EURO NCAP

#FORSAFERTRUCKS

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Collision Avoidance
Lane Departure Collisions

Test Protocol

Implementation November 2024

PREFACE

During the test preparation, vehicle manufacturers are encouraged to liaise with the laboratory and to check that they are satisfied with the way cars are set up for testing. Where a manufacturer feels that a particular item should be altered, they should ask the laboratory staff to make any necessary changes. Manufacturers are forbidden from making changes to any parameter that will influence the test, such as dummy positioning, vehicle setting, laboratory environment etc.

It is the responsibility of the test laboratory to ensure that any requested changes satisfy the requirements of Euro NCAP. Where a disagreement exists between the laboratory and manufacturer, the Euro NCAP secretariat should be informed immediately to pass final judgment. Where the laboratory staff suspect that a manufacturer has interfered with any of the set-up, the manufacturer's representative should be warned that they are not allowed to do so themselves. They should also be informed that if another incident occurs, they will be asked to leave the test site.

Where there is a recurrence of the problem, the manufacturer's representative will be told to leave the test site and the Euro NCAP secretariat should be immediately informed. Any such incident may be reported to the manufacturer and the person concerned may not be allowed to attend further Euro NCAP tests.

CONTENTS

DEFINITIONS

Throughout this protocol the following terms are used:

Heavy Goods Vehicle (HGV) – a category N2 or N3 vehicle with gross mass exceeding 3,500 kg.

Peak Braking Coefficient (PBC) – the measure of tyre to road surface friction based on the maximum deceleration of a rolling tyre, measured using the American Society for Testing and Materials (ASTM) E1136-10 (2010) standard reference test tyre, in accordance with ASTM Method E 1337-90 (reapproved 1996), at a speed of 64.4 km/h, without water delivery. Alternatively, the method as specified in UNECE R13-H.

Emergency Lane Keeping (ELK) – default ON heading correction that is applied automatically by the vehicle in response to the detection of the vehicle that is about to drift beyond the edge of the road or into oncoming or overtaking traffic in the adjacent lane.

Lane Keeping Assist (LKA) – heading correction that is applied automatically by the vehicle in response to the detection of the vehicle that is about to drift beyond a delineated edge line or road edge of the current travel lane.

Vehicle Under Test (VUT) – means the vehicle, or vehicle and trailer combination, tested according to this protocol with a Lane Support System.

Vehicle width – the widest point of the vehicle ignoring the rear-view mirrors, side marker lamps, tyre pressure indicators, direction indicator lamps, position lamps, flexible mudguards and the deflected part of the tyre side-walls immediately above the point of contact with the ground.

Global Vehicle Target (GVT) – means the vehicle target used in this protocol as defined in ISO 19206-3:2021

Time To Collision (TTC) – means the remaining time before the VUT strikes the GVT, assuming that the VUT and GVT would continue to travel with the speed it is travelling.

Lane edge – means the inner side of the lane marking or the road edge

Distance To Lane Edge (DTLE) – means the remaining lateral distance (perpendicular to the Lane Edge) between the Lane Edge and most outer edge of the tyre, before the VUT crosses Lane Edge, assuming that the VUT would continue to travel with the same lateral velocity towards it.

1 INTRODUCTION

Heavy Goods Vehicle (HGV) lane departure is one of the main causes of single vehicle and frontal head-on collisions. Incidents can be severe because of the vehicle mass and regular highway driving speeds. An analysis of European road traffic crash data revealed that head-on and single vehicle collisions involving an HGVs account for 7 % of all road traffic fatalities. Lane changing collision on highways, whilst often less severe in their outcome, also have the potential to cause serious injury and major disruption. Therefore, Euro NCAP has expanded its safety testing programme to HGVs to help countries across Europe to achieve their 'Vision Zero' target and end traffic-related fatalities.

Typical incidents include the HGV drifting out of lane on highways and colliding with stationary or adjacent moving vehicles, roadside furniture or temporary roadworks equipment because of a range of factors including driver distraction, fatigue or misjudgement. Incidents on rural roads include drifting out of lane into the path of oncoming vehicles or running off the road, frequently resulting in HGV rollover. The high energy of the HGV presents a risk of serious injury to the HGV driver and the occupants of the struck vehicle(s).

To support the driver in avoiding lane departure collisions, vehicle manufactures offer collision avoidance technology that monitors the road and traffic environment and has the ability to warn the driver of imminent lane departure and support the directional control of the vehicle by itself. Euro NCAP call this technology Lateral Support Systems (LSS).

A Euro NCAP study of Swedish in-depth accident data identified that, accounting for loss of control and other limiting factors, LSS had the potential to have a beneficial effect in 45 % of fatal heavy truck single vehicle crashes. This effect was relevant to all of the highway collision cases and half of the rural road collision cases.

Whilst regulation makes Lane Departure Warning (LDW) a mandatory requirement for new HGVs, Euro NCAP strives to drive performance improvements to ensure robust and effective LSS operation in a broad range of real-world collision types. To this end, the Euro NCAP scheme builds on the regulatory requirement by:

- Recognising systems that actively intervene to correct the HGV path in case of imminent lane departure, returning the HGV back in line with the road ahead
- Incorporating additional challenging real-world collision scenarios with adjacent vehicles in hard to see locations to encourage imminent collision threat detection
- Rewarding features that promote driver acceptance through effective and efficient real-world operation

This protocol specifies the HGV LSS test procedures, which are used to evaluate system performance in a repeatable and reproducible manner for the HGV City and Highway safety rating scheme. To be eligible to score points for LSS, the vehicle must be equipped with an ESC system meeting the regulatory requirements.

2 REFERENCE SYSTEM

2.1 Convention

For the VUT and GVT use the convention specified in ISO 8855:1991 in which the x-axis points towards the front of the vehicle, the y-axis towards the left and the z-axis upwards (right hand system), with the origin at the most forward point on the centreline of the VUT for dynamic data measurements as shown in Figure 2-1.

Viewed from the origin, roll, pitch and yaw rotate clockwise around the x, y and z axes respectively. Longitudinal refers to the component of the measurement along the x-axis, lateral the component along the y-axis and vertical the component along the z-axis.

This reference system should be used for both left hand drive (LHD) and right-hand drive (RHD) vehicles tested. Figure 2-1 Coordinate system and notation (LHD & RHD) and near side – far side for LHD vehicle

shows the near and far side of the vehicle for a left-hand drive (LHD) vehicle. The far side always corresponds to the hand of drive, and therefore swaps sides accordingly for a right-hand drive (RHD) vehicle.

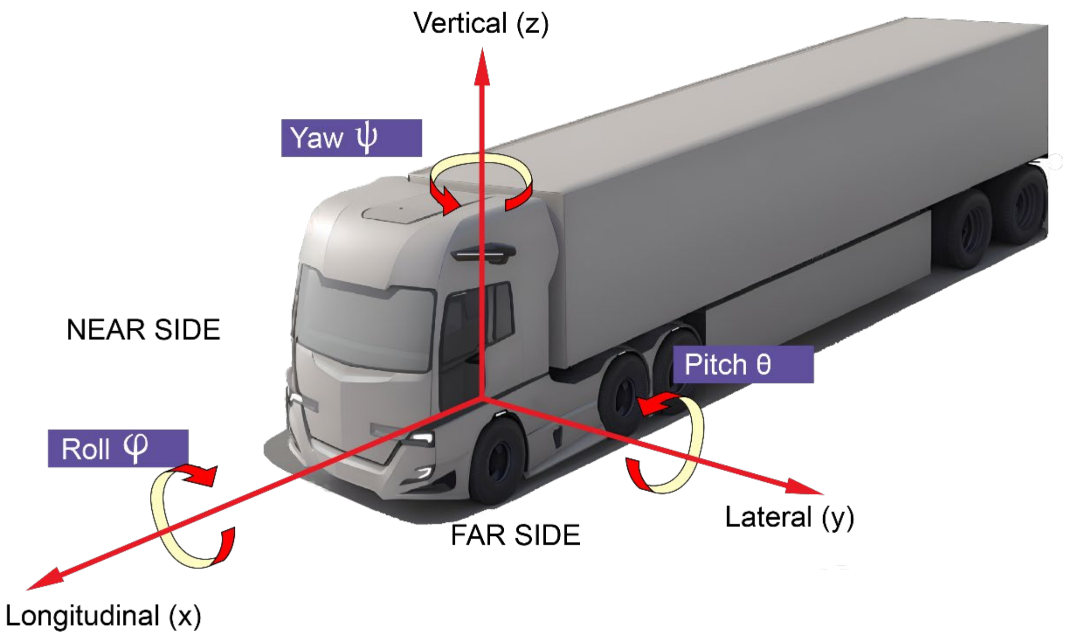

Figure 2-1 Coordinate system and notation (LHD & RHD) and near side – far side for LHD vehicle

2.2 Lateral Path Error

The lateral offset (Y_{VUT} error) is determined as the lateral distance between the centre of the front of the VUT when measured in parallel to the intended straight-lined path as shown in Figure 2-2 below.

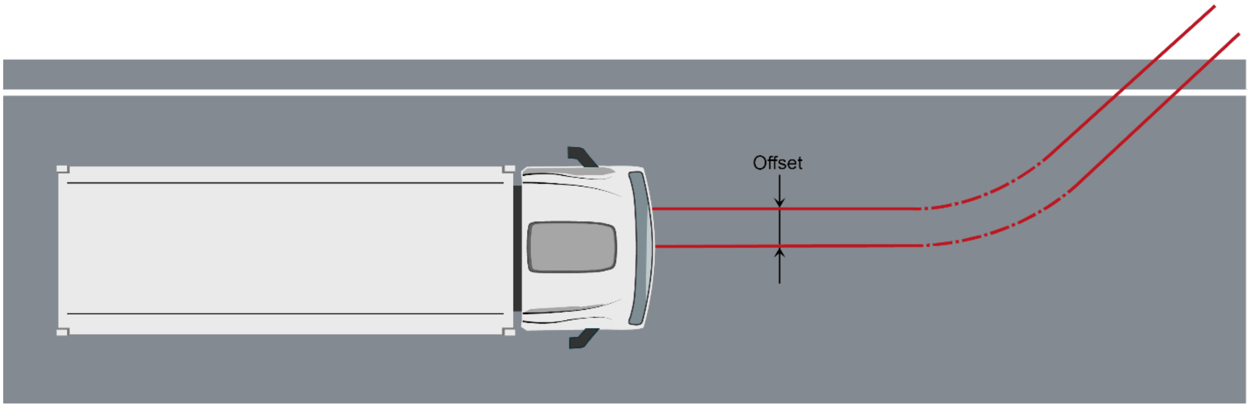

Figure 2-2 Lateral path error

3 MEASURING EQUIPMENT

Sample and record all dynamic data at a frequency of at least 100 Hz. Synchronise using the DGPS time stamp the GVT data with that of the VUT.

3.1 Measurements and Variables

Time	**T**
T_0, time where the manoeuvre starts with 2 s straight path	$\mathbf{T}_0$
T_{LKA}, time when LKA activates (for calibration purposes only if required)	$\mathbf{T}_{LKA}$
T_{ELK}, time when ELK activates (for calibration purposes only if required)	$\mathbf{T}_{ELK}$
T_{steer}, time when VUT enters into curved path segment	$\mathbf{T}_{steer}$
$T_{crossing}$, time when VUT crosses the line edge	$\mathbf{T}_{\mathbf{crossing}}$
Position of the VUT during the entire test	$\mathbf{X}_{VUT}$, $\mathbf{Y}_{VUT}$
Position of the GVT during the entire test	$\mathbf{X}_{GVT}$ / $\mathbf{Y}_{GVT}$
Speed of the VUT during the entire test	$\mathbf{V}_{longVUT}$
	$\mathbf{V}_{latVUT}$
Speed of the GVT during the entire test	$\mathbf{V}_{GVT}$
Yaw velocity of the VUT during the entire test	$\dot{\Psi}_{VUT}$
Steering wheel velocity of the VUT during the entire test	$\mathbf{\Omega}_{VUT}$

3.2 Measuring Equipment

Equip the VUT and GVT with data measurement and acquisition equipment to sample and record data with an accuracy of at least:

- VUT and GVT speed to 0.1 km/h
- VUT and GVT lateral and longitudinal position to 0.03 m
- VUT heading angle to 0.1 °
- VUT and GVT yaw rate to 0.1 °/s
- VUT longitudinal acceleration to 0.1 m/s2
- VUT steering wheel velocity to 1.0 °/s

3.3 Data Filtering

Filter the measured data as follows:

Position and speed are not filtered and are used in their raw state
Acceleration, yaw rate, steering wheel velocity and force are filtered with a 12-pole phaseless Butterworth filter with a cut off frequency of 10 Hz

4 TARGET SYSTEMS

4.1 Global Vehicle Target

Where specified, conduct tests in this protocol using the Global Vehicle Target (GVT) as shown in Figure 4-1 below. The GVT replicates the visual, radar and LIDAR attributes of a typical M1 passenger vehicle.

Figure 4-1 Global Vehicle Target (GVT)

To ensure repeatable results the combination of the propulsion system and GVT must meet the requirements as detailed in ISO 19206-3.

Only equipment listed in the current version of TB 029 – Suppliers List may be used for testing. The current version can be found on the Euro NCAP website.

The GVT is designed to work with the following types of sensors:

Radar (24 and 77 GHz)
LIDAR
Camera

When a manufacturer believes that the GVT is not suitable for another type of sensor system used by the VUT but not listed above, the manufacturer is asked to contact the Euro NCAP Secretariat.

5 TEST CONDITIONS

5.1 Test Track

5.1.1 Paved Surface

Conduct tests on a dry (no visible moisture on the surface), uniform, solid-paved surface with a maximum slope of 1 % in the longitudinal direction, < 2 % for half a lane width either side of the centreline and < 3 % for the outer half of the test lane in lateral direction.

The test surface shall have a minimal peak braking coefficient (PBC) of 0.9, must be paved and may not contain any irregularities (e.g. large dips or cracks, manhole covers or reflective studs) within a lateral distance of 3.0m to either side of the centre of the test lane and with a longitudinal distance of 30m ahead of the VUT from the point after the test is complete.

5.1.2 Lane Markings

The tests described in this document require use of two different types of lane markings conforming to one of the lane markings as defined in UNECE Regulation 130 to mark a lane with a width of 3.5 to 3.7 m:

Dashed line with a width between 0.10 and 0.25 m (0.10 and 0.15 m for centre lines)
Solid line with a width between 0.10 and 0.25 m

The lane markings should be sufficiently long to ensure that there is at least 20 m of marking remaining ahead of the vehicle after the test is complete.

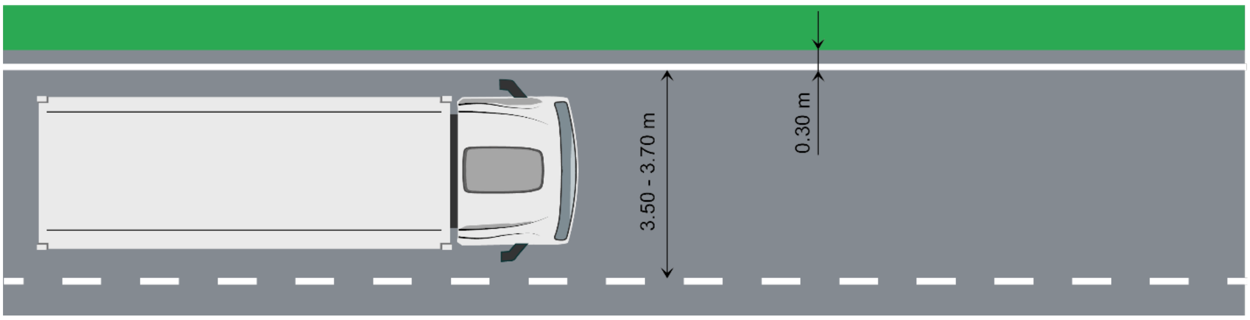

Figure 5-1 Lane marking layout

5.1.3 Weather Conditions

Conduct tests in dry conditions with ambient temperature above 5 °C and below 40 °C.

No precipitation shall be falling and horizontal visibility at ground level shall be greater than 1 km. Wind speeds shall be below 10 m/s to minimise VUT disturbance.

Natural ambient illumination must be homogenous in the test area and in excess of 2,000 lux for daylight testing with no strong shadows cast across the test area other than those caused by the VUT or GVT. Ensure testing is not performed driving towards, or away from the sun when there is direct sunlight.

Measure and record the following parameters preferably at the commencement of every single test or at least every 30 minutes

Ambient temperature in °C
Track Temperature in °C
Wind speed in m/s
Wind direction in azimuth ° and/or compass point direction (monitoring)
Ambient illumination in Lux

5.1.4 Surroundings

Conduct testing such that there are no other vehicles, highway infrastructure, obstructions (except where detailed in the test scenario), other objects or persons protruding above the test surface, that may give rise to abnormal sensor measurements.

Test areas where the VUT needs to pass under overhead signs, bridges, gantries or other significant structures are not permitted.

The general view ahead and to either side of the test area shall comprise of a wholly plain man made or natural environment (e.g. further test surface, plain coloured fencing or hoardings, natural vegetation or sky etc.) and must not comprise any highly reflective surfaces or contain any vehicle-like silhouettes that may give rise to abnormal sensor measurements.

5.2 VUT Preparation

5.2.1 System Settings

Set any driver configurable elements of the system to the middle setting or midpoint and then next latest setting similar to the examples shown in Figure 5-2. Lane centering functions should be turned off.

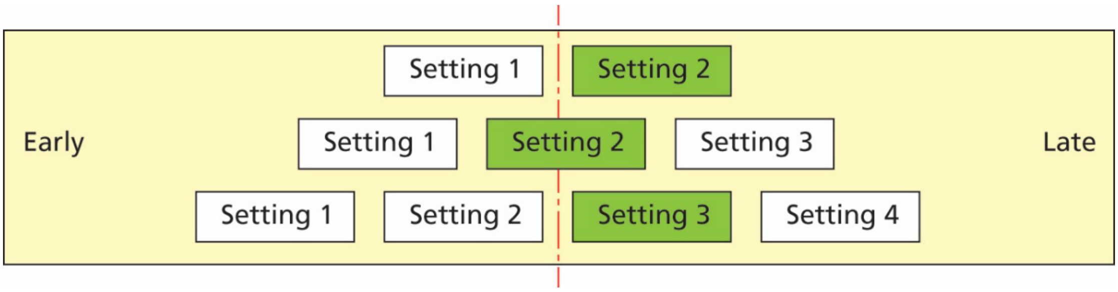

Figure 5-2 System setting for testing

5.2.2 Drawing Vehicles

Where the VUT is designed as a prime mover intended for drawing a trailer, complete testing with the VUT coupled to an appropriate trailer of the following specification:

Of length approaching but not exceeding maximum permitted
Of adequate gross trailer mass to fulfil the gross train mass of the VUT
Box or curtain side body
Equipped with disc brakes, category A Antilock Braking System (ABS) and an Electronic Braking System (EBS)

5.2.3 Tyres

Perform the testing with new original fitment tyres of the make, model, size, speed and load rating as specified by the vehicle manufacturer. It is permitted to change the tyres which are supplied by the manufacturer or acquired at an official dealer representing the manufacturer if those tyres are identical make, model, size, speed and load rating to the original fitment. Use inflation pressures corresponding to the manufacturer's instructions for the appropriate loading condition.

Run-in tyres according to the tyre conditioning procedure specified in **Error! Reference source not found.**. After running-in maintain the run-in tyres in the same position on the vehicle for the duration of the testing.

5.2.4 Running Order

Confirm that all VUT safety and operational systems are functioning correctly with no warning messages or indicators displayed to the driver. Rectify any faults before commencing testing.

Set any configurable driving controls to their automatic setting e.g. ride height setting. If an automatic setting is not available, set to a middle setting.

When driven on the test track with the steering control centrally aligned, ensure the VUT exhibits good straight line driving order. In case of unsatisfactory driving order, the test laboratory should undertake remedial work to return the geometry to within the OEM tolerances and confirm good driving order.

5.2.5 Loading and Vehicle Preparation

Complete testing with the VUT half laden to represent typical category N vehicle operation, with 'as tested' mass as follows:

As tested mass = Unladen kerb mass + ((GVW – Unladen kerb mass)/2)

The procedure to prepare the VUT load requirement for testing is:

- Maintain adequate fuel in the vehicle to perform the testing
- Check the levels of all fluids and top up to their maximum levels if necessary
- Ensure that the VUT has all its bodywork and spare wheel on board, if fitted, along with any equipment or tools supplied. Nothing else should be in the VUT
- Ensure that all tyres are inflated according to the manufacturer's instructions for the appropriate loading condition
- Measure the VUT axle masses and determine the total mass. The total mass is the 'unladen kerb mass' of the VUT. Record this mass in the test details
- Calculate the load mass required to achieve the 'as tested mass'. Note the 'as tested mass' will also account for nominal half fuelling where the fuel source affects the vehicle mass
- Apply the load mass to the vehicle comprising of the driver, test equipment (i.e. on-board test equipment and instrumentation, associated cables, cabling boxes and power sources) and ballast, with a tolerance of the lesser of [5% of the GVW or 1000kg]. Locate the centre of mass of the ballast centrally within the cargo space (longitudinally and laterally) as far as is as practically possible. Ballast must be securely attached to the VUT. If water is used as ballast, it should be used in full containers to prevent the movement under acceleration
- Measure the VUT axle masses with the driver, test equipment and ballast on board and determine the 'as tested mass', confirming that individual axle weights do not exceed their permitted maximums

5.2.6 Dimensional Measurements

VUT dimensional measurements shall be taken. For purposes of this test procedure, VUT dimensions shall be represented by a two-dimensional polygon defined by the lateral and longitudinal dimensions relative to the centroid of the VUT using the standard SAE coordinate system. The corners of the polygon are defined by the lateral and longitudinal locations where the plane of the outside edge of each tyre makes contact with the road. This plane is defined by running a perpendicular line from the outer most edge of the tyre to the ground at the wheelbase, as illustrated in Figure 5-3.

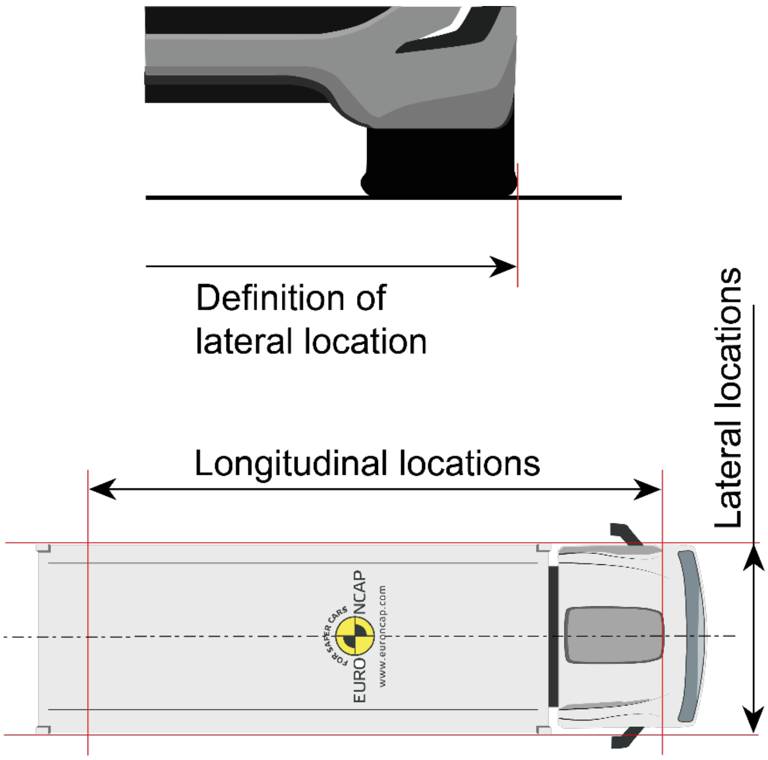

Figure 5-3 VUT dimensional measurements

6 TEST PROCEDURE

6.1 VUT Pre-test Conditioning

6.1.1 General

A new vehicle is used as delivered to the test laboratory, however a vehicle may have been used for other Euro NCAP active safety tests.

If requested by the vehicle manufacturer and where not already performed for other tests, drive a maximum of 100 km on a mixture of urban and rural roads with other traffic and roadside furniture to 'calibrate' the sensor system. Avoid harsh acceleration and braking.

6.1.2 Brakes

Condition the vehicle's brakes in the following manner (if it has not been done before for another test or in case the laboratory has not performed 100 km of driving) to ensure they are neither brand new nor corroded. Before commencing the next brake conditioning run, confirm the temperature of the hottest brake rotor is less than [400] °C, or wait [120] seconds between runs to prevent brake overheating.

Perform ten stops from a speed of 56 km/h with an average deceleration of approximately [0.2 to 0.3 g]
Immediately following the series of 56 km/h stops, perform three additional stops from a speed of 72 km/h, each time applying sufficient force to the pedal to operate the vehicle's antilock braking system (ABS) for the majority of each stop
Immediately following the series of 72 km/h stops, drive the vehicle at a speed of approximately 72 km/h for five minutes to cool the brakes

6.1.3 Tyres

Condition the vehicle's tyres in the following manner (if it has not been done before for another test or in case the laboratory has not performed 100 km of driving) to remove the mould sheen,

Drive around a circle of [30 m] in diameter at a speed sufficient to generate a lateral acceleration of approximately [0.1 to 0.2 g] for three clockwise laps followed by three anticlockwise laps
Immediately following the circular driving, drive four passes at 56 km/h, performing ten cycles of a sinusoidal steering input in each pass at a frequency of 1 Hz and amplitude sufficient to generate a peak lateral acceleration of approximately [0.1 to 0.2 g]
Make the steering wheel amplitude of the final cycle of the final pass double that of the previous inputs

In case of instability in the sinusoidal driving, reduce the amplitude of the steering input to an appropriately safe level and continue the four passes.

6.1.4 System Check

Before any testing begins, perform a maximum of ten runs at the lowest test speed the system is supposed to work, to ensure proper functioning of the system.

6.2 Test Scenarios

6.2.1 General

The performance of the VUT LSS is assessed in different scenarios that are applicable to the system:

Lane Keep Assist
Emergency Lane Keeping (overtaking) (only when ELK system is default ON)

Tests in all scenarios will be performed with 0.1 m/s incremental steps within the lateral velocities specified for the test scenarios.

For testing purposes, assume an initial straight-line path followed by a fixed radius as specified for the test scenarios, followed again by a straight line, hereby known as the test path. Control the VUT with driver inputs or using alternative control systems that can modulate the vehicle controls as necessary to perform the tests.

The vehicle manufacturer shall provide information describing the location when the closed loop path and/or speed control shall be ended so as not to interfere with the system intervention for each test. Otherwise, when the vehicle manufacturer does not provide information, two calibration runs shall be performed for each lateral velocity in order to determine when the system activates. Compare steering wheel torque, vehicle speed or yaw rate of both runs and determine where there is a notable difference that identifies the location of intervention.

Run 1: Complete the required test path with the system turned OFF and measure the control parameter

Run 2: Complete the required test path with the system turned ON and measure the control parameter

Complete the tests while ending the closed loop control before system activation. In the case of calibration runs the release of steering control should occur on the test path and no less than 5 m longitudinally before the location of intervention.

The ideal parameters in Table 6-1 should be used to create the test paths for unintentional lane departures. In case the lateral velocity at the point of LKA intervention is out of tolerance it is permitted to tune the yaw angle to achieve in tolerance manoeuvres.

$Vlat_{VUT}$ [m/s]	R [m]	Ψ_{VUT} [°]	d1 [m]	d2 [m]
0.2	1200	0.57	0.06	0.44
0.3		0.86	0.14	0.56
0.4		1.15	0.24	0.46
0.5		1.43	0.38	0.32

Table 6-1 Unintentional lane change parameters

Where the lateral offset d from the lane marking in Figure 6-1 is:

$$d = d1 + d2 + \text{Half of the vehicle width (m)}$$

With:

d1: Lateral distance travelled during curve establishing yaw angle (m)

d2: Lateral distance travelled during V_{lat} steady state (m)

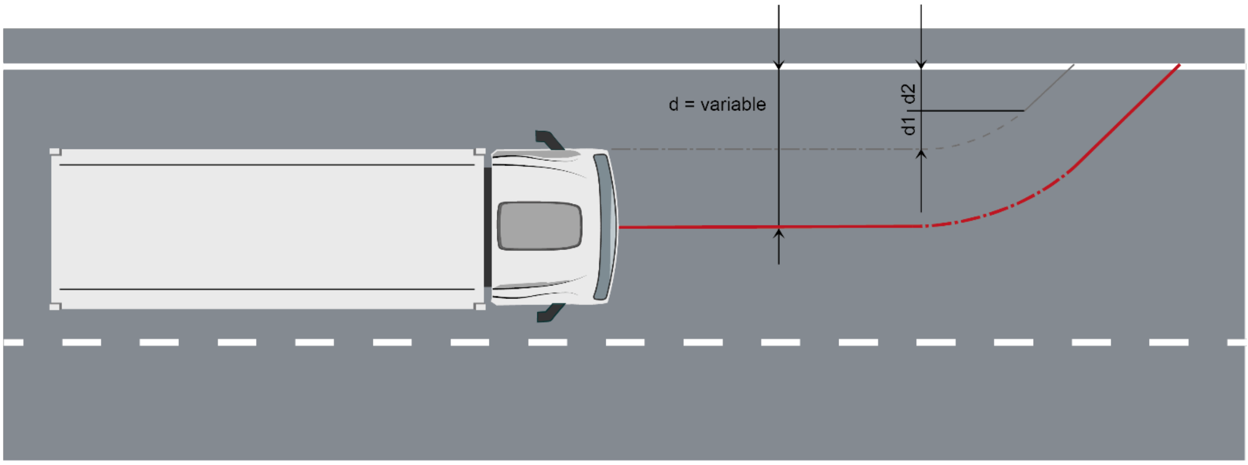

Figure 6-1 Lateral offset from lane marking

When the closed loop path ends, the driver's hands or the control will remain passive on the steering wheel without applying deliberate force but reflecting the behaviour of an inattentive driver holding the steering wheel.

If the intervention point of the function occurs before the target $Vlat_{VUT}$ is reached, the test laboratory will conduct a verification check of the $Vlat_{VUT}$ = 0.5 m/s test case (both for dashed and solid line) using a straight-line vehicle path intersecting with a curved lane marking which results in the yaw angle (Ψ_{VUT}) shown in Table 6-1. A maximum of 3 runs shall be conducted (both for solid and dashed line), where the system intervention and resulting DTLE is monitored.

6.2.2 Lane Keep Assist

LKA dashed line marking tests for unintentional lane departure will be performed with 0.1 m/s incremental steps within the lateral velocity range of 0.2 to 0.5 m/s for departures from a fully marked lane to both sides of the VUT.

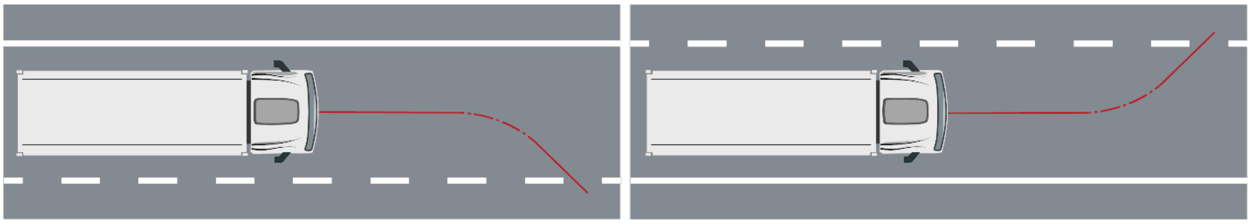

Figure 6-2 LKA dashed line marking scenarios

LKA solid line marking tests for unintentional lane departure will be performed with 0.1 m/s incremental steps within the lateral velocity range of 0.2 to 0.5 m/s for departures from a fully marked lane to both sides of the VUT.

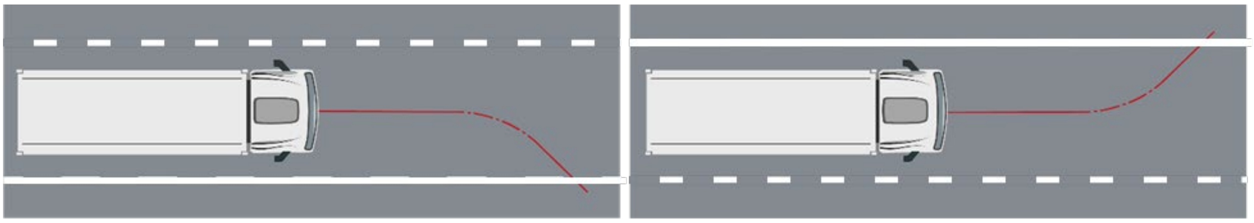

Figure 6-3 LKA solid line marking scenarios

6.2.3 Emergency Lane Keeping – Overtaking

For the ELK overtaking near side (passenger side) scenario a GVT will follow a straight-line path in the lane adjacent to the VUT's initial position to the near side, travelling in the same direction as the VUT. The straight-line path of the GVT will be 1.5 m from the inner side of the centre dashed lane marking.

The paths of the VUT and GVT will be synchronised so that the longitudinal position of the leading edge of the GVT is [2.0 m ahead of the driver's accelerator heel point] of the VUT at the impact point (assuming no system reaction) as illustrated in Figure 6-4.

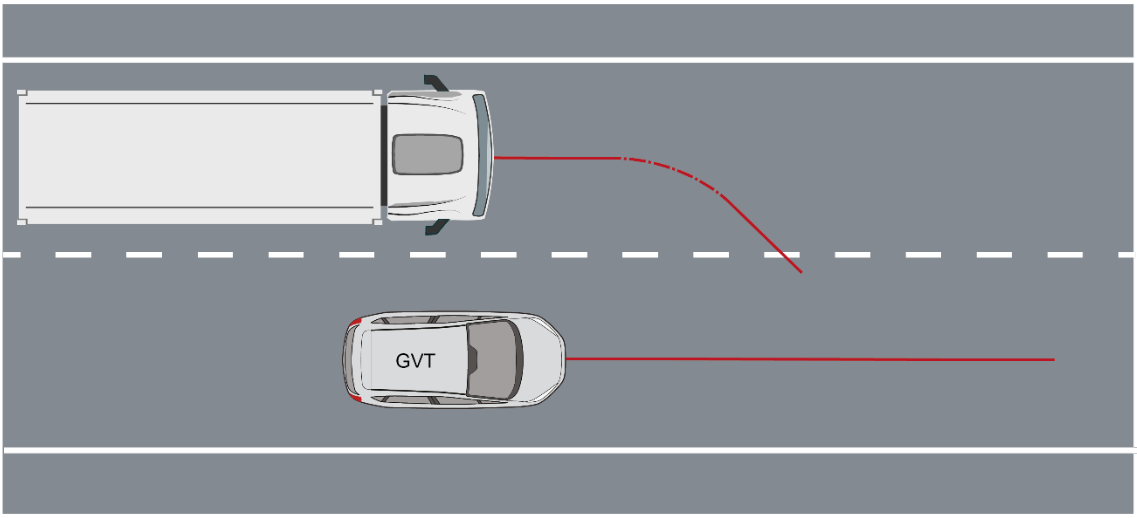

Figure 6-4 ELK overtaking near side scenario

For the ELK overtaking far side (driver side) scenario a GVT will follow a straight-line path in the lane adjacent to the VUT's initial position to the near side, travelling in the same direction as the VUT. The straight-line path of the GVT will be 1.5 m from the inner side of the centre dashed lane marking.

The paths of the VUT and GVT will be synchronised so that the longitudinal position of the leading edge of the GVT is [1.0 m behind the driver's accelerator heel point] of the VUT at the impact point (assuming no system reaction) as illustrated in Figure 6-5.

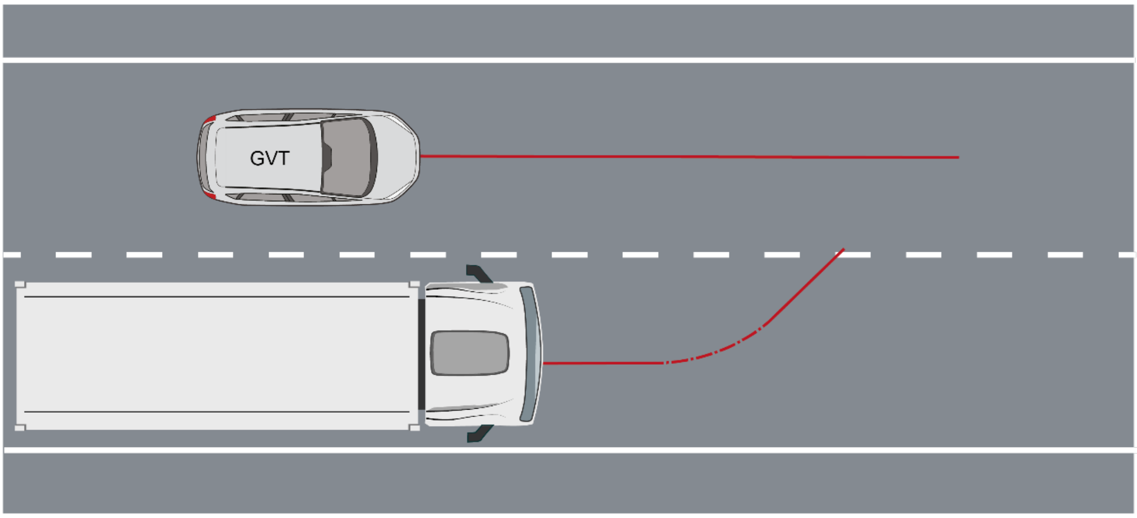

Figure 6-5 ELK overtaking far side scenario

ELK overtaking near side and far vehicle tests will be performed with 0.1 m/s incremental steps within the lateral velocity range of 0.3 to 0.5 m/s for unintentional lane departure (without turn signal usage) and 0.5 to 0.7 m/s for intentional lane changes (with turn signal usage) for departures at the passenger side only.

Both unintentional and intentional lane changes are tested in with the GVT and VUT travelling at the same speed of 72 km/h (zero relative longitudinal velocity). The parameters in Table 6-1 should be used to create the test paths for the unintentional lane change tests.

The ideal parameters in Table 6-2 should be used to create the test paths for the intentional lane change tests where the turn signal is applied at 1.0 s ± 0.5 s before T_{STEER}. In case the lateral velocity at the point of ELK intervention is out of tolerance it is permitted to tune the yaw angle to achieve in tolerance manoeuvres.

$Vlat_{VUT}$ [m/s]	R [m]	Ψ_{VUT} [°]	d1 [m]	d2 [m]
0.5		1.43	0.25	0.45
0.6	800	1.72	0.36	0.34
0.7		2.01	0.49	0.21

Table 6-2 Intentional lane change parameters

Where the lateral offset d from the lane marking in Figure 6-1 is:

$$d = d1 + d2 + \text{Half of the vehicle width (m)}$$

With:

d1: Lateral distance travelled during curve establishing yaw angle (m)

d2: Lateral distance travelled during V_{lat} steady state (m)

6.3 Test Conduct

Before every test run, drive the VUT around a full circular path, and then manoeuvre the VUT into position on the test path. If requested by the OEM an initialisation run may be included before every test run.

For vehicles with an automatic transmission select D. For vehicles with a manual transmission select the highest gear where the RPM will be at least [1000] at the test speed. If fitted, a speed limiting device or cruise control may be used to maintain the VUT speed (not ACC), unless the vehicle manufacturer shows that there are interferences of these devices with the LSS in the VUT. Apply only minor steering inputs as necessary to maintain the VUT tracking along the test path.

Between tests, manoeuvre the VUT at a maximum speed of 50 km/h and avoid riding the brake pedal and harsh acceleration, braking or turning unless strictly necessary to maintain a safe testing environment.

6.4 Test Execution

Accelerate the VUT to 72 km/h.

Where applicable accelerate the target vehicle to 72 km/h or 80 km/h depending on the test scenario.

The test shall start at T_0 and is valid when all boundary conditions are met between T_0 and T_{LKA}/T_{ELK}:

LKA scenarios:

- Speed of VUT (GPS speed)	72 ± 1.0 km/h
- Lateral deviation from test path VUT	0 ± 0.10 m
- Steady state lane departure lateral velocity	± 0.05 m/s
- Yaw velocity of VUT (up to TSTEER)	0 ± 1.0 °/s
- Steering wheel velocity (up to TSTEER)	0 ± 15.0 °/s

ELK overtaking scenario:

- GVT relative longitudinal speed	0 ± 1.0 km/h
- Relative longitudinal distance	
• At 0 km/h relative velocity	0 ± [0.20] m
• Lateral deviation from test path GVT	0 ± 0.20 m

Steer the VUT as appropriate to achieve the lateral velocity in a smooth controlled manner and with minimal overshoot.

The end of an LKA test is considered complete when one of the following occurs:

- The LKA system fails to maintain the VUT within the permitted lane departure distance, plus an additional 2 seconds of data illustrating the VUT path
- The LKA/ELK system intervenes to maintain the VUT within permitted lane departure distance, such that a maximum lateral position is achieved that subsequently diminishes causing the VUT to turn back towards the lane, plus an additional [5] seconds of data illustrating the vehicle path and any subsequent LKA intervention correcting the VUT heading

The end of an ELK overtaking test is considered as when one of the following occurs:

- The ELK system intervenes to prevent a collision between the VUT and target vehicle such that a minimum lateral separation is achieved that subsequently increases causing the VUT to turn back towards the lane, plus an additional [5] seconds of data illustrating the vehicle path and any subsequent LKA intervention correcting the VUT heading
- The ELK system has failed to intervene (sufficiently) to prevent a collision between the VUT and target vehicle. This can be assumed when one of the following occurs:
  - The lateral separation between the VUT and GVT is < 0.3 m
  - No intervention is observed at a TTC = 0.8 s or a TTC submitted by the OEM

It is at the discretion of the laboratory to select and use one of the options above to ensure a safe testing environment.

If the test ends because the vehicle has failed to intervene (sufficiently) or if the GVT has left it’s designated path by more than 0.2 m, it is recommended that the VUT and/or GVT are steered away from the impact acknowledging safety and VUT stability, either manually or by reactivating the steering control.

The subsequent lateral velocity for the next test is incremented with 0.1m/s.