



Lane Departure Warning System Confirmation Test

1 Introduction

Note: Nothing in this standard supercedes applicable laws and regulations.

Note: In the event of conflict between the English and domestic language, the English language shall take precedence.

1.1 Purpose. To define the tests that will determine if a vehicle meets the performance requirements of the United States (U.S.) Department of Transportation (DOT) National Highway Traffic Safety Administration's (NHTSA) Crash Avoidance New Car Assessment Program (NCAP) Lane Departure Warning (LDW) System Confirmation Test (NHTSA-2006-26555-0125) and Lane Keeping Support (LKS) Performance Documentation. This test is hereafter referred to as the NHTSA Test.

1.2 Applicability. This procedure applies to U.S. light passenger vehicles with Gross Vehicle Weight Ratings (GVWR) of up to 4536 kg (10 000 lb) that are equipped with a LDW system and intend to comply with the NHTSA NCAP requirements.

1.3 Remarks. This procedure covers the test requirements of the NHTSA Test for the LDW feature only. It does not cover the content for the LKS feature as this is being used by NHTSA for data collection purposes only and does not affect the vehicles NCAP LDW evaluation. Obtain the latest version of the test (see 2.3.) and review prior to performing this procedure. This procedure will refer to the NHTSA Test and follow the steps of that test.

Note: After March 1, 2014 NHTSA will not consider vehicle Controller Area Network (CAN) data as an acceptable alert for passing this test. NHTSA will only accept actual audio, visual or haptic alert signals as verification of the alert.

2 References

Note: Only the latest approved standards are applicable unless otherwise specified.

2.1 External Standards/Specifications.

E9-28322, Manual on Uniform Traffic Control Devices

NHTSA-2006-26555-0125, Lane Departure Warning System Confirmation Test

2.2 GM Standards/Specifications.

None

2.3 Additional References.

- CG2681 LDW summary data sheet for GMW16373
- E9-28322 Manual on Uniform Traffic Control Devices (MUTCD) for Streets and Highways, 74 FR 66730, available at Uniform Resource Locator (URL): <http://mutcd.fhwa.dot.gov/>. See also URL: <https://federalregister.gov/a/E9-28322>.
- NHTSA-2006-26555-0125 NCAP LDW Test Procedure, available at URL: <http://www.safercar.gov/>. See also URL: <http://www.regulations.gov/#!documentDetail;D=NHTSA-2006-26555-0125>

3 Resources

3.1 Facilities. Defined in 11.2 Road Test Surface, and following paragraphs of the NHTSA Test. At the Milford Proving Ground (MPG), the west side of the Vehicle Dynamics Test Area (VDTA) and south side of the Active Safety Test Area (ASTA) has been prepared for this testing.

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3.1.1 Calibration. The test facilities and equipment shall be in good working order and shall have a valid calibration label.

3.1.2 Alternatives. Alternative test facilities and equipment may also be used. However, all measuring variables as specified in this standard shall be determined correctly with respect to their physical definition.

3.1.3 Road Test Surface. The test shall be conducted on a dry, uniform, high friction, solid-paved road surface of peak friction coefficient 0.9.

3.1.4 Line Markings. The road surface shall be marked as described in the NHTSA Test with all markings in very good condition. All lines shall meet U.S. DOT specifications as required by the MUTCD (E9-28322). Only one edge line should be seen by the LDW system. For GM, this means the test lines should be spaced at least 9 m (30 ft) apart.

3.1.5 Lane Marker Width. The width of the line marker shall be 10 cm to 15 cm (4 in to 6 in). The length of the line markers shall be at least 300 m (1000 ft).

3.1.6 Line Styles. There are three (3) line configurations:

3.1.6.1 Continuous White Line.

3.1.6.2 Dashed Yellow Line. 3 m (10 ft) line segments spaced 9 m (30 ft) apart.

3.1.6.3 Raised Pavement Marker Line. Type AY and D raised pavement markers (Bott's Dots), set up as shown in Figure 2 California Standard Plan A20A, Detail 4, of the NHTSA Test.

3.2 Equipment. Instrumentation and filtering criteria are defined in 8.1, Test Equipment, and 11.6, Instrumentation Required, of the NHTSA Test. Complete the Instrument Calibration data sheet, Data Sheet B1 in Appendix B. Measurements required are:

- Longitudinal vehicle speed.
- Yaw rate.
- Lateral position with respect to the road markings.
- Lateral velocity with respect to the road markings.
- LDW system alert status.

3.2.1 Global Positioning System (GPS) with Base Station. Hardware and software solution shall provide position data with at least 1.0 cm (0.4 in) static accuracy and update at a rate of at least 100 Hz. A RT3000 series with Hunter solution from Oxford Technical Solutions (OxTS) is available at MPG.

3.2.2 Data Acquisition (DAQ) System to record the LDW Alert Status, Time, GPS data, and Yaw Rate data. Log the signals as defined in Table A5: Signals to Record Appendix A. A laptop computer with Vehicle Spy 3 and NeoVI Fire (from Intrepid Control Systems) is available at MPG.

3.2.3 DAQ System with Microphone, Light Sensor and/or Accelerometer. Record the audible, visual and/or haptic alerts from the LDW system. An AVAD-2 (from OxTS) and CANSas module (from IMC Datworks) is available at MPG.

3.2.4 Tire Pressure Gauge. Operating pressure of 700 kPa (100 psi), increments of 1.0 kPa (0.1 psi) and accuracy of $\pm 2.0\%$.

3.2.5 Scale. Capable of measuring vehicle weight. A vehicle scale can be found in Building 104 at MPG.

3.3 Test Vehicle/Test Piece. The test vehicle should be equipped with the LDW system to be tested, and should be selected as being representative of the group of vehicles for which compliance to this standard is being demonstrated. For certification to this standard, all components involved must have the latest production intent released hardware, software and calibrations.

3.4 Test Time.

Calendar time: 2 days
Test hours: 4 hours
Coordination hours: 8 hours

3.5 Test Required Information.

3.5.1 Production alignment procedure or service point calibration procedure for LDW cameras.

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3.5.2 Cold tire inflation pressure from placard or optional tire inflation pressure label.

3.5.3 Setup information for the GPS and data acquisition system.

3.5.4 Vehicle measurements for GPS setup software. Specifically the outermost points at which the Left Front (LF) and Right Front (RF) tires contact the road.

3.5.5 GPS map files, if necessary, for the lines (types and directions) to be tested. There can be separate files for each line and each driving direction. These files are available for the MPG VDTA test site and will need to be created for lines at other test sites.

3.5.6 CG2681 LDW summary data sheet for GMW16373.

3.6 Personnel/Skills. The test engineer or technician will need driving privileges and access to the test site being used, i.e., VDTA at MPG. Contact MPG Traffic Safety to schedule test time on the VDTA. Access to a laptop computer running the data acquisition software, and familiarity with use of the software and the GPS equipment, is required.

4 Procedure

4.1 Preparation. Defined in 8.3 Test Vehicle Measurement and Preparation, of the NHTSA Test. Following vehicle procurement, assemble a Test Readiness Team (TRT) with the following members; Vehicle Validation Engineer (VE), Interface Engineering Group Manager (IEGM), Design Release Engineers (DRE) of each test component, Vehicle Software Integration Engineer (VSIE) and Assembly Verification Software Engineer/Dynamic Vehicle Testing (AVSE/DVT). This team will determine the proper component hardware, software and calibration configurations required for test, and verify that the test components are production intent per the appropriate tracking systems, i.e., Calibration Development System (Cal DS), GM Electronic Controller (GMEC), Global Data File Release System (GDFRS).

4.1.1 Obtain TRT approval on vehicle configuration levels and complete the Test Information data sheet, Data Sheet B2 in Appendix B. Explain any additional readiness steps taken to complete vehicle update. Approvals can be signed documentation or hard copy of email approvals from each TRT DRE for their component attached to the Engineering Test Report. The Engineering Test Report is considered to be both the Instrument Calibration and Test Information data sheets, Data Sheets B1 and B2, in Appendix B, and the contents of the Data Summary tab of CG2681.

4.1.2 If a new camera, radar, etc., has been installed, align the unit per the production or service procedure.

4.1.3 Install the GPS test equipment and the DAQ equipment into the vehicle. Take the needed vehicle dimensional measurements. A 2-dimensional polygon defined by the plane of the outside edge of each tire where it makes contact with the road. This plane is defined by running a perpendicular line from the outer most edge of the tire to the ground. See A1 through A5 in Appendix A for using the GPS equipment at MPG.

4.1.4 Set up GPS base station if a permanently mounted one is not available.

4.1.5 Set up DAQ equipment, i.e., AVAD-2, CANSas, to monitor the LDW alert methods.

4.1.6 Mount the microphone in close proximity to the speaker that broadcasts the chime sound. Set the filter to the proper chime frequency, i.e., 2000 Hz.

4.1.7 Mount the photo sensor to monitor the LDW telltale in the cluster and set the on/off level.

4.1.8 Attach an accelerometer to the haptic device (if equipped).

4.1.9 Measure the vehicle weight and cold tire pressures with the driver and all required test equipment included. Record this on the Test Information data sheet, Data Sheet B2 in Appendix B.

4.1.10 If necessary, set up the Bott's Dots on the painted markings as described in 11.2.2.3 Raised Pavement Marker Line, of the NHTSA Test. At MPG, dots are located in the garage of the VDTA control tower.

4.1.11 Use of the cones, pylons and start line described in 12.2 Test Maneuver Overview, and 12.3 Straight Lane Departure Test Course, of the NHTSA Test are optional, but can be helpful in achieving the required lane position and lateral velocity of lane departure. Set these up if desired.

4.1.12 Start the computer data acquisition system and verify the status and accuracy of the GPS data and verify communication with the base station. A zero calibration should be performed for the GPS system. An acceptable tolerance is ± 5 cm (± 2.0 in) of the actual zero.

4.1.13 Perform any needed initialization of the vehicle LDW system.

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4.2 Conditions. Refer to 11 Pretest and Facility Requirements, of the NHTSA Test.

4.2.1 Environmental Conditions. As defined in 11.3 Ambient Conditions, of the NHTSA Test.

4.2.1.1 The ambient temperature shall be between 0 °C (32 °F) and 38 °C (100 °F).

4.2.1.2 The wind speed shall be no greater than 35 km/h (22 mph).

4.2.1.3 Tests shall not be conducted in inclement weather. Rain, snow, hail, fog, smoke, ash, etc.

4.2.1.4 Tests shall be conducted during daylight hours with visibility greater than 5 km (3 mile).

4.2.1.5 Tests shall not be conducted with the vehicle oriented into the sun, when the sun is 15 degrees or less from the horizontal. This can create a "washout" condition.

4.2.1.6 There shall be no significant structures over or near the testing site and no stationary objects within one lane width of either side of the vehicle path.

4.2.2 Test Conditions. Deviations from the requirements of this standard shall have been agreed upon. Such requirements shall be specified on component drawings, test certificates, reports, etc. The MPG VDTA has been painted to meet the test requirements of 11.2 Road Test Surface, of the NHTSA Test and the painted lines have been surveyed using GPS equipment. Use of cruise control is permitted as long as the vehicle speed requirements are satisfied. Vehicles with non-adaptive cruise control shall not be permitted during the tests. Non-adaptive cruise control could compound results.

4.3 Instructions. Defined in 12 Test Execution and Test Requirements, of the NHTSA Test. Proceed to the test location.

4.3.1 If needed, load the GPS map data for the line and direction being tested. Drive to the test line and verify that the lateral position reading is zero when the outermost edge of the tire is touching the innermost edge of the lane line. Make any necessary adjustments.

4.3.2 Begin the test as described in 12.1 Static Instrumentation Calibration, and 12.2 Test Maneuver Overview, of the NHTSA Test. Drive the vehicle in a straight line at 72 km/h $\pm$ 2 km/h (45 mph $\pm$ 1.2 mph) approximately 1 m (3 ft) away from and along the line to be departed.

4.3.3 Drive between the cones if they are set up. Slowly turn the vehicle towards the line with sufficient steering input to obtain a target lateral velocity of 0.5 m/s (1.6 ft/s). Maintain lateral velocity of between 0.1 m/s and 0.6 m/s (0.3 ft/s and 2 ft/s) and yaw rate of less than 1.0 degree/s during the entire maneuver

4.3.4 Depart the line until the warning is received or the vehicle is at least 0.5 m (1.7 ft) past the line boundary. Bring the vehicle to a stop in a safe location, and verify that the data file has been collected.

4.3.5 Use the Data Macro tab of CG2681 to transfer the raw data at the time of the warning to the summary sheet and verify that the trial is valid and whether the trial was passed or failed.

4.3.6 Repeat the test until the first five (5) valid trials are obtained for each line type (solid white, dashed yellow and Bott's Dots) and each direction (left/right) per Table 3 LDW Test Matrix, of the NHTSA Test. Thirty (30) trials total.

4.3.7 Complete the Test Information data sheet, Data Sheet B2 in Appendix B. for inclusion in the Engineering Test Report.

4.3.8 Complete the Data Summary tab of CG2681 for inclusion in the Engineering Test Report.

5 Data

5.1 Calculations. Calculate average lateral position at warning for each line and number of runs passed. NHTSA has defined positive lateral position as prior to lane departure and negative lateral position as after departure. Verify that the proper sign is used for each trial when the average is calculated. Refer to Table 1 Average Departure.

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Table 1 Average Departure

	Average Departure ^{Note 1} (m)	Valid Trials Passed (Right and Left)
Solid White Line		Up to 10
Dashed Yellow Line		Up to 10
Bott's Dots Line		Up to 10

Note 1: Use three significant digits, e.g., X.XX m

5.2 Interpretation of Results. As defined in 12.5 LDW Pass or Fail Criteria, of the NHTSA Test.

5.2.1 A trial is valid if the test vehicle's speed is 72 km/h $\pm$ 2 km/h (45 mph $\pm$ 1.2 mph) with a lateral velocity of 0.1 m/s to 0.6 m/s (0.3 ft/s to 2.0 ft/s) and yaw rate not greater than 1.0 degree/s.

5.2.2 A valid trial is passed if the lane departure warning occurs when any part of the two dimensional polygon used to represent the test vehicle breaches the inboard lane line edge.

5.2.3 The LDW alert must not occur when the lateral position is greater than 0.75 m (2.5 ft) from the lane line edge. A positive number represents in-lane position (before crossing).

5.2.4 The LDW alert must occur before the lane departure exceeds -0.3 m (-1.0 ft). A negative number represents post-line position (after crossing).

5.2.5 The overall system passes if three (3) of five (5) individual trials are passed for each combination (departure direction/line type) and pass 20 of 30 trials overall. If more than five (5) trials are deemed valid, the Pass/Fail criteria must be met for three (3) of the first five (5) valid trials.

5.2.6 If the LDW system has a warning time adjustment for the driver, at least one setting must meet the criterion of the test.

5.3 Test Documentation. The Engineering Test Report, i.e., the Instrument Calibration and Test Information data sheets, Data Sheets B1 and B2, in Appendix B, and the contents of the Data Summary tab of CG2681, along with a hard copy of email approvals from each TRT DRE for their component.

6 Safety

This standard may involve hazardous materials, operations, and equipment. This standard does not propose to address all the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

7 Notes

7.1 Glossary.

Bott's Dots: Raised pavement markers used in lieu of painted stripes for marking roads in California and other Western states.

Figure Eight: A driving maneuver in which the vehicle is driven in a complete circle in one direction, followed immediately by a complete circle in the opposite direction, ending the maneuver at the starting point.

Lane Departure Warning (LDW) System: A driver assistance system that alerts the driver when the vehicle is about to drift beyond a delineated edge line of the current travel lane.

Lane Keeping Support (LKS) System: A driver assistance system that actively affects the heading of the vehicle when it is about to drift beyond a delineated edge line of the current travel lane.

7.2 Acronyms, Abbreviations, and Symbols.

A/D	Analog to Digital
ABD	AB Dynamics
abs	Absolute (time)
ALDL	Assembly Line Diagnostic Link

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