				50	A
60	A				

Table B 43 S1c 2022 Hyundai Tucson Crash Avoidance and Speed Reduction Results

2022 Hyundai Tucson					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S1c	Adult	5.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	A
				60	38.6
				60	A
				60	26.0
				60	A
				60	A
			Darkness – Lower Beam	10	A
				20	A
				30	A
				60	A

Table B 44d S1 2022 Hyundai Tucson Crash Avoidance and Speed Reduction Results

2022 Hyundai Tucson					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S1d	Adult	5.0	Daylight	10	A
				20	A
				30	A
				40	22.1
				40	A
				40	14.7
				40	A
				40	A
				50	21.7
				Darkness – Lower Beam	10
			20		A
			30		14.8

Table B 45e S1 2022 Hyundai Tucson Crash Avoidance and Speed Reduction Results

2022 Hyundai Tucson					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S1e	Adult	5.0	Daylight	10	0.0
				20	A
				30	A
				40	A
				50	24.7
			Darkness – Lower Beam	10	0.0
				20	A
				30	A
				40	32.2
				40	A
				40	21.5
				40	A
				40	11.0

Table B 46 S4a 2022 Hyundai Tucson Crash Avoidance and Speed Reduction Results

2022 Hyundai Tucson					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S4a	Adult	0.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	A
				60	A
			Darkness – Lower Beam	10	A
				20	A
				30	A
				40	A
				50	A
				60	46.8
				60	34.5
				60	A
			Darkness – Upper Beam	60	49.1
				10	A
				20	A
				30	A
				40	A
				50	A
				60	53.0
				60	A
				60	A
				60	A
				60	A

Table B 47 S4b 2022 Hyundai Tucson Crash Avoidance and Speed Reduction Results

2022 Hyundai Tucson					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S4b	Adult	0.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	A
				60	A
			Darkness – Lower Beam	10	A
				20	A
				30	A
				40	A
				50	A
				60	47.8
				60	34.3
				60	52.4

Table B 48 S4c 2022 Hyundai Tucson Crash Avoidance and Speed Reduction Results

2022 Hyundai Tucson					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S4c	Adult	5.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	A
				60	A
				65	49.5
				65	A
				65	A
				65	A
				65	A
			Darkness – Lower Beam	10	A
				20	A
				30	A
				40	A
				50	A
				60	33.4
				60	A
			Darkness – Upper Beam	60	44.2
				60	13.1
				10	A
				20	A
				30	A
				40	A
50	A				
60	A				
65	A				

2022 Ford Mustang Mach E

Table B 49 S1a 2022 Ford Mach E Crash Avoidance and Speed Reduction Results

2022 Ford Mustang Mach E					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S1a	Adult	5.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	A
				60	27.6
			Darkness – Lower Beam	10	A
				20	A
				30	A
				40	A
				50	A
				60	28.3

Table B 50 S1b 2022 Ford Mach E Crash Avoidance and Speed Reduction Results

2022 Ford Mustang Mach E					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S1b	Adult	5.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	A
				60	32.4
				60	31.6
				60	34.4
				Darkness – Lower Beam	10
			20		A
			30		A
			40		A
			50		6.1
			Darkness – Upper Beam	10	A
				20	A
				30	A
				40	A
				50	A
				60	40.9
				60	45.1
				60	32.3

Table B 51 S1c 2022 Ford Mach E Crash Avoidance and Speed Reduction Results

2022 Ford Mustang Mach E					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S1c	Adult	5.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	A
				60	20.6
			Darkness – Lower Beam	10	A
				20	A
				30	A
				40	A
				50	A
				60	32.2
				60	32.2
				60	14.2

Table B 52 S1d 2022 Ford Mach E Crash Avoidance and Speed Reduction Results

2022 Ford Mustang Mach E					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S1d	Adult	5.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	A
				60	32.5
				60	32.8
				60	27.1
			Darkness – Lower Beam	10	A
				20	A
				30	A
				40	24.3
				40	30.4
				40	21.0

Table B 53 S1e 2022 Ford Mach E Crash Avoidance and Speed Reduction Results

2022 Ford Mustang Mach E					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S1e	Adult	5.0	Daylight	10	0.0
				20	A
				30	A
				40	A
				50	A
				60	33.5
				60	A
				60	25.2
				60	30.8
			Darkness – Lower Beam	10	A
				20	A
				30	A
				40	A
				50	A
				60	34.7
				60	25.3
60	25.9				

Table B 54 S4a 2022 Ford Mach E Crash Avoidance and Speed Reduction Results

2022 Ford Mustang Mach E					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S4a	Adult	0.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	A
				60	29.8
			Darkness – Lower Beam	10	A
				20	A
				30	A
				40	A
				50	A
				60	28.2
			Darkness – Upper Beam	10	A
				20	A
				30	A
				40	A
				50	A
				60	50.7
				60	49.3
			60	56.2	

Table B 55 S4b 2022 Ford Mach E Crash Avoidance and Speed Reduction Results

2022 Ford Mustang Mach E					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S4b	Adult	0.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	A
				60	40.9
				60	30.0
				60	37.8
			Darkness – Lower Beam	10	A
				20	A
				30	A
				40	A
				50	A
				60	38.0
60	40.7				
60	53.1				

Table B 56 S4c 2022 Ford Mach E Crash Avoidance and Speed Reduction Results

2022 Ford Mustang Mach E					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S4c	Adult	5.0	Daylight	10	3.4
				20	A
				30	A
				40	A
				50	A
				60	28.4
			Darkness – Lower Beam	10	2.8
				20	A
				30	A
				40	A
				50	A
				60	21.2
			Darkness – Upper Beam	10	0.0
				20	A
				30	A
				40	A
				50	A
				60	A
				65	43.9
				65	59.1
				65	A
65	32.1				

2022 Tesla Model 3

Table B 57 S1a 2022 Tesla model 3 Crash Avoidance and Speed Reduction Results

2022 Tesla Model 3					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S1a	Adult	5.0	Daylight	10	A
				20	A
				30	A
				40	21.6
				40	A
				40	21.2
			Darkness – Lower Beam	10	A
				20	A
				30	A
				40	16.1

Table B 58 S1b 2022 Tesla model 3 Crash Avoidance and Speed Reduction Results

2022 Tesla Model 3						
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance	
S1b	Adult	5.0	Daylight	10	A	
				20	A	
				30	A	
				40	A	
				50	25.7	
				50	32.5	
				50	30.2	
				Darkness – Lower Beam	10	A
					20	A
					30	A
					40	31.1
					40	31.1
			40		A	
			40		A	
			40		34.7	
			Darkness – Upper Beam	10	A	
				20	A	
				30	A	
				40	A	
				50	32.4	
				50	34.4	
				50	31.1	

Table B 59 S1c 2022 Tesla model 3 Crash Avoidance and Speed Reduction Results

2022 Tesla Model 3					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S1c	Adult	5.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	27.7
				50	31.8
				50	A
			Darkness – Lower Beam	50	28.0
				10	A
				20	A
				30	A
				40	26.7
				40	27.2
				40	A
40	26.6				

Table B 60 S1d 2022 Tesla model 3 Crash Avoidance and Speed Reduction Results

2022 Tesla Model 3					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S1d	Adult	5.0	Daylight	10	A
				20	A
				30	A
				40	23.2
				40	19.0
				40	A
				40	A
				40	27.1
			Darkness – Lower Beam	10	A
				20	A
				30	A
				40	9.1

Table B 61 S1e 2022 Tesla model 3 Crash Avoidance and Speed Reduction Results

2022 Tesla Model 3					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S1e	Adult	5.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	A
				60	15.6
			Darkness – Lower Beam	10	3.6
				20	A
				30	A
				40	A
				50	35.7
				50	16.9
				50	A
				50	A
60	A				
65	14.0				

Table B 62 S4a 2022 Tesla model 3 Crash Avoidance and Speed Reduction Results

2022 Tesla Model 3					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S4a	Adult	0.0	Daylight	10	A
				20	A
				30	A
				40	33.4
				40	31.0
				40	31.5
			Darkness – Lower Beam	10	A
				20	A
				30	A
				40	A
				50	33.8
				50	30.0
			Darkness – Upper Beam	50	34.0
				10	A
				20	A
				30	A
				40	A
				50	29.8
			50	35.2	
			50	33.9	

Table B 63 S4b 2022 Tesla model 3 Crash Avoidance and Speed Reduction Results

2022 Tesla Model 3					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S4b	Adult	0.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	31.9
				50	31.7
				50	30.7
			Darkness – Lower Beam	10	A
				20	A
				30	A
				40	A
				50	31.2
				50	31.0
				50	28.6

Table B 64 S4c 2022 Tesla model 3 Crash Avoidance and Speed Reduction Results

2022 Tesla Model 3					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S4c	Adult	5.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	33.0
				50	34.8
				50	30.4
			Darkness – Lower Beam	10	A
				20	A
				30	A
				40	A
				50	38.0
				50	40.1
				50	38.2
			Darkness – Upper Beam	10	A
				20	A
				30	A
				40	A
				50	50.2
				50	A
				50	36.5
				50	A
				50	A
				60	41.6
60	28.4				
60	31.3				

2022 Honda Odyssey

Table B 65 S1a 2022 Honda Odyssey Crash Avoidance and Speed Reduction Results

2022 Honda Odyssey					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S1a	Adult	5.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	A
				60	A
			Darkness – Lower Beam	10	A
				20	A
				30	A
				40	A
				50	33.0
				50	A
				50	29.5
				50	A
50	A				
60	23.3				

Table B 66 S1b 2022 Honda Odyssey Crash Avoidance and Speed Reduction Results

2022 Honda Odyssey					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S1b	Adult	5.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	A
				60	A
			Darkness – Lower Beam	10	A
				20	A
				30	A
				40	A
				50	26.4
				50	18.7
			Darkness – Upper Beam	50	9.8
				10	A
				20	A
				30	A
				40	A
				50	A
60	A				

Table B 67 S1c 2022 Honda Odyssey Crash Avoidance and Speed Reduction Results

2022 Honda Odyssey					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S1c	Adult	5.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	A
				60	A
			Darkness – Lower Beam	10	A
				20	A
				30	A
				40	A
				50	30.6
				50	A
				50	27.9
				50	31.7

Table B 68 S1d 2022 Honda Odyssey Crash Avoidance and Speed Reduction Results

2022 Honda Odyssey					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S1d	Adult	5.0	Daylight	10	0.0
				20	A
				30	A
				40	18.7
			Darkness – Lower Beam	10	0.0
				20	0.0

Table B 69 S1e 2022 Honda Odyssey Crash Avoidance and Speed Reduction Results

2022 Honda Odyssey					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S1e	Adult	5.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	A
				60	21.7
			Darkness – Lower Beam	10	0.0
				20	0.0

Table B 70 S4a 2022 Honda Odyssey Crash Avoidance and Speed Reduction Results

2022 Honda Odyssey					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S4a	Adult	0.0	Daylight	10	2.2
				20	A
				30	A
				40	A
				50	A
				60	54.8
				60	A
				60	54.7
				60	A
				60	52.8
			Darkness – Lower Beam	10	1.7
				20	A
				30	A
				40	2.5
			Darkness – Upper Beam	10	0.0
				20	0.0

Table B 71 S4b 2022 Honda Odyssey Crash Avoidance and Speed Reduction Results

2022 Honda Odyssey					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S4b	Adult	0.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	A
				60	A
			Darkness – Lower Beam	10	1.1
				20	A
				30	A
				40	A
				50	A
				60	19.1

Table B 72 S4c 2022 Honda Odyssey Crash Avoidance and Speed Reduction Results

2022 Honda Odyssey					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S4c	Adult	5.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	A
				60	A
				65	A
			Darkness – Lower Beam	10	A
				20	A
				30	A
				40	11.2
			Darkness – Upper Beam	10	A
				20	A
				30	A
				40	A
				50	A
				60	A
				65	28.2

2022 Jeep Grand Cherokee

Table B 73 S1a 2022 Jeep Grand Cherokee Crash Avoidance and Speed Reduction Results

2022 Jeep Grand Cherokee					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S1a	Adult	5.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	A
				60	A
			Darkness – Lower Beam	10	A
				20	A
				30	A
				40	A
				50	A
				60	26.5

Table B 74 S1b 2022 Jeep Grand Cherokee Crash Avoidance and Speed Reduction Results

2022 Jeep Grand Cherokee					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S1b	Adult	5.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	A
				60	A
			Darkness – Lower Beam	10	A
				20	A
				30	A
				40	A
				50	34.4
				50	27.0
				50	28.3
			Darkness – Upper Beam	10	A
				20	A
				30	A
				40	A
				50	37.7
				50	A
				50	29.5
			50	36.6	

Table B 75 S1c 2022 Jeep Grand Cherokee Crash Avoidance and Speed Reduction Results

2022 Jeep Grand Cherokee					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S1c	Adult	5.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	A
				60	A
			Darkness – Lower Beam	10	A
				20	A
				30	A
				40	A
				50	A
				60	28.6

Table B 76 S1d 2022 Jeep Grand Cherokee Crash Avoidance and Speed Reduction Results

2022 Jeep Grand Cherokee					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S1d	Adult	5.0	Daylight	10	A
				20	A
				30	8.3
			Darkness – Lower Beam	10	A
				20	0.0

Table B 77 S1e 2022 Jeep Grand Cherokee Crash Avoidance and Speed Reduction Results

2022 Jeep Grand Cherokee					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S1e	Adult	5.0	Daylight	10	0.0
				20	A
				30	A
				40	A
				50	A
				60	A
			Darkness – Lower Beam	10	0.0
				20	A
				30	A
				40	A
				50	19.8

Table B 78 S4a 2022 Jeep Grand Cherokee Crash Avoidance and Speed Reduction Results

2022 Jeep Grand Cherokee					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S4a	Adult	0.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	A
				60	A
			Darkness – Lower Beam	10	A
				20	A
				30	A
				40	A
				50	A
				60	42.0
				60	26.2
			Darkness – Upper Beam	60	36.9
				10	A
				20	A
				30	A
				40	A
				50	A
				60	46.0
				60	42.3
			60	42.6	

Table B 79 S4b 2022 Jeep Grand Cherokee Crash Avoidance and Speed Reduction Results

2022 Jeep Grand Cherokee					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S4b	Adult	0.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	A
				60	A
			Darkness – Lower Beam	10	A
				20	A
				30	A
				40	A
				50	A
				60	38.0
				60	42.0
				60	37.3

Table B 80 S4c 2022 Jeep Grand Cherokee Crash Avoidance and Speed Reduction Results

2022 Jeep Grand Cherokee					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S4c	Adult	5.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	A
				60	A
				65	0.0
			Darkness – Lower Beam	10	0.0
				20	A
				30	A
				40	A
				50	A
				60	A
				65	1.0
			Darkness – Upper Beam	10	0.0
				20	A
				30	A
				40	A
				50	A
				60	41.9
				60	36.3
			60	37.7	

2022 Honda Civic

Table B 81 S1a 2022 Honda Civic Crash Avoidance and Speed Reduction Results

2022 Honda Civic					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S1a	Adult	5.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	A
				60	44.6
				60	42.2
				60	20.8
			Darkness – Lower Beam	10	A
				20	A
				30	A
				40	A
				50	A
				60	36.3
60	13.9				
60	19.6				

Table B 82 S1b 2022 Honda Civic Crash Avoidance and Speed Reduction Results

2022 Honda Civic					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S1b	Adult	5.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	34.1
				50	A
				50	A
				50	A
				50	A
			Darkness – Lower Beam	60	A
				10	A
				20	A
				30	A
				40	A
			Darkness – Upper Beam	50	24.6
				10	A
				20	A
				30	A
40	A				
50	9.6				

Table B 83 S1c 2022 Honda Civic Crash Avoidance and Speed Reduction Results

2022 Honda Civic					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S1c	Adult	5.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	A
				60	A
			Darkness – Lower Beam	10	A
				20	A
				30	A
				40	A
50	15.9				

Table B 84 S1d 2022 Honda Civic Crash Avoidance and Speed Reduction Results

2022 Honda Civic					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S1d	Adult	5.0	Daylight	10	1.2
				20	A
				30	A
				40	A
				50	A
				60	33.3
				60	22.3
				60	25.3
			Darkness – Lower Beam	10	A
				20	A
				30	A
				40	12.8

Table B 85 S1e 2022 Honda Civic Crash Avoidance and Speed Reduction Results

2022 Honda Civic					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S1e	Adult	5.0	Daylight	10	3.4
				20	A
				30	A
				40	A
				50	34.5
				50	35.4
				50	A
				50	18.1
			Darkness – Lower Beam	10	A
				20	A
				30	A
				40	A
				50	A
				60	A

Table B 86 S4a 2022 Honda Civic Crash Avoidance and Speed Reduction Results

2022 Honda Civic					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S4a	Adult	0.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	A
				60	55.4
				60	A
				60	A
				60	A
				60	A
			Darkness – Lower Beam	10	A
				20	A
				30	A
				40	A
				50	A
				60	20.5
			Darkness – Upper Beam	10	A
				20	A
				30	A
				40	A
				50	A
				60	53.9
				60	10.9
				60	27.5

Table B 87 S4b 2022 Honda Civic Crash Avoidance and Speed Reduction Results

2022 Honda Civic					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S4b	Adult	0.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	A
				60	A
			Darkness – Lower Beam	10	A
				20	A
				30	A
				40	A
				50	A
				60	A

Table B 88 S4c 2022 Honda Civic Crash Avoidance and Speed Reduction Results

2022 Honda Civic							
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance		
S4c	Adult	5.0	Daylight	10	A		
				20	A		
				30	A		
				40	A		
				50	A		
				60	A		
				65	42.2		
				65	49		
				65	A		
				65	A		
				65	40.5		
			Darkness – Lower Beam	10	0.0		
				20	A		
				30	A		
				40	A		
				50	A		
				60	A		
			Darkness – Upper Beam	65	3.3		
				10	A		
				20	A		
				30	A		
						40	11.1

2022 Ford F150

Table B 89 S1a 2022 Ford F150 Crash Avoidance and Speed Reduction Results

2022 Ford F150					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S1a	Adult	5.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	43.8
				50	39.5
				50	42.2
			Darkness – Lower Beam	10	A
				20	A
				30	A
				40	17.3

Table B 90 S1b 2022 Ford F150 Crash Avoidance and Speed Reduction Results

2022 Ford F150					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S1b	Adult	5.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	A
				60	36.2
				60	43.2
				60	37.4
			Darkness – Lower Beam	10	A
				20	A
				30	A
				40	A
				50	A
				60	33.1
				60	31.5
				60	43.9
			Darkness – Upper Beam	10	A
				20	A
				30	A
				40	A
				50	A
				60	31.1
				60	41.6
				60	34.7

Table B 91 S1c 2022 Ford F150 Crash Avoidance and Speed Reduction Results

2022 Ford F150					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S1c	Adult	5.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	A
				60	A
			Darkness – Lower Beam	10	A
				20	A
				30	A
				40	A
				50	A
				60	A

Table B 92 S1d 2022 Ford F150 Crash Avoidance and Speed Reduction Results

2022 Ford F150					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S1d	Adult	5.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	A
				60	28.3
			Darkness – Lower Beam	10	A
				20	A
				30	8.3

Table B 93 S1e 2022 Ford F150 Crash Avoidance and Speed Reduction Results

2022 Ford F150					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S1e	Adult	5.0	Daylight	10	0.0
				20	A
				30	A
				40	A
				50	30.7
				50	35.9
				50	35.4
			Darkness – Lower Beam	10	0.0
				20	A
				30	A
				40	A
				50	13.0

Table B 94 S4a 2022 Ford F150 Crash Avoidance and Speed Reduction Results

2022 Ford F150					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S4a	Adult	0.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	A
				60	58.7
				60	59.4
				60	A
				60	43.7
			Darkness – Lower Beam	10	A
				20	A
				30	A
				40	A
				50	A
				60	26.1
			Darkness – Upper Beam	10	A
				20	A
				30	A
				40	A
				50	A
				60	46.1
				60	40.0
			60	44.7	

Table B 95 S4b 2022 Ford F150 Crash Avoidance and Speed Reduction Results

2022 Ford F150					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S4b	Adult	0.0	Daylight	10	A
				20	A
				30	A
				40	A
				50	A
				60	58.0
				60	46.5
				60	A
			60	17.4	
			Darkness – Lower Beam	10	A
				20	A
				30	A
				40	A
				50	A
				60	32.3
				60	39.0
60	34.5				

Table B 96 S4c 2022 Ford F150 Crash Avoidance and Speed Reduction Results

2022 Ford F150					
Scenario	Stature	PTM Speed (km/h)	Lighting	SV Speed (km/h)	Speed Reduction (km/h) A = Crash Avoidance
S4c	Adult	5.0	Daylight	10	4.2
				20	A
				30	A
				40	A
				50	A
				60	A
				65	59.9
				65	A
				65	28.4
				65	55.6
			Darkness – Lower Beam	10	0.0
				20	A
				30	A
				40	A
				50	A
				60	23.7
			Darkness – Upper Beam	10	0.0
				20	A
				30	A
				40	A
				50	A
				60	A
				65	36.9
				65	34.3
65	45.1				