

SAE Government Industry Meeting | January 25-27, 2017

Objective Test Procedures for Pedestrian Automatic Emergency Braking Systems

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1/27/2017

NHTSA
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION





Agenda

- Research Update
- Test Equipment
- Test Scenarios
- Test Conditions
- Test Vehicles
- Results



Research Update

Volpe -

- New safety benefit analysis for PAEB systems that will include new estimates for the benefits of PAEB in combination with different safety systems
- Completed
- Final Report - (early 2017)

NHTSA -

- Current research focuses on objective performance test development
 - Assessment of mannequins (posable/articulated)
 - Testing Apparatus
 - Test Scenarios
 - Test Procedures

Tests Mannequins

- Leg articulation only



Pedestrian Static



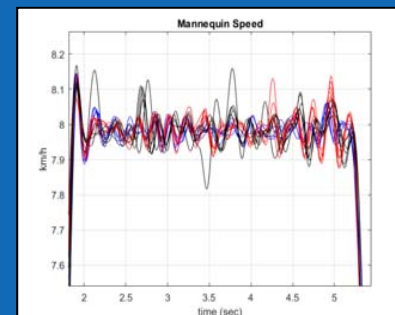
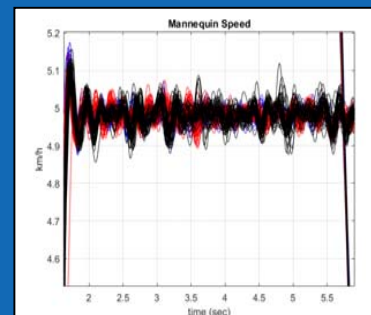
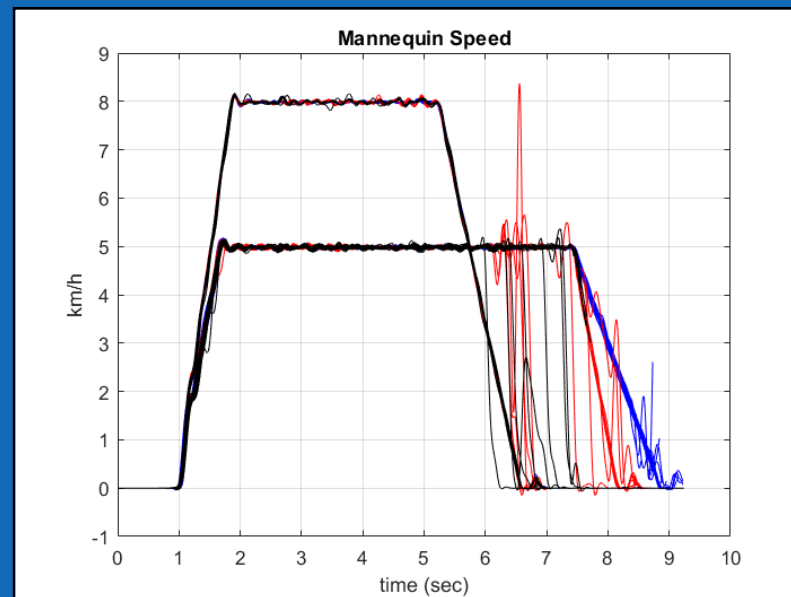
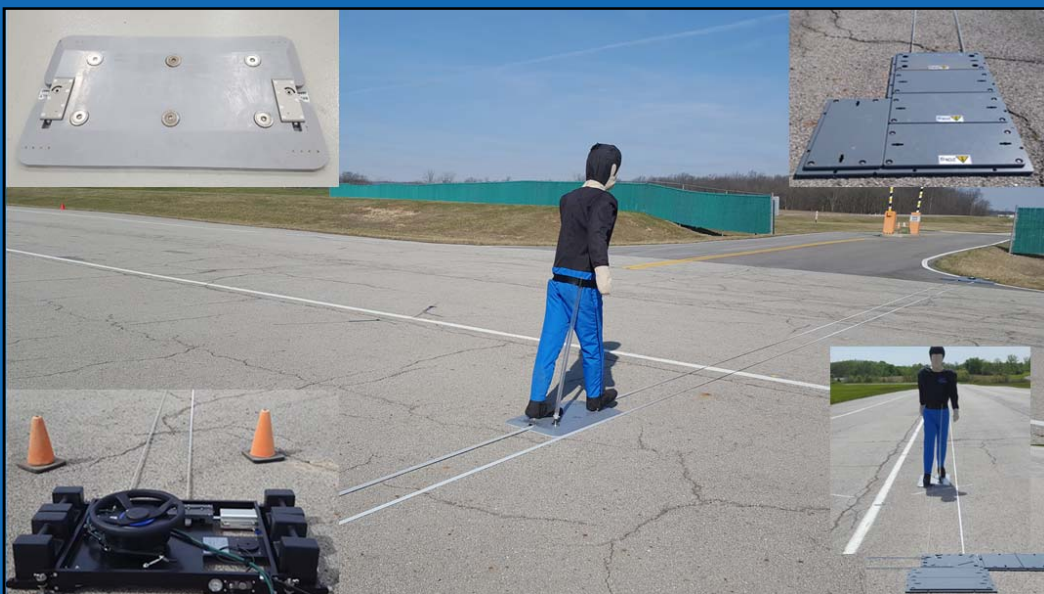
Pedestrian Articulated



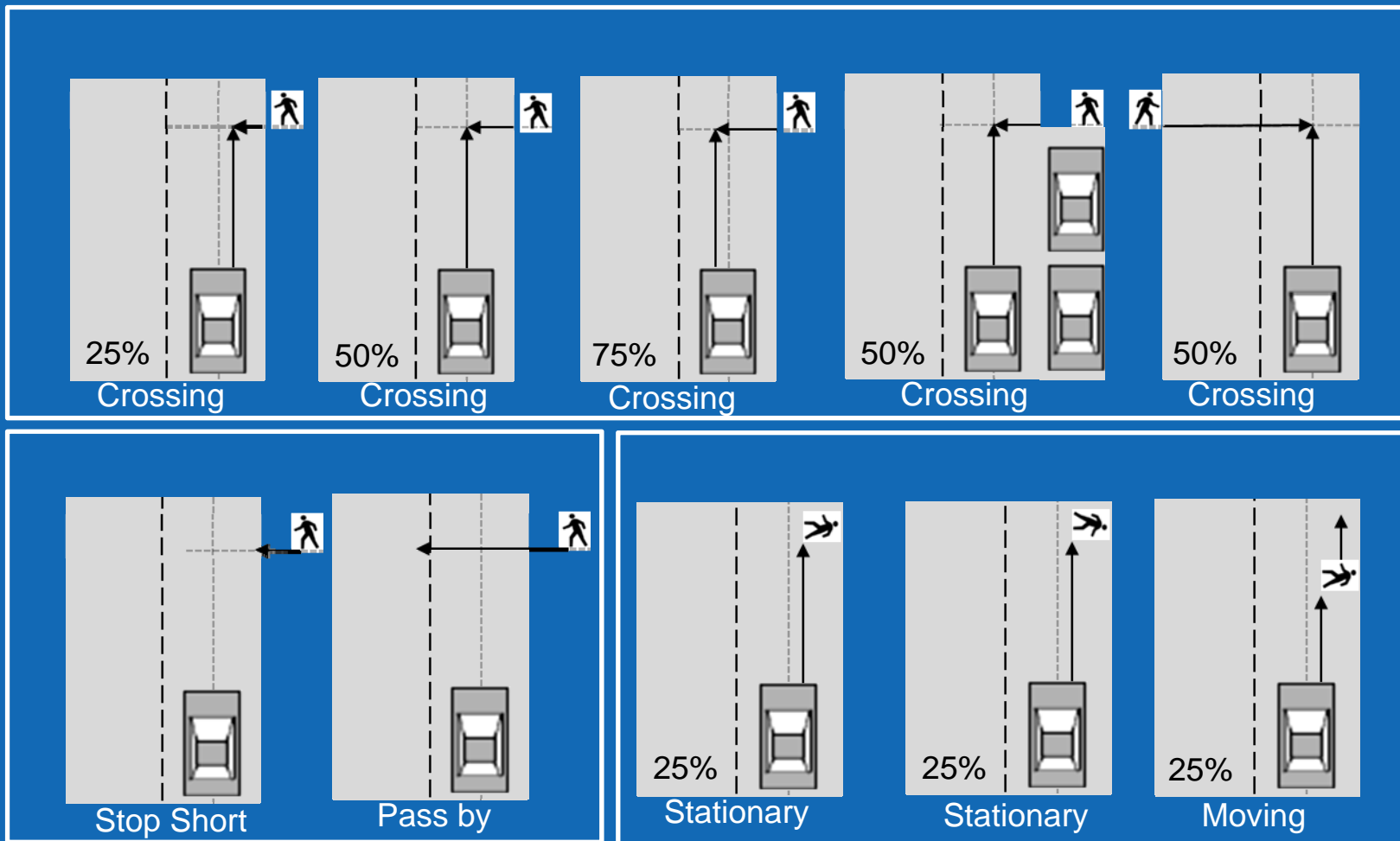


Test Apparatus

- 5 km/h mannequin walk speed (~100 tests)
- 8 km/h mannequin run speed (~50 tests)
- 0.1 km/h = 0.0621 mph



Test Scenarios





Test Conditions

	1	2	3	4	5	6	7	8	9	10
Mannequin Size	Adult	Adult	Adult	Child	Adult	Adult	Adult	Adult	Adult	Adult
Mannequin Clothing Color (upper/lower)	Black/Blue	Black/Blue	Black/Blue	Black/Blue	Black/Blue	Black/Blue	Black/Blue	Black/Blue	Black/Blue	Black/Blue
Mannequin Motion Profile	Walk	Walk	Walk	Run	Run	Walk	Walk	Stationary	Stationary	Walk
Overlap (%)	25	50	75	50	50	Stop Short	Clear Path	25	25	25
Mannequin Start Location (relative to test vehicle)	Nearside	Nearside	Nearside	Nearside	Offside	Nearside	Nearside	Nearside	Nearside	Nearside
Mannequin offset Distance from SV path (before motion) meter (feet)	3.5 (11.4)	3.5 (11.4)	3.5 (11.4)	3.5 (11.4)	5.5 (18.0)	3.5 (11.4)	3.5 (11.4)	25% SV Width	25% SV Width	25% SV Width
Mannequin Orientation (direction facing)	Offside	Offside	Offside	Offside	Offside	Offside	Offside	Away from SV	Towards SV	Away from SV
SV Test Speed km/h (mph)	16/40 (10/25)	16/40 (10/25)	16/40 (10/25)	16/40 (10/25)	16/40 (10/25)	16/40 (10/25)	16/40 (10/25)	16/40 (10/25)	16/40 (10/25)	16/40 (10/25)
Mannequin Speed km/h (mph)	5 (3.1)	5 (3.1)	5 (3.1)	5 (3.1)	8 (4.9)	5 (3.1)	5 (3.1)	0.0	0.0	5 (3.1)
Mannequin Acceleration Distance meter (feet)	0.5 (1.64)	0.5 (1.64)	0.5 (1.64)	0.5 (1.64)	1.0 (3.28)	0.5 (1.64)	0.5 (1.64)	NA	NA	0.5 (1.64)

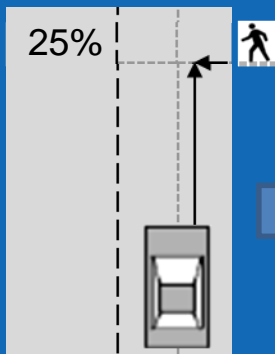


Test Vehicles

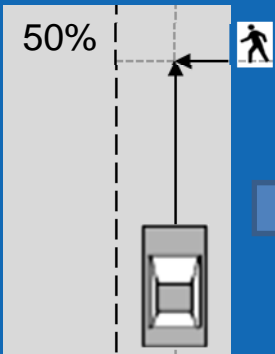
Vehicle	Production	Sensor Technology	CIB/AEB
Vehicle 1 2015	Y	RADAR, LIDAR, and Stereo Camera	Up to Full Braking
Vehicle 2 2015	Y	Stereo Camera	Up to Full Braking
Vehicle 3 2016	Y	RADAR and Mono Camera	Up to Full Braking



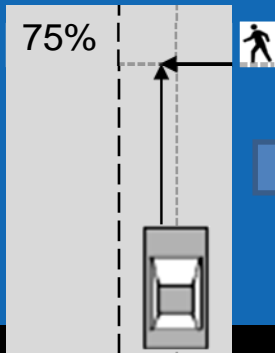
Tests Results S1



Scenario	Pedestrian Speed (km/h)	Pedestrian Size	Pedestrian Type	Vehicle Speed (km/h)	No Impact Tests / Test Conducted		
					Vehicle 1	Vehicle 2	Vehicle 3
S1	5.0 Walk	Adult	4a Posable	16	5/5	1/5 (3.2)	7/7
				40	5/5	6/6	7/7
			4a Articulated	16	7/7	0/3 (1.1)	7/7
				40	7/7	7/7	5/7 (29.3)

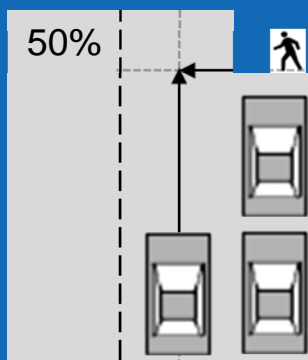


Scenario	Pedestrian Speed (km/h)	Pedestrian Size	Pedestrian Type	Vehicle Speed (km/h)	No Impact Tests / Test Conducted		
					Vehicle 1	Vehicle 2	Vehicle 3
S1	5.0 Walk	Adult	4a Posable	16	5/5	7/7	7/7
				40	5/5	6/6	7/7
			4a Articulated	16	7/7	6/7 (0.0)	7/7
				40	5/5	5/7 (23.8)	6/7 (17.2)

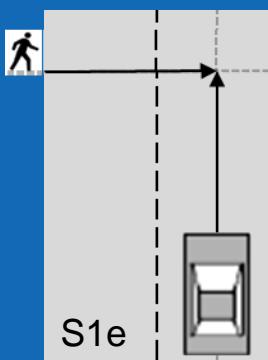


Scenario	Pedestrian Speed (km/h)	Pedestrian Size	Pedestrian Type	Vehicle Speed (km/h)	No Impact Tests / Test Conducted		
					Vehicle 1	Vehicle 2	Vehicle 3
S1	5.0 Walk	Adult	4a Posable	16	5/5	5/5	7/7
				40	5/5	6/6	7/7
			4a Articulated	16	7/7	7/7	5/7 (1.22)
				40	7/7	6/6	4/6 (11.0)

Test Results S1

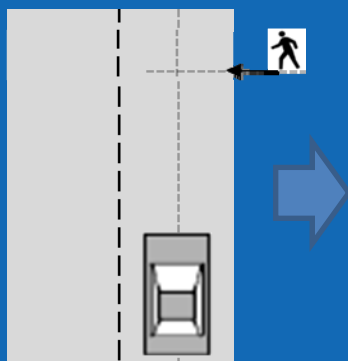


Scenario	Pedestrian Speed (km/h)	Pedestrian Size	Pedestrian Type	Vehicle Speed (km/h)	No Impact Tests / Test Conducted		
					Vehicle 1	Vehicle 2	Vehicle 3
S1	5.0 Run	Child	4a Posable	16	5/5	5/5	7/7
				40	0/5 (10.9)	0/5 (11.1)	6/7 (11.7)
			4a Articulated	16	7/7	3/7 (4.9)	7/7
				40	0/3 (8.0)	0/3 (8.6)	3/7 (20.7)

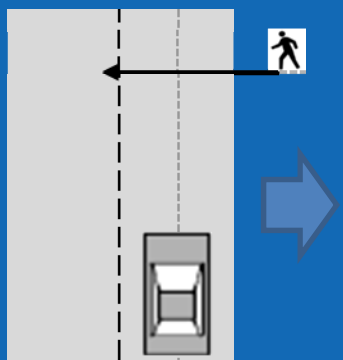


Scenario	Pedestrian Speed (km/h)	Pedestrian Size	Pedestrian Type	Vehicle Speed (km/h)	No Impact Tests / Test Conducted		
					Vehicle 1	Vehicle 2	Vehicle 3
S1	8.0 Run	Adult	4a Posable	16	0/5 (0.9)	0/2 (0.0)	6/7 (1.1)
				40	5/5	6/6	7/7
			4a Articulated	16	0/3 (0.0)	0/3 (0.0)	7/7
				40	6/7 (20.9)	6/7 (29.8)	7/7

Test Results S1



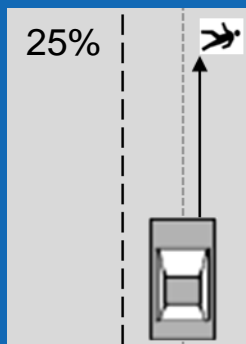
Scenario	Pedestrian Speed (km/h)	Pedestrian Size	Pedestrian Type	Vehicle Speed (km/h)	Decel < 0.5 g / Test Conducted		
					Vehicle 1	Vehicle 2	Vehicle 3
S1	5.0 Walk	Adult	4a Posable	16	1/5	5/5	2/7
				40	0/5	4/5	0/7
			4a Articulated	16	3/7	7/7	5/7
				40	0/7	2/7	3/7



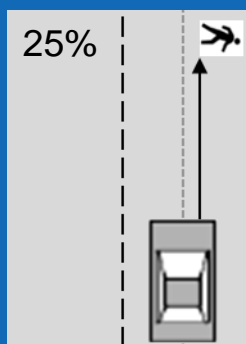
Scenario	Pedestrian Speed (km/h)	Pedestrian Size	Pedestrian Type	Vehicle Speed (km/h)	Decel < 0.5 g / Test Conducted		
					Vehicle 1	Vehicle 2	Vehicle 3
S1	5.0 Walk	Adult	4a Posable	16	3/3	5/5	7/7
				40	5/5	5/5	7/7
			4a Articulated	16	7/7	7/7	7/7
				40	7/7	7/7	7/7



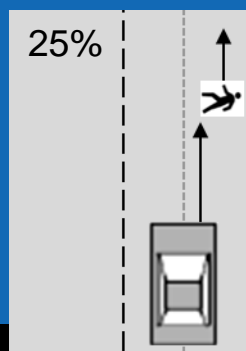
Test Results S4



Scenario	Pedestrian Speed (km/h)	Pedestrian Size	Pedestrian Type	Vehicle Speed (km/h)	No Impact Tests / Test Conducted		
					Vehicle 1	Vehicle 2	Vehicle 3
S4	0.0	Adult	4a Posable	16	5/7 (0.8)	7/7	7/7
				40	6/7 (15.9)	6/6	4/7 (12.6)
			4a Articulated	16	6/7 (7.1)	2/7 (0.4)	7/7
				40	5/7 (22.8)	7/7	6/7 (22.4)



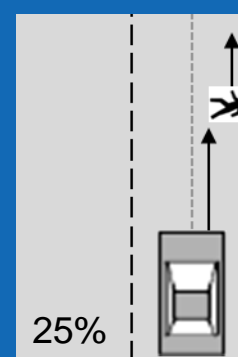
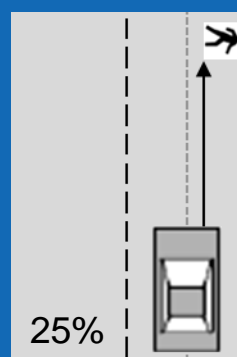
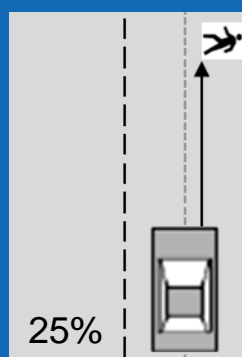
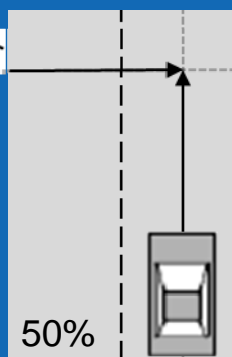
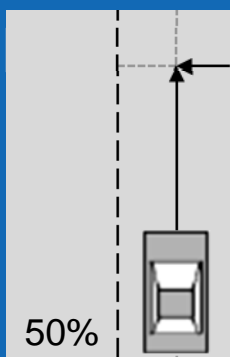
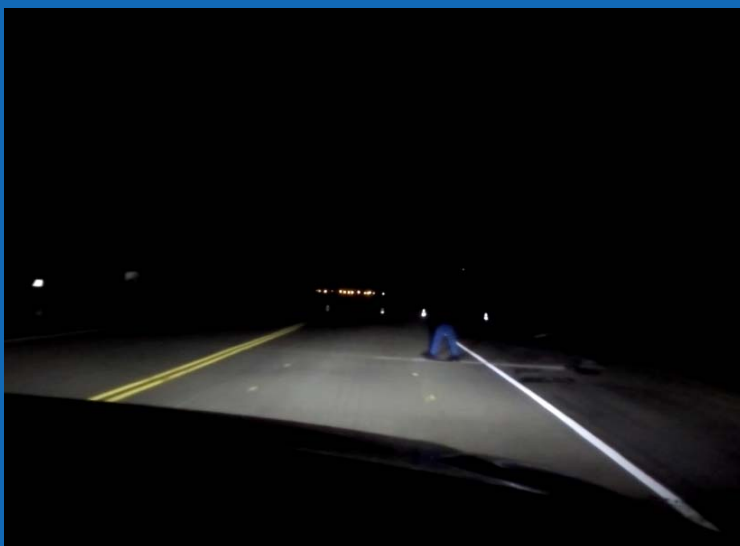
Scenario	Pedestrian Speed (km/h)	Pedestrian Size	Pedestrian Type	Vehicle Speed (km/h)	No Impact Tests / Test Conducted		
					Vehicle 1	Vehicle 2	Vehicle 3
S4	0.0	Adult	4a Posable	16	5/7 (7.7)	7/7	7/7
				40	5/7 (34.1)	7/7	7/7
			4a Articulated	16	7/7	6/7 (0.8)	7/7
				40	5/7 (34.2)	6/7 (21.8)	5/7 (31.1)



Scenario	Pedestrian Speed (km/h)	Pedestrian Size	Pedestrian Type	Vehicle Speed (km/h)	No Impact Tests / Test Conducted		
					Vehicle 1	Vehicle 2	Vehicle 3
S4	5.0 Walk	Adult	4a Posable	40	5/7 (21.1)	7/7	4/7 (13.5)
			4a Articulated	40	4/7 (17.5)	7/7	7/7

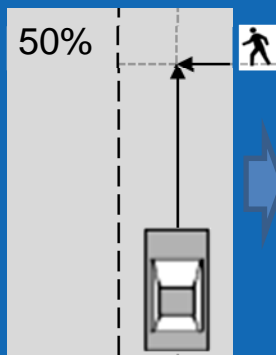


Night Testing

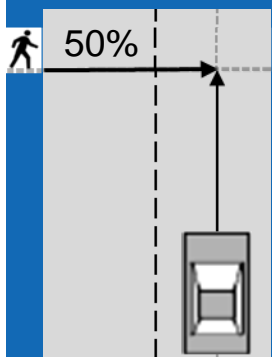




Test Results S1



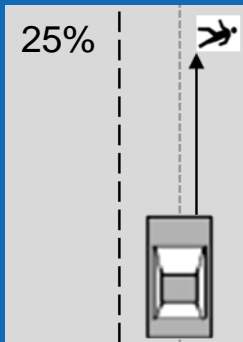
Scenario	Pedestrian Speed (km/h)	Pedestrian Size	Pedestrian Type	Light	Vehicle Speed (km/h)	SV Headlight State	No Impact Tests / Test Conducted		
							Vehicle 1	Vehicle 2	Vehicle 3
S1	5.0	Adult	4a Posable	Day	16	-	5/5	7/7	7/7
				Night	16	Lower	1/7 (4.6)	0/5 (0.0)	6/7 (0.4)
						Upper	3/7 (6.8)	7/7	-
				Day	40	-	5/5	6/6	7/7
				Night	40	Lower	7/7	0/2 (0.7)	6/7 (0.5)
						Upper	-	7/7	-



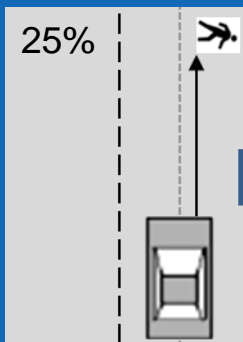
Scenario	Pedestrian Speed (km/h)	Pedestrian Size	Pedestrian Type	Light	Vehicle Speed (km/h)	SV Headlight State	No Impact Tests / Test Conducted		
							Vehicle 1	Vehicle 2	Vehicle 3
S1	8.0	Adult	4a Posable	Day	16	-	0/5 (0.9)	0/2 (0.0)	6/7 (1.1)
				Night	16	Lower	0/3 (0.0)	0/3 (0.0)	0/6 (1.4)
						Upper	0/2 (0.0)	0/3 (0.0)	0/2 (0.1)
				Day	40	-	5/5	6/6	7/7
				Night	40	Lower	0/3 (1.4)	0/2 (0.5)	0/2 (0.7)
						Upper	0/3 (3.6)	7/7	7/7



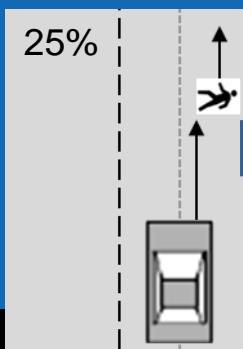
Test Results S4



Scenario	Pedestrian Speed (km/h)	Pedestrian Size	Pedestrian Type	Light	Vehicle Speed (km/h)	SV Headlight State	No Impact Tests / Test Conducted		
							Vehicle 1	Vehicle 2	Vehicle 3
S4	0.0	Adult	4a Posable	Day	16	-	5/7 (0.8)	7/7	7/7
				Night	16	Lower	2/7 (3.6)	0/3 (0.5)	7/7
						Upper	?	7/7	-
				Day	40	-	6/7 (15.9)	6/6	4/7 (12.6)
Night	40	Lower	4/7 (22)	0/2 (0.8)	0/7				
		Upper	?	7/7	0/3 (23.4)				



Scenario	Pedestrian Speed (km/h)	Pedestrian Size	Pedestrian Type	Light	Vehicle Speed (km/h)	SV Headlight State	No Impact Tests / Test Conducted		
							Vehicle 1	Vehicle 2	Vehicle 3
S4	0.0	Adult	4a Posable	Day	16	-	5/7 (7.7)	7/7	7/7
				Night	16	Lower	0/7 (1.6)	0/5 (0.4)	7/7
						Upper	3/7 (3.5)	7/7	-
				Day	40	-	5/7 (34.1)	7/7	7/7
Night	40	Lower	3/6 (19)	0/2 (1.2)	7/7				
		Upper	?	7/7	-				



Scenario	Pedestrian Speed (km/h)	Pedestrian Size	Pedestrian Type	Light	Vehicle Speed (km/h)	SV Headlight State	No Impact Tests / Test Conducted		
							Vehicle 1	Vehicle 2	Vehicle 3
S4	5.0	Adult	4a Posable	Day	40	-	5/7 (21.1)	7/7	4/7 (13.5)
				Night	40	Lower	3/7 (13)	0/2 (1.4)	6/7 (19.8)
						Upper	?	7/7	-



S1 – 40 km/h – Adult – Walking – 50 % Overlap





S1 – 16 km/h – Child – Running – 50 % Overlap





S1 – 40 km/h – Adult – Stop Short





S1 – 40 km/h – Adult – Pass By





S4 – 40 km/h – Adult – Walking – 25 % Overlap





QUESTIONS?

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NHTSA

