



Light Vehicle and Heavy Truck Test Track Verification Test Results

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Outline

- Introduction
- Light Vehicle Test Track Verification Test Results
- Heavy Truck Test Track Verification Test Results



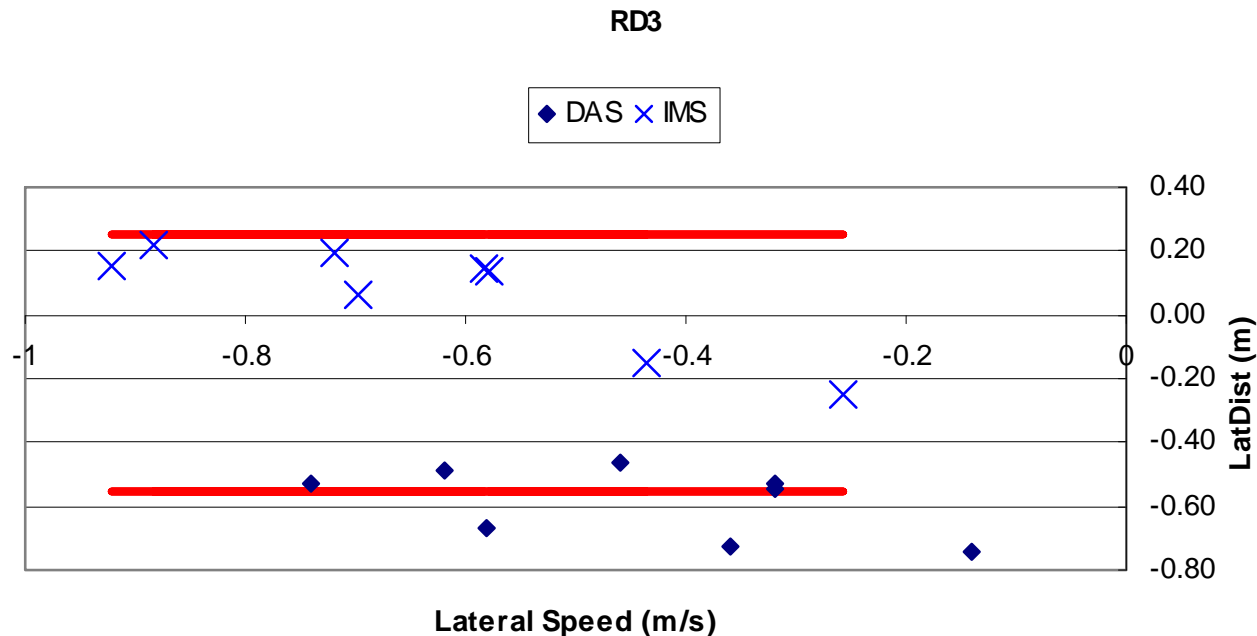
Objectives of Track Verification Tests

Objectives:

1. Judge pass/fail of the system in crash-imminent tests for all valid test runs
2. Evaluate the consistency of system performance

Pass/Fail Judgment

- Must meet pass/fail criteria in 8 out of 10 valid runs
- Use of NIST Independent Measurement System (IMS) measures
- Comparison between NIST IMS and UMTRI Data Acquisition System (DAS) measures - check on DAS accuracy and latency.





Run Validity Assessment

- Meeting run validity criteria in test procedures
- Use of UMTRI DAS measures supplemented by NIST IMS
- Verification with video images
- Key variables of interest:
 - Longitudinal speed
 - Relative longitudinal speed
 - Lateral average speed
 - Range between host and lead vehicles @ brake onset by lead vehicle
 - Range between host and lead vehicles @ cut-in by lead vehicle
 - In-lane vehicle position

Heavy Truck - Road

- LWDR**
- Driver #243
Trip #476-(397) [00:00:18]
Alert Starts @ 208520
LWDR
 - Driver #243
Trip #478-(399) [00:00:18]
Alert Starts @ 212290
LWDR
 - Driver #243
Trip #479-(402) [00:00:18]
Alert Starts @ 239600
LWDR
 - Driver #243
Trip #481-(414) [00:00:18]
Alert Starts @ 32370
LWDR
 - Driver #243
Trip #483-(420) [00:00:18]
Alert Starts @ 120110
LWDR
 - Driver #243
Trip #483-(421) [00:00:18]
Alert Starts @ 250050
LWDR
- LWDL**
- Driver #243
Trip #477-(398) [00:00:18]
Alert Starts @ 167170
LWDL
 - Driver #243
Trip #478-(400) [00:00:18]
Alert Starts @ 268590

- Heavy Truck - Track
- Heavy Truck - Road**
- Light Vehicle - Track
- Light Vehicle - Road



Data Analysis Tool

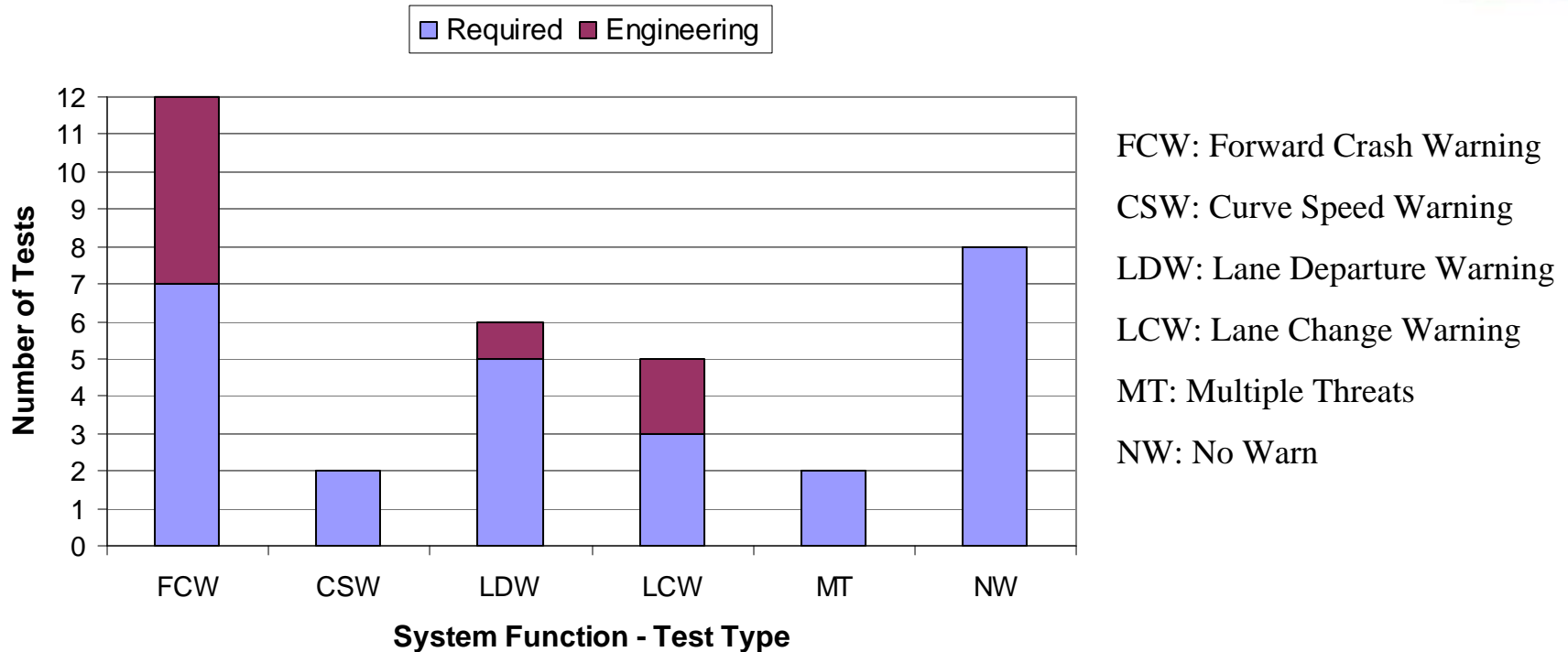
Table: FCW1 (Row: 238640)

	Tractor	Trip	Time	AccelPedal	LdwCurvature	BoundaryLeft	BoundaryRight	Brake	BSLeftFront	BSLeftRear	BSRightFront	BSRightRear	Cu
	243	479	238600	78	0	1	2	0	2	1	14	0	0.0
	243	479	238610	76.8	0	1	2	0	2	1	0	0	0.0
	243	479	238620	76.4	6.3E-05	1	2	0	1	1	0	0	0.0
	243	479	238630	76.4	0.000126	1	2	0	1	1	0	0	0.0
	243	479	238640	72	0.000126	1	2	0	1	1	0	0	0.0
	243	479	238650	71.2000046	0.000189	1	2	0	1	1	0	0	0.0
	243	479	238660	70.8	0.000189	1	2	0	1	1	0	0	0.0
	243	479	238670	64	0.000252	1	2	0	1	1	0	0	0.0
	243	479	238680	62.8	0.000189	1	2	0	1	1	0	0	6.3
	243	479	238690	57.2	0.000189	1	2	0	1	1	0	0	-0.0
	243	479	238700	50	0.000126	1	2	0	1	1	0	0	-0.0

Light Vehicle

Test Track Verification Test Results

Breakdown of Light Vehicle Tests



35 tests:

- 27 *Required*
- 8 *Engineering*
- Tests were conducted in September-October 2007
- 5 LCW & 1 MT tests were retested in February 2008

FCW Crash-Imminent Tests

No	FCW Tests	Initial Conditions				Pass/ Fail	Test Type
		SV (mph)	POV (mph)	R _H (m)	a _{POV} (g)		
1	Constant speed POV	50	25			Pass	Req
2	Slowing POV at close range	45	45	30	0.20	Pass	Req
3	Slowing POV at far range	45	45	60	0.35	Pass	Req
4	Stopped POV at moderate speed	45	0			Pass	Req
5	Stopped POV at low speed	30	0			Pass	Req
6	Slower POV after lane change by SV	45	35	50		Pass	Req
7	Stopped POV in curve	30	0			Fail	Eng
8	Slower POV in curve	45	35			Pass	Eng
9	Constant speed motorcycle behind truck	45	25			Pass	Eng
10	Cut-in by POV	35	25	45		Pass	Eng
11	Slowing POV1 after POV2 cut-out	50	25	60		Pass	Eng
12	Constant speed motorcycle	45	25			Pass	Req

SV: Subject vehicle or IVBSS-equipped vehicle

POV: Principal other vehicle or lead vehicle

R_H: Initial gap between the SV and POV

a_{POV}: Deceleration level of lead vehicle

Red row indicates a “failed” test

LDW Crash-Imminent Tests

No	LDW Test	Initial Conditions				Pass/ Fail	Test Type
		Speed (mph)	POV (mph)	Lateral Speed (m/s)	Curve Radius (m)		
1	Toward opposing traffic lane	45		0.3		Pass	Req
2	Toward clear shoulder	45		0.7		Pass	Req
3	Toward clear shoulder on small radius curve	35		0.3	200	Pass	Req
4	Toward clear shoulder on large radius curve	45		0.3	300	Pass	Req
5	Toward shoulder barrier with solid lane marker	35		0.3		Pass	Eng
8	Toward adjacent lane with POV forward on left	45	45	0.4		Pass	Req

Lateral Speed: Lateral speed of the IVBSS-equipped vehicle relative to the lane boundary lines

CSW Crash-Imminent Tests

No	CSW Test	Initial Conditions		Pass/ Fail	Test Type
		Speed (mph)	Curve Radius (m)		
6	Toward curve with excessive speed in dry/warm condition	50	100	Pass	Req
7	Toward curve with excessive speed in wet/cold condition	50	100	Pass	Req



LCW Crash-Imminent Tests

September-October 2007 Tests

No	Test	Initial Conditions				Pass/ Fail	Test Type
		SV Speed (mph)	Lateral Speed (m/s)	POV Speed (mph)	Curve Radius (m)		
1	LC conflict with POV in blind spot on right	45	0.25	40		Fail	Req
3	LC into adjacent POV on curve	35	0.25	40	300	Fail	Eng
4	LC into adjacent POV on merge - Lane marker not available	35		40		Fail	Req
5	LC into adjacent POV after passing	37	0.25	35		Fail	Eng
6	LC into approaching POV	30	0.25	45		Fail	Req

Phase I Extension - February 2008 Tests

Test No	LCW Tests	Initial Condition					Pass/ Fail	Test Type
		SV Speed (mph)	Lateral Speed (m/s)	Lateral Distance (m)	POV Speed (mph)	Curve Radius (m)		
1	LC conflict with POV in blind spot on right	45	0.65	0.91	45		Pass	Req
3	LC into adjacent POV on curve	35	0.65	0.91	35	150-300	Pass	Eng
4	LC into adjacent POV on merge - Lane marker not available	35	0.65	0.91	35		Pass	Req
5	LC into adjacent POV after passing	37	0.65	0.91	35		Pass	Eng
6	LC into approaching POV	50	0.65	0.91	60		Pass	Req

MT Crash-Imminent Tests

September-October 2007 Tests

No	Test	Initial Conditions					Pass/ Fail	Test Type
		SV Speed (mph)	Lateral Speed (m/s)	POV Speed (mph)	a _{POV} (g)	R _H (m)		
1	Avoid RE with slower POV1 and encounter LC with adjacent POV2	50	0.5	25		100	Fail LCM	Req
2	Avoid LC with POV2, RE with slowing POV1, and encounter RD toward clear shoulder	35	0.5	35	0.2	40	Pass	Req

Phase I Extension - February 2008 Tests

No	Test	Initial Condition					Pass/ Fail	Test Type
		SV Speed (mph)	Lateral Speed (m/s)	POV Speed (mph)	a _{POV} (g)	R _H (m)		
1	Avoid RE with slower POV1 and encounter LC with adjacent POV2	50	0.5	25	0	100	Pass	Req

No-Warn Tests

September-October 2007 Tests

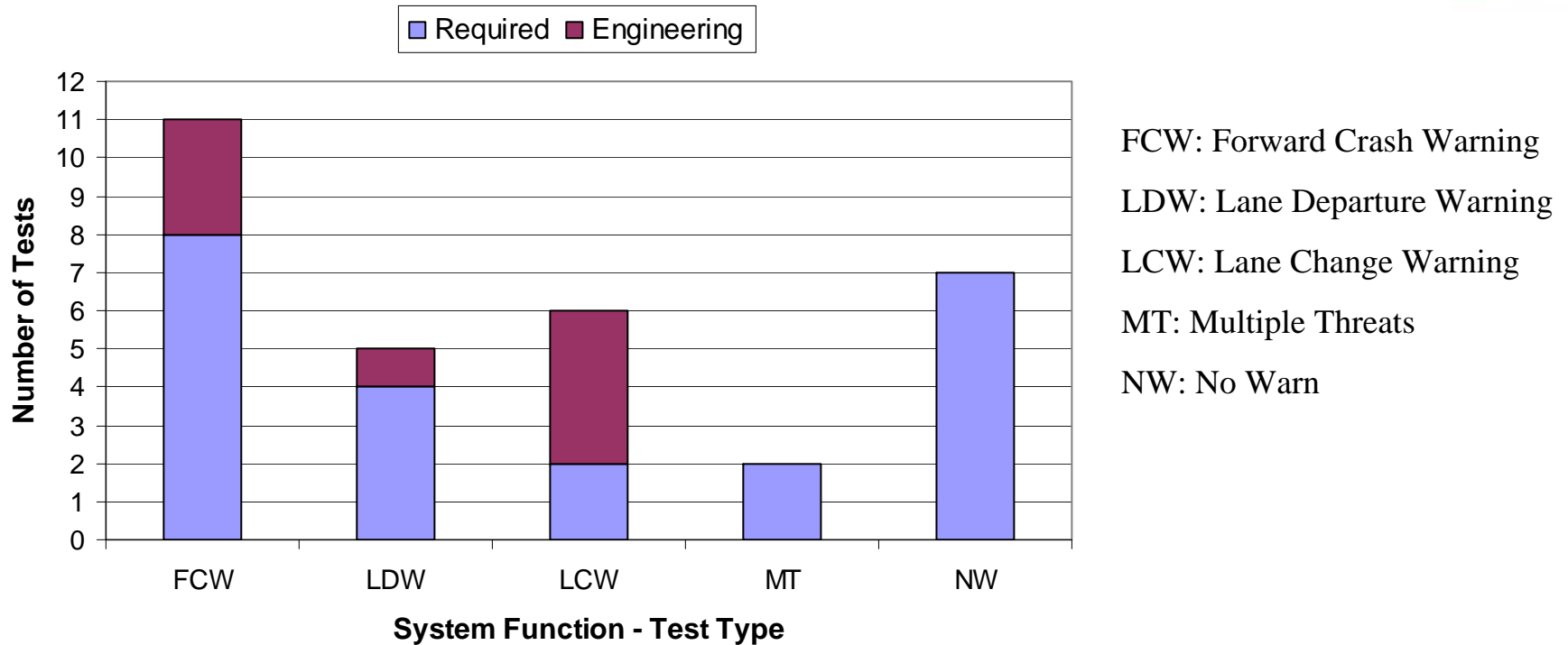
Test No.	Description	Initial Conditions				
		SV Speed (mph)	POV Speed (mph)	Longitudinal Range (m)	SV Lateral Speed (m/s)	Curve Radius (m)
NW-1	No FCW when SV closely follows POV	40	40	18		
NW-2	No FCW when SV on curve passes stopped POV in adjacent lane on curve	35	0			300
NW-3	No FCW when faster moving POV cuts in front of SV at a very close headway gap	40	45	10	0.5	
NW-4	No FCW when SV approaches POVs in left and right adjacent lanes	45	40			
NW-5	No RDW with poor lane keeping and a continuous barrier on the left	35			0.3	
NW-6	No LCW when SV changes lane into adjacent faster POV behind the SV rear bumper	30	35	15	0.4	
NW-7	No LCW when SV changes lane and POV is 2 lanes over in blind spot	45	45		0.4	
NW-8	No CSW when SV is approaching a curve with safe speed	35				100

All NW tests passed

Heavy Truck

Test Track Verification Test Results

Breakdown of Heavy Truck Tests



31 tests:

- 23 *Required*
- 8 *Engineering*
- All tests were conducted in September 2007
- 4 LDW and 2 LCW tests were retested in November 2007
- 1 FCW, 1 LDW, 3 LCW, 1 MT, and 1 NW tests were retested in March 2008

FCW Crash-Imminent Tests

September 2007 Tests

No	FCW Tests	Initial Conditions				Pass/ Fail	Test Type
		SV (mph)	POV (mph)	R _H (m)	a _{POV} (g)		
1	Constant speed POV	55	30			Pass	Req
2	Slowing POV at close range	40	40	40	0.15	Pass	Req
3	Slowing POV at far range	40	40	60	0.31	Pass	Req
4	Stopped POV at moderate speed	35	0			Pass	Req
6	Slower POV after lane change by SV	45	35	40		Pass	Req
7	Stopped POV in curve	30	0			Fail	Eng
8	Slower POV in curve	55	40			Pass	Eng
9	Constant speed motorcycle behind truck	50	35			Pass	Req
10	Cut-in by POV	45	35	30		Fail	Req
11	Slowing POV1 after POV2 cut-out	40	40	60	0.15	Pass	Eng
12	Constant speed motorcycle	50	30			Pass	Req

Phase I Extension - March 2008 Tests

No	FCW Tests	Initial Conditions				Pass/ Fail	Test Type
		SV (mph)	POV (mph)	R _H (m)	a _{POV} (g)		
10	Cut-in by POV	45	35	30		Pass	Req

SV: Subject vehicle or IVBSS-equipped vehicle

POV: Principal other vehicle or lead vehicle

R_H: Initial gap between the SV and POV

a_{POV}: Deceleration level of lead vehicle

Red row indicates a “failed” test

LDW Crash-Imminent Tests

September 2007 Tests

No	LDW Test	Initial Conditions			Pass/ Fail	Test Type
		Speed (mph)	Lateral Speed (m/s)	Curve Radius (m)		
1	Toward opposing traffic lane	45	0.3		Pass	Req
2	Toward clear shoulder	45	0.7		Pass	Req
3	Toward clear shoulder on small radius curve	40	0.3	185	Pass	Req
4	Toward clear shoulder on large radius curve	45	0.3	280	Pass	Req
5	Toward shoulder barrier with solid lane marker	40	0.3		Pass	Eng

November 2007 Tests

No	LDW Test	Initial Conditions			Pass/ Fail	Test Type
		Speed (mph)	Lateral Speed (m/s)	Curve Radius (m)		
1	Toward opposing traffic lane	45	0.3		Pass	Req
2	Toward clear shoulder	45	0.7		Pass	Req
3	Toward clear shoulder on small radius curve	40	0.3	185	Fail	Req
5	Toward shoulder barrier with solid lane marker	40	0.3		Pass	Eng

Lateral Speed: Lateral speed of the IVBSS-equipped vehicle relative to the lane boundary lines

LDW Crash-Imminent Tests

(cont.)

Phase I Extension - March 2008 Tests

No	LDW Test	Initial Conditions			Pass/ Fail	Test Type
		Speed (mph)	Lateral Speed (m/s)	Curve Radius (m)		
3	Toward clear shoulder on small radius curve	40	0.3	185	Pass	Req

Lateral Speed: Lateral speed of the IVBSS-equipped vehicle relative to the lane boundary lines



LCW Crash-Imminent Tests

September 2007 Tests

No	Test	Initial Conditions				Pass/ Fail	Test Type
		SV Speed (mph)	Lateral Speed (m/s)	POV Speed (mph)	Curve Radius (m)		
1	Adjacent POV in blind spot on right	40	0.25	40		Pass	Req
2	Adja vent POV in blind spot on left	40	0.25	40		Pass	Req
3	Adja vent POV on curve	40	0.25	40	280	Pass	Eng
4	Adja vent POV on merge	40		40		Fail	Eng
5	Adjacent POV after passing	45	0.25	35		Pass	Eng
6	Approaching POV	35	0.25	45		Pass	Eng

November 2007 Tests

No	Test	Initial Conditions				Pass/ Fail	Test Type
		SV Speed (mph)	Lateral Speed (m/s)	POV Speed (mph)	Curve Radius (m)		
1	Adjacent POV in blind spot on right	40	0.25	40		Pass	Req
2	Adja vent POV in blind spot on left	40	0.25	40		Pass	Req



LCW Crash-Imminent Tests

(cont.)

Phase I Extension - March 2008 Tests

No	Test	Initial Conditions				Pass/ Fail	Test Type
		SV Speed (mph)	Lateral Speed (m/s)	POV Speed (mph)	Curve Radius (m)		
1	Adjacent POV in blind spot on right	40	0.25	40		Pass	Req
2	Adjacent POV in blind spot on left	40	0.25	40		Pass	Req
4	Adjacent POV on merge	40		40		Pass	Eng

MT Crash-Imminent Tests

September 2007 Tests

No	Test	Initial Conditions					Pass/ Fail	Test Type
		SV Speed (mph)	Lateral Speed (m/s)	POV Speed (mph)	a_{POV} (g)	R_H (m)		
1	Avoid RE with slower POV1 and encounter LC with adjacent POV2	45	0.3	45	0.31	60	Fail LCM	Req
2	Avoid LC with POV2, RE with slowing POV1, and encounter RD toward clear shoulder	45	0.25	45	0.15	45	Pass	Req

Phase I Extension - March 2008 Tests

No	Test	Initial Conditions					Pass/ Fail	Test Type
		SV Speed (mph)	Lateral Speed (m/s)	POV Speed (mph)	a_{POV} (g)	R_H (m)		
1	Avoid RE with slower POV1 and encounter LC with adjacent POV2	45	0.3	45	0.31	60	Pass	Req

No-Warn Tests

September 2007 Tests

Test No.	Description	Initial Conditions					Pass/Fail	Test Type
		SV Speed - V_{SV} (mph)	POV Speed - V_{POV} (mph)	Range - R_{POV} (m)	SV Lateral Speed - $LatV_{SV}$ (m/s)	Radius of Curvature (m)		
NW-1	No FCW when SV closely follows POV	40	40	44.8			PASS	Req
NW-2	No FCW when passing stopped POV in adjacent lane on curve	40				285	PASS	Req
NW-3	No FCW when faster POV cuts in front of SV	40	45	15 ± 5			PASS	Req
NW-4	No FCW when passing between two slower moving POVs in adjacent lane	55	30				PASS	Req
NW-5	No LDW with poor lane keeping and barrier on the left	45			0.3		PASS	Req
NW-6	No LCW when SV changes lanes in front of close POV	45	45	10	0.25		PASS	Req
NW-7	No LCW when SV changes lanes while POV is two lanes over	45	45		0.25		PASS	Req

Phase I Extension - March 2008 Tests

Test No.	Description	Initial Conditions			Pass/Fail	Test Type
		SV Speed (mph)	POV Speed (mph)	SV Lateral Speed (m/s)		
NW-7	No LCW when SV changes lanes while POV is two lanes over	45	45	0.25	PASS	Req