EURO NCAP

#FORSAFERVANS

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Crash Avoidance
Lane Departure Collisions

Protocol

Implementation January 2026

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 Secretary General should be immediately informed. Any such incident may be reported by the Secretary General to the manufacturer and the person concerned may not be allowed to attend further Euro NCAP tests.

DISCLAIMER: Euro NCAP has taken all reasonable care to ensure that the information published in this protocol is accurate and reflects the technical decisions taken by the organisation. In the unlikely event that this protocol contains a typographical error or any other inaccuracy, Euro NCAP reserves the right to make corrections and determine the assessment and subsequent result of the affected requirement(s).

CONTENTS

DEFINITIONS

Throughout this protocol the following terms are used:

Peak Braking Coefficient (PBC) – the measure of tyre to road surface friction based on the maximum deceleration of a rolling tyre, measured using 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 a lane boundary (i.e. solid lane marking, road edge) and/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 of the current travel lane.

Lane Departure Warning (LDW) – a warning that is provided automatically by the vehicle in response to the vehicle that is about to drift beyond a delineated edge line of the current travel lane.

Blind Spot Monitoring (BSM) – A sensing system that detects and warns the driver of an object (i.e. other road user) in an adjacent lane, which may be obscured from vision. This system must be default ON to be eligible for assessment.

Vehicle under test (VUT) – means the vehicle tested according to this protocol with an Emergency Lane Keeping, Lane Keep Assist and/or Lane Departure Warning system.

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

Euro NCAP Motorcyclist Target (EMT) – means the Motorcyclist target used in this protocol as specified in ISO 19206-5.

Real Motorcycle – Means a motorcyclist target that can be used in the Blind-Spot Monitoring Tests of this protocol, as an alternative to the EMT. The Real Motorcycle shall be a type approved two-wheeled motorcycle, with a maximum speed of at least 80km/h by design, without front fairing or windshield. It shall closely resemble the EMT (as specified in section 2.1 of deliverable D2.1 of the MUSE project), thus staying within the mean dimensions of the most registered middleweight naked motorcycles in Europe (i.e. wheelbase >1405mm. and <1445mm.).

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

Lane Edge – the road edge or inner side of the lane marking for the lane that the VUT is travelling.

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.

Driver Intention Monitoring system – means a system that is effective at distinguishing intentional from unintentional lane crossing and suppressing undesired interventions and/or warnings.

1 MEASURING EQUIPMENT

1.1 Reference system

Use the convention specified in ISO 8855:2011, with the origin at the most forward point on the centreline of the VUT for dynamic data measurements as shown in Figure 1-1. This reference system should be used for both left- and right-hand drive vehicles. In Figure 1-1 nearside and far-side are shown for a left-hand drive vehicle. For a right-hand drive vehicle, nearside and far-side are swapped.

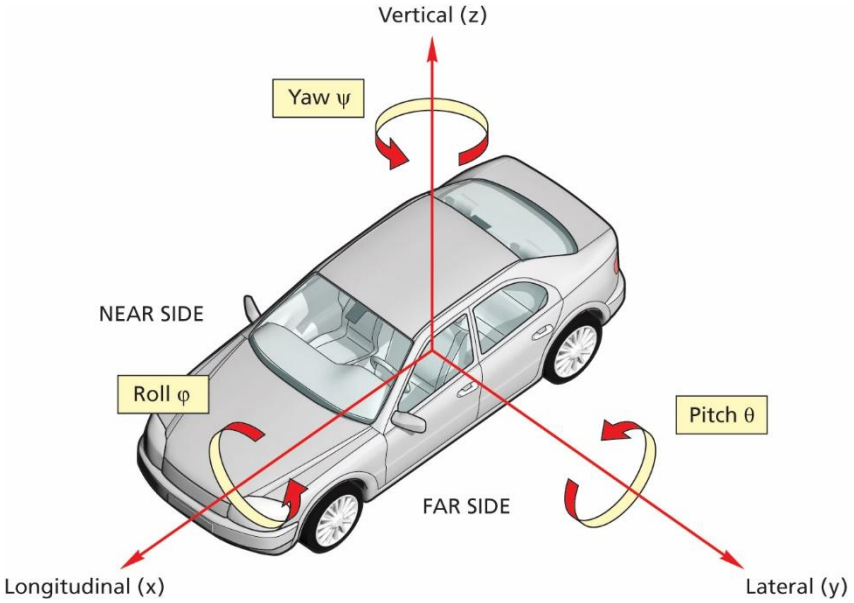


Figure 1-1 Coordinate system and notation

1.2 Impact location

1.2.1 Van-to-car Oncoming

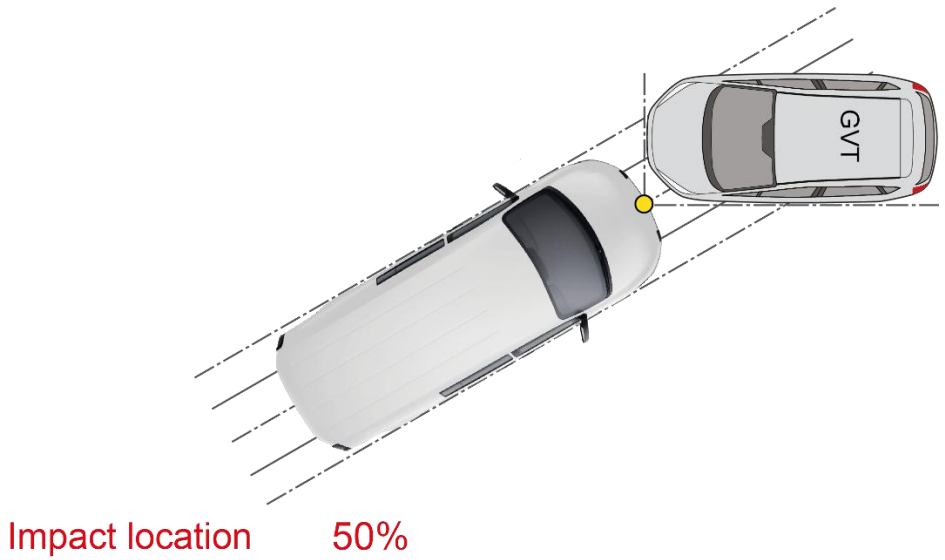


Figure 1-2 Impact Locations for Van-to-Car Oncoming

1.2.2 Van-to-Motorcyclist Oncoming

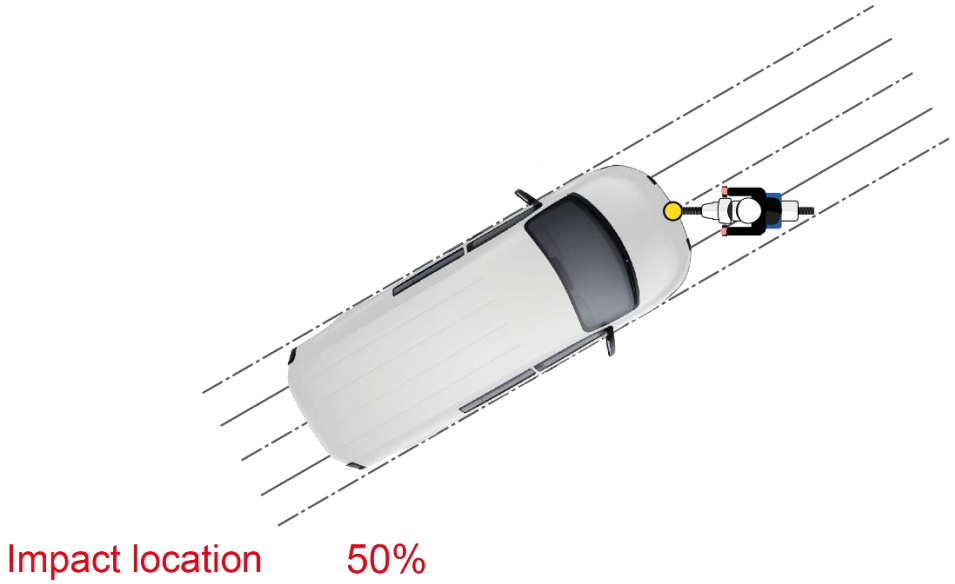


Figure 1-3 Impact Locations for Van-to-Motorcyclist Oncoming

1.2.3 Van-to-car Overtaking

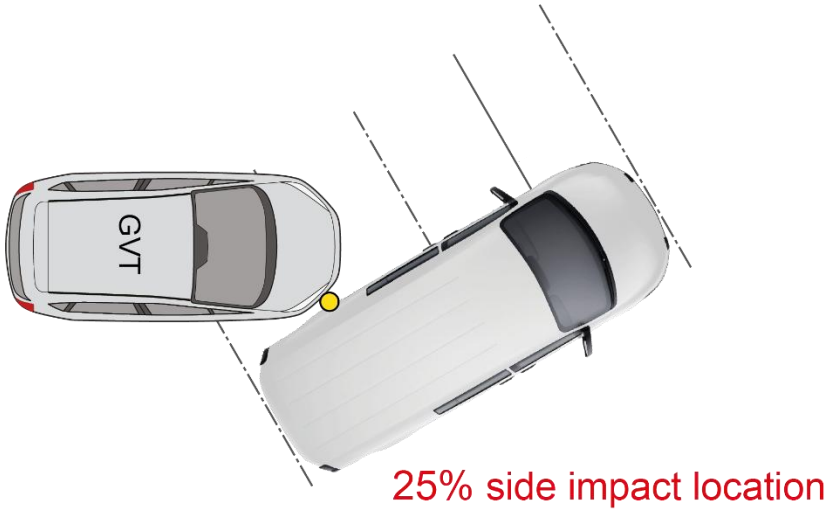


Figure 1-4 Impact Locations for Van-to-Car Overtaking

1.2.4 Van-to-Motorcyclist Overtaking

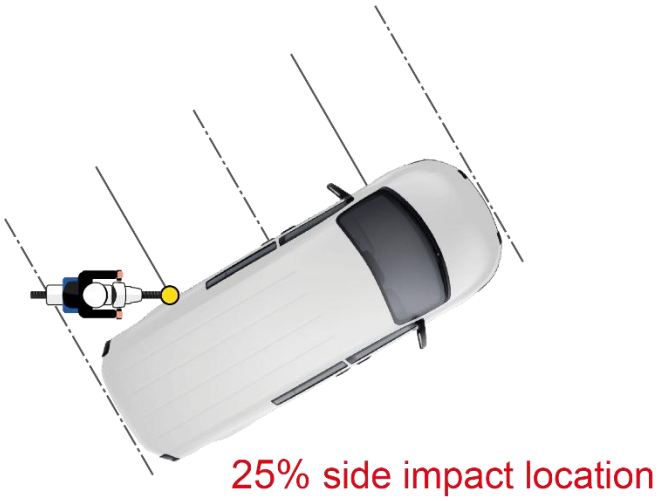


Figure 1-5 Impact Locations for Van-to-Motorcyclist Overtaking

1.3 Targets

Only equipment listed in the current version of Technical Bulletin G 003 may be used for testing. The current version can be found on the Euro NCAP website.

1.4 Measurements and variables

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

1.4.1 Variables

Variable	Description
T	Time
T_0	Time of test start T_0 = time where manoeuvre starts with 2s straight path
T_{LDW}	Time where LDW activates
T_{steer}	Time where the VUT enters in curve segment
$T_{crossing}$	Time where VUT crosses the line or road edge
T_{end}	Time of test end (see chapter 4.3.2)
X_{VUT}, Y_{VUT}	Position of the VUT during the entire test
$V_{long,VUT}$, $V_{lat,VUT}$	Speed of the VUT during the entire test
$\dot{\Psi}_{VUT}$	Yaw velocity of the VUT during the entire test
Ω_{VUT}	Steering wheel velocity of the VUT during the entire test
X_{target}, Y_{target}	Position of the target during the entire test
V_{target}	Speed of the target during the entire test
A_{target}	Acceleration of the target during the entire test
$\dot{\Psi}_{target}$	Yaw velocity of the target during the entire test

1.4.2 Equipment

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

- VUT and target longitudinal speed to 0.1km/h
- VUT and target lateral and longitudinal position to 0.03m
- VUT heading angle to 0.1°
- VUT and target yaw rate to 0.1°/s
- VUT longitudinal acceleration to 0.1m/s^2
- VUT steering wheel velocity to 1.0°/s.

1.4.3 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 torque and steering wheel velocity with a 12-pole phase less Butterworth filter with a cut off frequency of 10Hz.

2 TEST CONDITIONS

2.1 Test track

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 and a maximum lateral slope of ±3%.

The test track 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.

2.1.1 Lane Markings and Road Edge

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 3.7m when measured from the inside edge of the lane marking and a road edge:

1. Dashed line with a width between 0.10 and 0.25m (0.10 and 0.15m for centre lines)
2. Solid line with a width between 0.10 and 0.25m
3. Road Edge consisting of grass and/or gravel

The inner edge of the lane marking shall be at 0.20 to 0.30m from the road edge (transition between paved test surface and road edge material), where applicable.

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

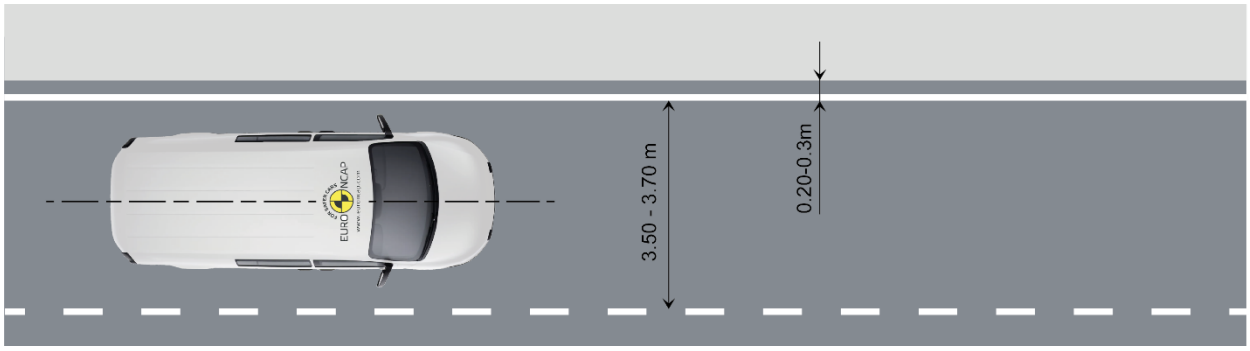


Figure 2-1: Layout of the lane markings

2.1.2 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 1km. Wind speeds shall be below 10m/s to minimise VUT disturbance.

Natural ambient illumination must be homogenous in the test area and in excess of 2000 lux for daylight testing with no strong shadows cast across the test area other than those caused by the VUT. 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:

a) Ambient temperature in °C;
b) Track Temperature in °C;
c) Wind speed in m/s;
d) Wind direction in azimuth ° and/or compass point direction (monitoring);
e) Ambient illumination in Lux.

2.2 VUT Preparation

2.2.1 System Settings

Set any driver configurable elements of the system (e.g. the timing of the Lane Departure Warning or the Lane Keep Assist if present) to the middle setting or midpoint and then next poorer performing setting similar to the examples shown in Figure 4. Lane Centering functions should be turned OFF. Furthermore, if a vehicle has a system where ELK or ELK + LKA mode can be selected, test the vehicle in ELK + LKA mode.

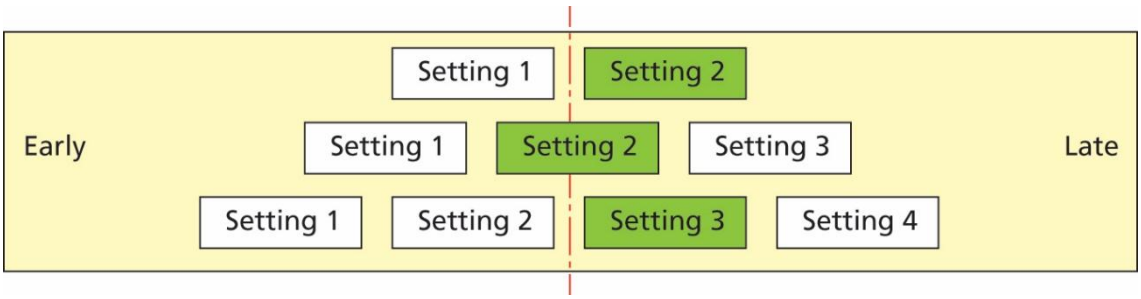


Figure 2-2: System setting for testing

2.2.2 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 least loading normal condition.

Run-in tyres according to the tyre conditioning procedure. After running-in maintain the run-in tyres in the same position on the vehicle for the duration of the testing.

2.2.3 Wheel Alignment Measurement

The vehicle should be subject to a vehicle (in-line) geometry check to record the wheel alignment set by the OEM. This should be done with the vehicle in kerb weight.

2.2.4 Vehicle loading

Complete testing with the vehicle half laden to represent typical N1 operation, with 'as tested' mass as follows:

$$As\ tested\ mass\ =\ Test\ ready\ mass\ +\ ((GVW\ -\ Test\ ready\ mass)/2)$$

With 'test ready' mass being:

$$Test\ ready\ mass\ =\ Unladen\ kerb\ mass\ +\ Interior\ load$$

And with 'interior load' being:

$$Interior\ load\ =\ 200kg\ =\ Driver\ +\ test\ equipment\ +\ additional\ required\ ballast$$

The procedure to prepare the van for the load requirements will be followed according to below steps:

a. Fill up the tank with fuel to at least 90% of the tank's capacity of fuel.
b. Check the oil level and top up to its maximum level if necessary. Similarly, top up the levels of all other fluids to their maximum levels if necessary.
c. Ensure that the vehicle has its spare wheel on board, if fitted, along with any tools supplied with the vehicle. Nothing else should be in the van.
d. Ensure that all tyres are inflated according to the manufacturer's instructions for the appropriate loading condition.
e. Measure the front and rear axle masses and determine the total mass of the vehicle. The total mass is the 'unladen kerb mass' of the vehicle. Record this mass in the test details.
f. Fit the test equipment in the vehicle (i.e. on-board test equipment and instrumentation , associated cables, cabling boxes and power sources).
g. With the driver and test equipment in the vehicle, weigh the vehicle. Record the driver + test equipment mass by subtracting the new measured mass to the initially measured unladen kerb mass.
h. Calculate the 'additional required ballast' by subtracting the mass of the driver and test equipment from the required 200kg interior load.
i. If applicable, place weights with a mass of the 'additional required ballast'. Any items added should be securely attached to the interior of the vehicle.
j. Compare these loads with the 'unladen kerb mass'.
k. Add additional ballast in the cargo space to increase the 'test ready' mass to 'as tested' mass, with an overall tolerance of ±1%. Locate the centre of mass of the ballast centrally within the cargo space (longitudinally, laterally and vertically) as far as is as practically possible. If the vertical limit of the cargo space is undefined (e.g. in the case of a flatbed or tipping body) locate the centre of mass of the ballast [0.6]m above the load bed. 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.

l. Note the ‘as tested’ front/rear axle load distribution may not necessarily remain within 5% of the front/rear axle load distribution of the original ‘unladen kerb mass’, which is acceptable for this testing.

Care needs to be taken when adding or removing weight in order to approximate the original vehicle inertial properties as close as possible. Record the final axle loads in the test details. Record the axle weights of the VUT in the ‘as tested’ condition.

2.2.5 Vehicle Dimensional Measurements

Vehicle dimensional measurements shall be taken. For purposes of this test procedure, vehicle dimensions shall be represented by a two-dimensional polygon defined by the lateral and longitudinal dimensions relative to the centroid of the vehicle using the standard ISO 8855 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 2-33.

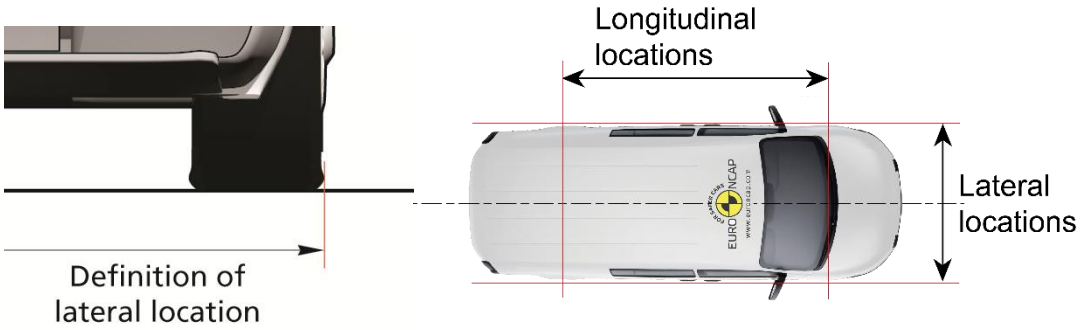


Figure 2-3: Vehicle dimensional measurements

The vehicle’s wheelbase and the lateral and longitudinal locations shall be measured and recorded.

Requirements for Steering Robot friction levels should be checked prior to testing, as detailed in the Technical Bulletin CA 201.

3 TEST PROCEDURE

Each scenario in this assessment consists of a matrix combining vehicle & target longitudinal speeds, and ranges of vehicle lateral speeds. Each combination in a matrix is referred to as grid cell. The assessment criteria is detailed in chapter 5.

3.1 Lane Departure

Lane Departure	Points	Total
ELK		**10.0**
Road edge	5.0	
Solid Line	5.0	
LKA		**3.0**
Dashed Line	1.5	
Solid Line	1.5	
HMI		**2.0**
BSM or LDW	2.0	

At the test labs discretion, and in agreement with the Vehicle Manufacturer, the ELK and LKA tests can be conducted either robotically, or manually by controlled inputs from the driver or intersecting a curved section.

Where the vehicle and test is to be controlled via driver inputs, the resulting V_{lat} and V_{long} shall be maintained within the grid points where performance is expected.

3.1.1 ELK

ELK-RE	Centre Line	Direction	0.2 m/s	0.3 m/s	0.4 m/s	0.5 m/s	0.6 m/s
72 km/h	No Line	Passenger Side					
72 km/h	Solid/Dashed	Passenger Side					

ELK-SL	Centre Line	Direction	0.2 m/s	0.3 m/s	0.4 m/s	0.5 m/s	0.6 m/s
72 km/h	Solid/Dashed	Passenger Side					
72 km/h	Solid/Dashed	Driver Side					

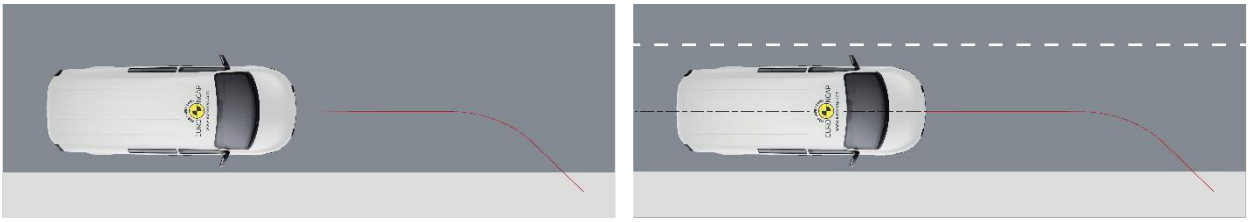


Figure 3-1 ELK - Road Edge scenarios

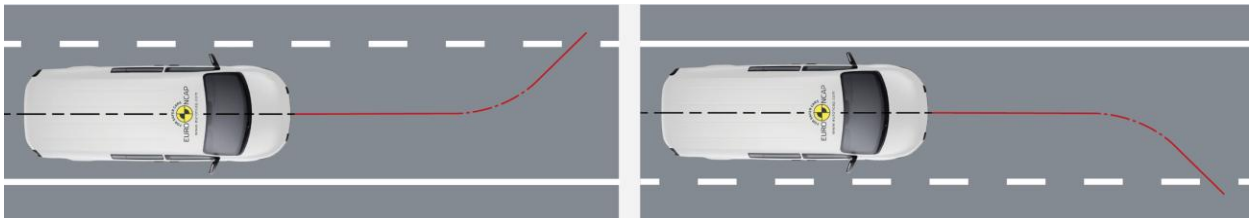


Figure 3-2 ELK – Solid Line scenarios

3.1.2 LKA

LKA-D	Target Line	Direction	0.2 m/s	0.3 m/s	0.4 m/s	0.5 m/s	0.6 m/s
72 km/h	Dashed	Driver Side					
72 km/h	Dashed	Passenger Side					

LKA-SL	Target Line	Direction	0.2 m/s	0.3 m/s	0.4 m/s	0.5 m/s	0.6 m/s
72 km/h	Solid	Driver Side					
72 km/h	Solid	Passenger Side					

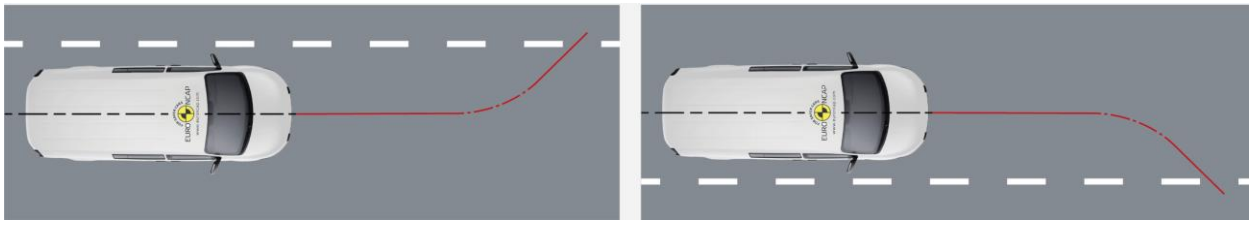


Figure 3-3 LKA Dashed line scenarios

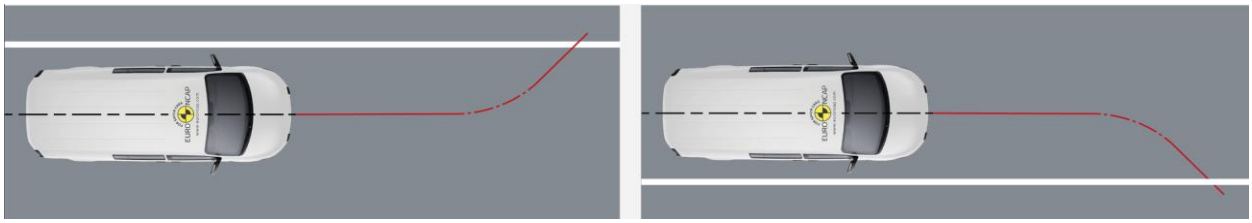


Figure 3-4 LKA solid line scenarios

For vehicles with a system where LKA dashed line is implemented as an ELK functionality (default-on) but not including a DIM feature, conduct the calibration runs as stated in 4.3.2.1 and monitor the steering torque at the intervention point for all the lateral velocities. The overriding torque shall be <= 3.5 Nm.

3.1.3 HMI

LDW	Target Line	Direction	0.6 m/s	0.7 m/s	0.8 m/s	0.9 m/s	1.0 m/s
72 km/h	Dashed	Driver Side					
72 km/h	Dashed	Passenger Side					
72 km/h	Solid	Driver Side					
72 km/h	Solid	Passenger Side					

BSM	Target Type*	Target Position	Target Speed
			80 km/h
72 km/h	GVT	Farside	
72 km/h	GVT	Nearside	
72 km/h	EMT	Farside	
72 km/h	EMT	Nearside	

*Real vehicle and/or motorcyclist target may be used

For the Blind Spot Monitoring scenario, the target vehicle will follow a straight-line path in the lane adjacent to the VUT's initial position in the same direction as the VUT. The straight-line path of the target will be 1.5m from the inner side of the centre dashed lane marking. The VUT is positioned in the centre of the driving lane.

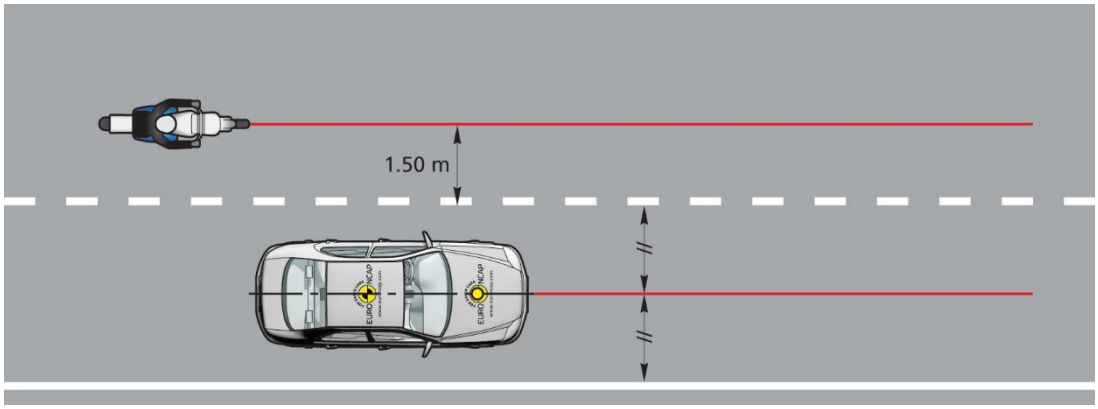


Figure 3-5 Blind Spot Monitoring scenario

3.2 Car & PTW

CAR & PTW	Points
ELK Van-to-car	**5.0**
Oncoming	2.5
Overtaking Intentional	1.25
Overtaking Unintentional	1.25
ELK Van-to-motorcyclist	**5.0**
Oncoming	2.5
Overtaking Intentional	1.25
Overtaking Unintentional	1.25

3.2.1 ELK Van-to-Car

3.2.1.1 Oncoming

For the oncoming scenario, the GVT will follow a straight-line path in the lane adjacent to the VUT's initial position, in the opposite direction to the VUT. The straight-line path of the target will be 1.5m from the inner side of the centre dashed lane marking of the VUT lane.

The paths of the VUT and target vehicle will be synchronised so that the reference point of the GVT meet with the VUT at a 90% impact location (assuming no system reaction).

ELK-ON	Target	0.2 m/s	0.3 m/s	0.4 m/s	0.5 m/s	0.6 m/s
72 km/h	72 km/h					

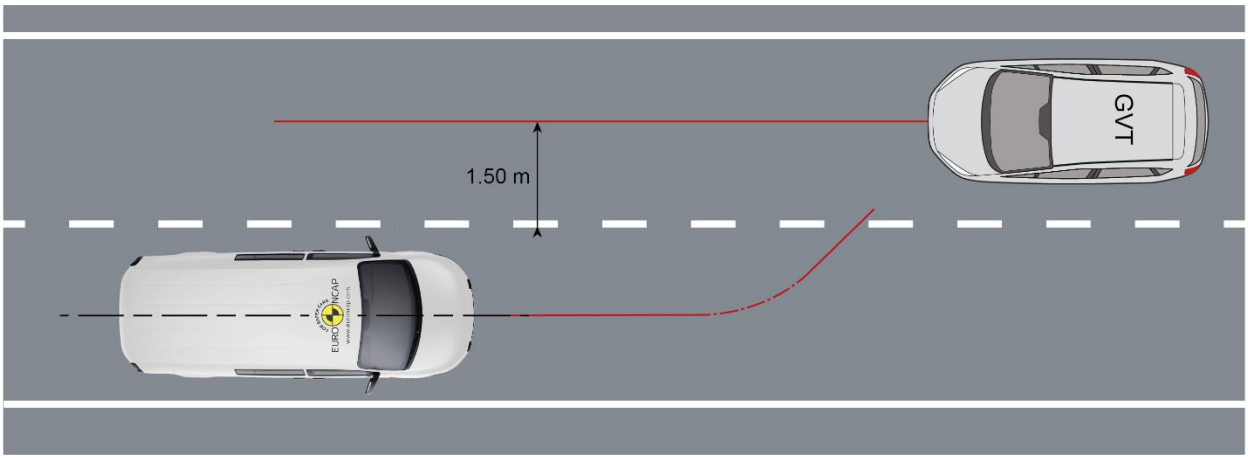


Figure 3-6 ELK Van-to-Car Oncoming test format

3.2.1.2 Overtaking

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

The paths of the VUT and target vehicle will be synchronised so that the longitudinal position of the leading edge of the target vehicle impacts 25% of the length of the VUT (assuming no system reaction).

Lane departures will be performed toward the driver side only, and intentional lane change manoeuvres will be conducted with the turn indicator ON, applied 1.0 ± 0.5sec before T_{steer}.

ELK-OV	Target	Manoeuvre	0.2 m/s	0.3 m/s	0.4 m/s	0.5 m/s	0.6 m/s	0.7 m/s
72 km/h	72 km/h	Intentional						
72 km/h	72 km/h	Unintentional						
72 km/h	80 km/h	Intentional						
72 km/h	80 km/h	Unintentional						

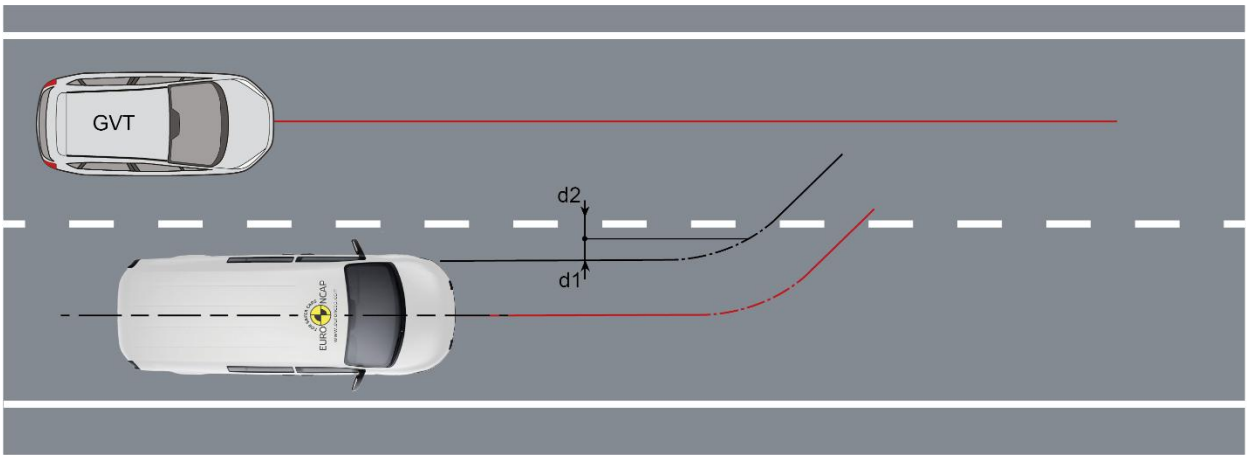


Figure 3-7 ELK Van-to-Car Overtaking test format

3.2.2 ELK Van-to-Motorcyclist

3.2.2.1 Oncoming

For the oncoming scenario the EMT will follow a straight-line path at 72 km/h in the lane adjacent to the VUT's initial position, in the opposite direction to the VUT who also drives at 72 km/h. The straight-line path of the target will be 1m for the EMT from the inner side of the centre dashed lane marking of the VUT lane.

ELK-ON	Target	0.2 m/s	0.3 m/s	0.4 m/s	0.5 m/s	0.6 m/s
72 km/h	72 km/h					

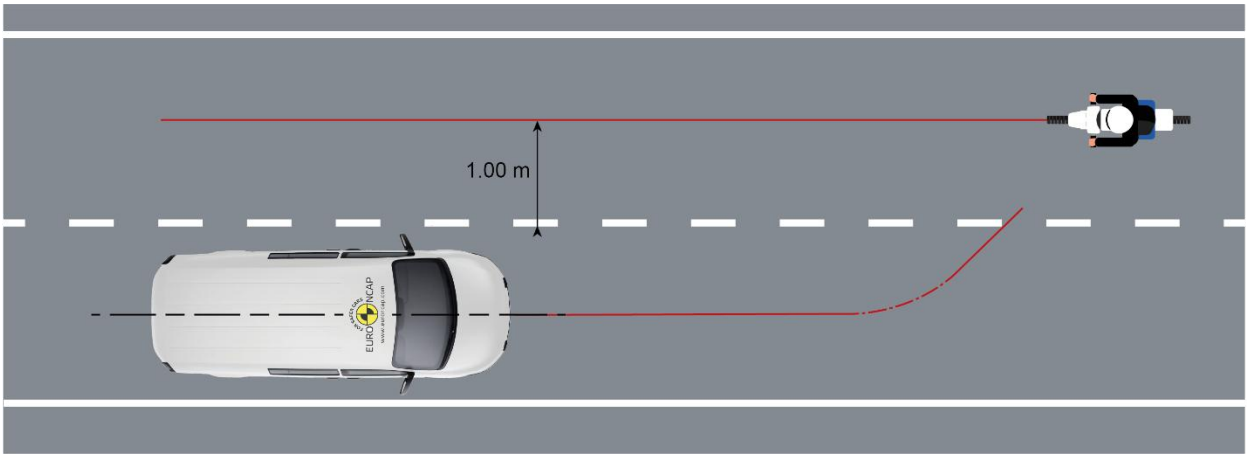


Figure 3-8 ELK Van-to-Motorcyclist Oncoming test format

The paths of the VUT and EMT will be synchronised so that the front wheel of the EMT impacts the VUT at a 110% impact location (assuming no system reaction).

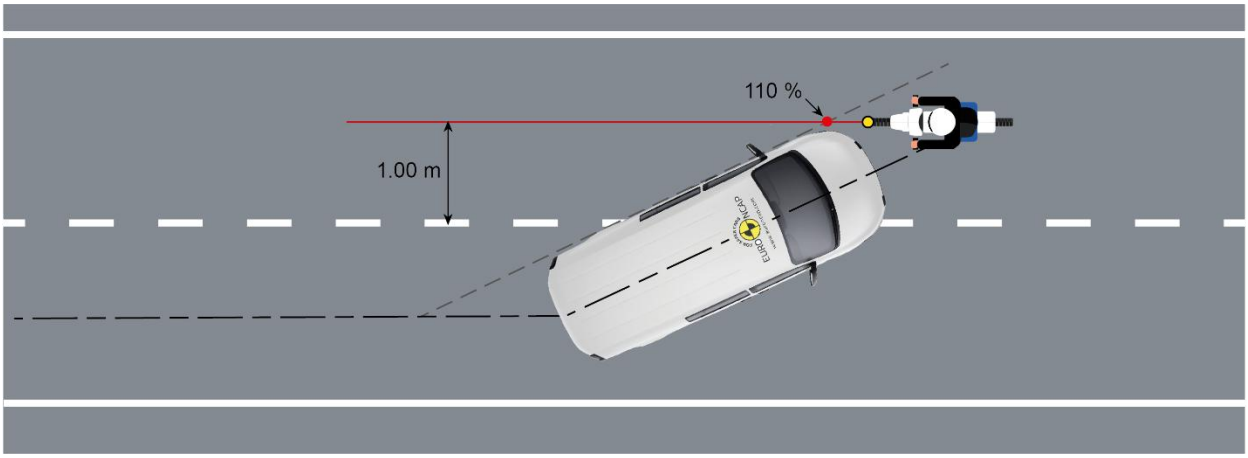


Figure 3-9 Impact location for ELK Van-to-Motorcyclist Oncoming

3.2.2.2 Overtaking

For the overtaking scenario a EMT will follow a straight-line path in the lane adjacent to the VUT's initial position at the driver side, in the same direction as the VUT. The straight-line path of the target will be 1m for the EMT from the inner side of the centre dashed lane marking of the VUT line

The ELK Van-to-Motorcyclist Overtaking tests will be performed with 0.1m/s incremental steps within the lateral velocity range of 0.2 to 0.6m/s for unintentional lane changes, and 0.5 to 0.7m/s for intentional lane changes.
Lane departures for ELK Van-to-Motorcyclist Overtaking will be performed toward the driver side only, and intentional lane change manoeuvres will be conducted with the turn indicator ON, applied 1.0 ± 0.5sec before T_{steer}.

ELK-OV	Target	Manoeuvre	0.2 m/s	0.3 m/s	0.4 m/s	0.5 m/s	0.6 m/s	0.7 m/s
50 km/h	60 km/h	Intentional						
50 km/h	60 km/h	Unintentional						
72 km/h	80 km/h	Intentional						
72 km/h	80 km/h	Unintentional						

Note: For the sake of scoring, the Van-to-Motorcyclist ELK Overtaking scenario is split into two sub-scenarios (one where the VUT travels at 50 km/h, and one where the VUT travels at 72 km/h).

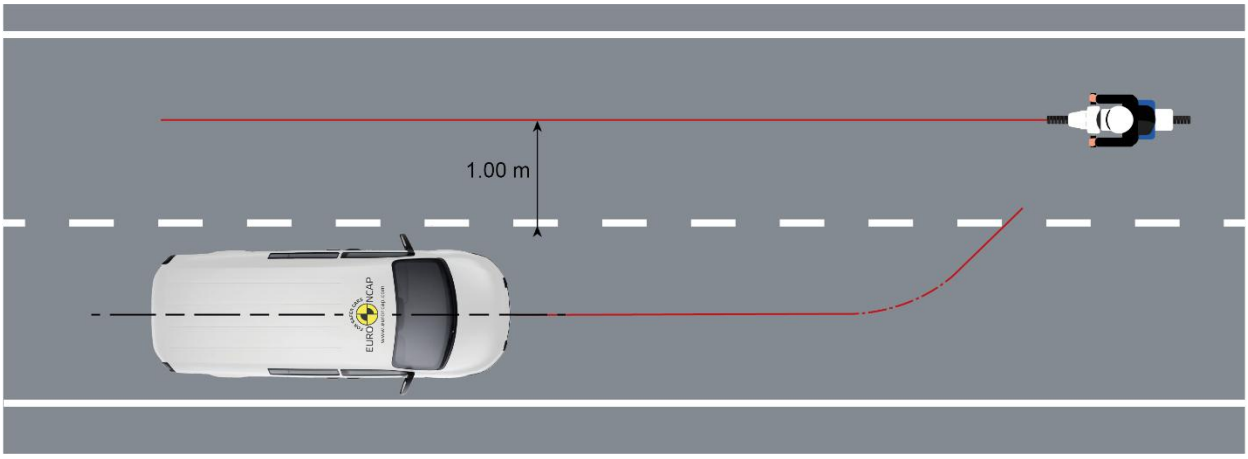


Figure 3-7 ELK Van-to-Motorcyclist Overtaking test format

The paths of the VUT and EMT will be synchronised so that the front wheel of the EMT impacts the 25% of the length of the VUT (assuming no system reaction).

4 TEST EXECUTION

4.1 Performance Predictions

The Vehicle Manufacturer shall provide the Euro NCAP with PASS/FAIL data detailing the predicted performance of the LSS for all test scenarios, and in accordance with the assessment criteria outlined in **Error! Reference source not found.**. The predicted performance will be used a s a reference to identify discrepancies between the predicted results and the test results.

4.2 Verification tests

Where the Vehicle Manufacturer provides predictions, the test laboratory will test as indicated in the following chapters. In absence of predictions, the test laboratory will test all test cases.

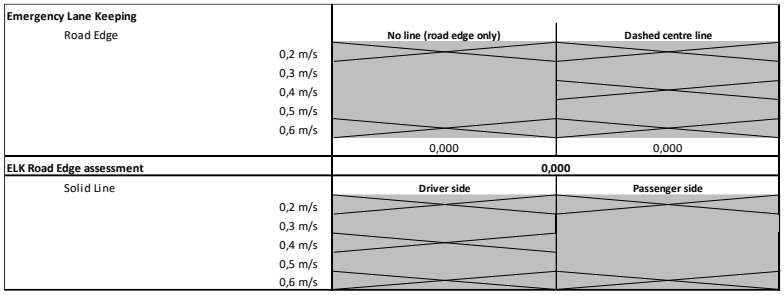
4.2.1 ELK

4.2.1.1 Road Edge

Test lowest and highest vlat, plus 1 random Vlat either No line (road edge only) or Dashed centre line (TOTAL = 5 runs)

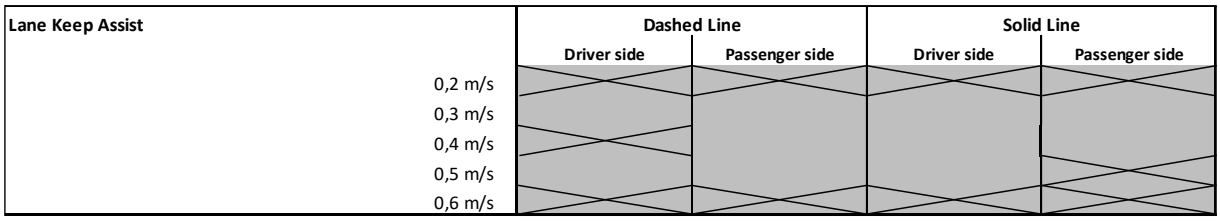
4.2.1.2 Solid line

Test lowest and highest vlat, plus 1 random Vlat either Driver side or Passenger side (TOTAL = 5 runs)



4.2.2 LKA

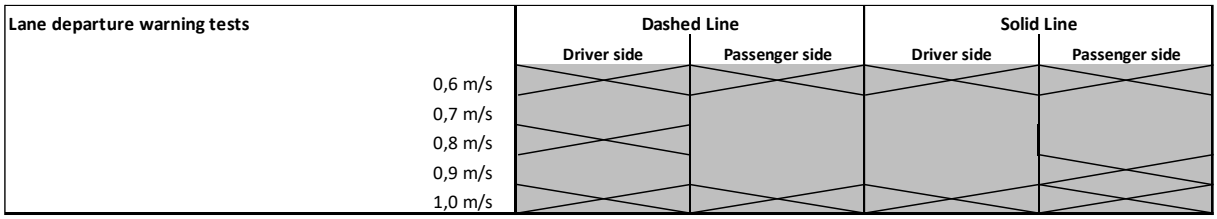
Test lowest and highest Vlat for every line type and departure direction, plus 1 random Vlat either driver or passenger side for Dashed and Solid line (TOTAL = 10 runs) :



4.2.3 LDW

4.2.3.1.1 LDW only / standalone:

Test lowest and highest Vlat for every line type and departure direction, plus 1 random Vlat either driver or passenger side for Dashed and Solid line (TOTAL = 10 runs) :



4.2.3.2 Combined systems:

Only test Vlat 1.0m/s for every line type and departure direction (TOTAL = 4 runs)

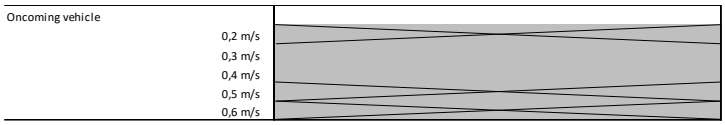
4.2.4 BSM

Perform visual check of BSM activation during ELK Overtaking tests (for car & PTW targets).

4.2.5 ELK Oncoming & Overtaking

4.2.5.1 Oncoming

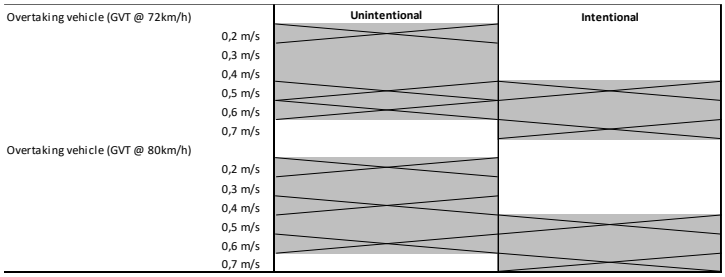
Test lowest and highest vlat, plus 1 random Vlat (TOTAL = 3 runs)

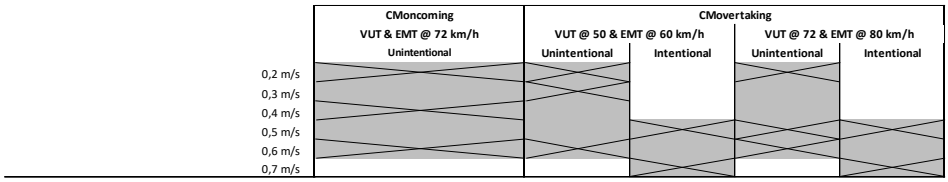


4.2.5.2 Overtaking

Intentional: Test lowest and highest vlat (TOTAL = 4 runs)

Unintentional: Test lowest and highest vlat, plus 1 random Vlat (TOTAL = 6 runs)





Note: Carry-over possibility for unintentional tests applies as per 5.2.2.1, except for Van-to-Motorcyclist with VUT speed 50 km/h.

4.3 Test Conduct

4.3.1 VUT Pre-test Conditioning

A new car is used as delivered to the test laboratory; however, a car 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 100km on a mixture of urban and rural roads with other traffic and roadside furniture to 'calibrate' the sensor system. Avoid harsh acceleration and braking.

4.3.1.1 Tyres

Condition the vehicle's tyres in the following manner to remove the mould sheen, if this has not been done before for another test or in case the lab has not performed a 100km of driving:

- Drive around a circle of 30m in diameter at a speed sufficient to generate a lateral acceleration of approximately 0.5 to 0.6g for three clockwise laps followed by three anticlockwise laps.
- Immediately following the circular driving, drive four passes at 56km/h, performing ten cycles of a sinusoidal steering input in each pass at a frequency of 1Hz and amplitude sufficient to generate a peak lateral acceleration of approximately 0.5 to 0.6g.
- 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.

4.3.1.2 System Check

Before any testing begins, perform a maximum of ten runs, to ensure proper functioning of the system.

4.3.2 Test Scenarios

Control the VUT with driver inputs or using alternative control systems that can modulate the vehicle controls as necessary to perform the tests.

Accelerate the VUT to the targeted speed.

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

Parameter	Condition	VUT	GVT	EMT
Speed		± 1.0 km/h		
Relative longitudinal speed	Overtaking	± 1.0 km/h		

Relative longitudinal distance	Overtaking	± [0.20]m		
Lateral deviation	Oncoming	0 ± 0.05 m	0 ± 0.30m	0 ± [0.15] m
	Overtaking	-	0 ± 0.20m	-
Steady state lane departure lateral velocity		± 0.05m/s	-	-
Yaw velocity	Up to T_{STEER} for VUT	0 ± 1.0 °/s		
Yaw angle			0 ± 1.5 °	
Steering wheel velocity		0 ± 15.0 °/s		

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

The end of a test is considered as:

- LDW tests: when the warning commences.
- BSM tests: when the longitudinal distance between the VUT and test target is 0m (i.e. when the front end of the VUT is aligned with the rear end of the test target).
- LKA/ELK Road Edge tests: 2 seconds after one of the following occurs:
    - The LKA/ELK system fails to maintain the VUT within the permitted lane departure distance.
    - 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.
- ELK oncoming or overtaking tests: when one of the following occurs:
    - The ELK system intervenes to prevent a collision between the VUT and target vehicle
    - 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 target vehicle equal < 0.3m in the oncoming and overtaking scenario
        - No intervention is observed at a TTC = 0.8s or a TTC submitted by the OEM

It is at the labs discretion 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 EMT has left it's designated path by more than 0.2m, it is recommended that the VUT and/or EMT are steered away from the impact, either manually or by reactivating the steering control of the driving robot/EMT.

4.3.2.1 Calibration runs

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. The test laboratory shall then verify the release point for the highest lateral velocity.

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 (as defined above). In the case of calibration runs, the release of steering control should occur on the test path and no less than 5m longitudinally before the location of intervention.

If the intervention point of the function occurs before the target V_{latVUT} is reached, the test laboratory will conduct a verification check of the V_{latVUT}=0.6m/s test case (both for dashed and solid line) using a straight-line vehicle path intersecting with a curved lane marking. The intersecting angle of the VUT test path and the curved lane marking shall be equal to the yaw angle (Ψ_{VUT}) achieved by the 0.6m/s test conducted in the standard test format (ie. straight lane marking tests).

A maximum of 3 runs shall be conducted (both for solid and dashed line), where the system intervention and resulting DTLE is monitored.

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.

4.3.2.2 Test parameters

The following figure details the parameters used to create the test paths:

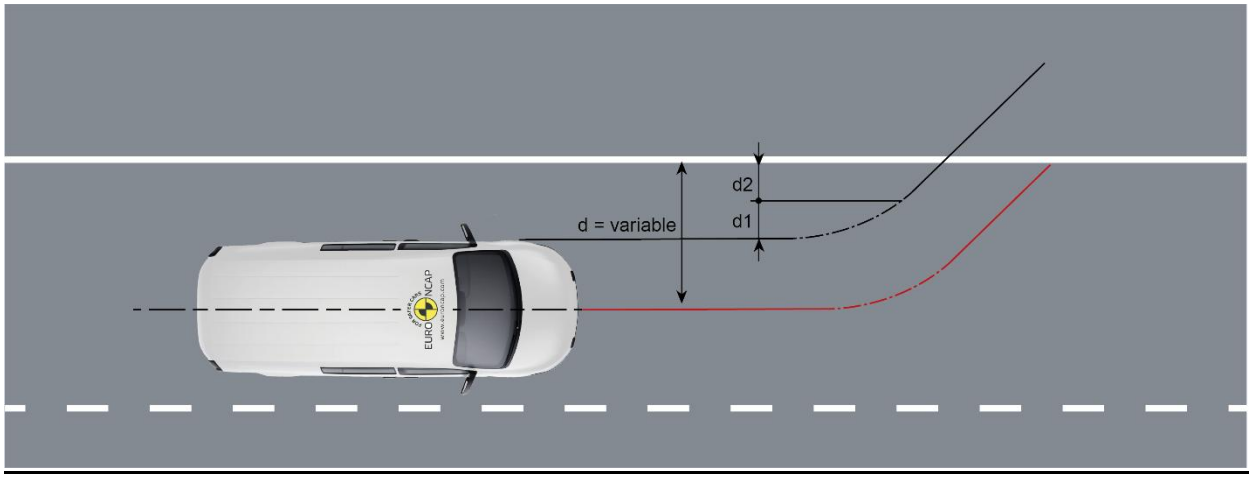


Figure 4-1: Vehicle paths definition

For the full definition of each scenario's test paths, see APPENDIX A.

5 ASSESSMENT

5.1 General requirements

To be eligible for scoring points in this assessment, the ELK function of the LSS system shall be default ON at the start of every journey and deactivation of the system shall not be possible with a momentary single push on a button. LKA, LDW and BSM are not necessary to be default ON.

5.2 Criteria

5.2.1 Lane Departure

The assessment criteria for Lane Departure ELK, LKA and LDW scenarios is based on a limit value in DTLE:

Scenario	DTLE limit (m)	Criteria
ELK-RE	- 0.1	VUT not allowed to go beyond the DTLE limit.
ELK-SL	- 0.3	
LKA-D	- 0.3	
LKA-SL	- 0.3	
LDW	- 0.2	Haptic warning clearly relating to the lateral control of the vehicle noticeable by the driver (e.g. notable heading correction, steering wheel vibration, etc.) before a

For BSM scenario, the assessment criteria used is the blind spot information supplied in respect to overtaking targets. For a pass to be awarded, visual blind spot information must be provided for overtaking cars and motorcycles.

Only for indicative purposes, the BSM should be supplied when the front end of the test target is within the red areas shown in red in the following diagram:

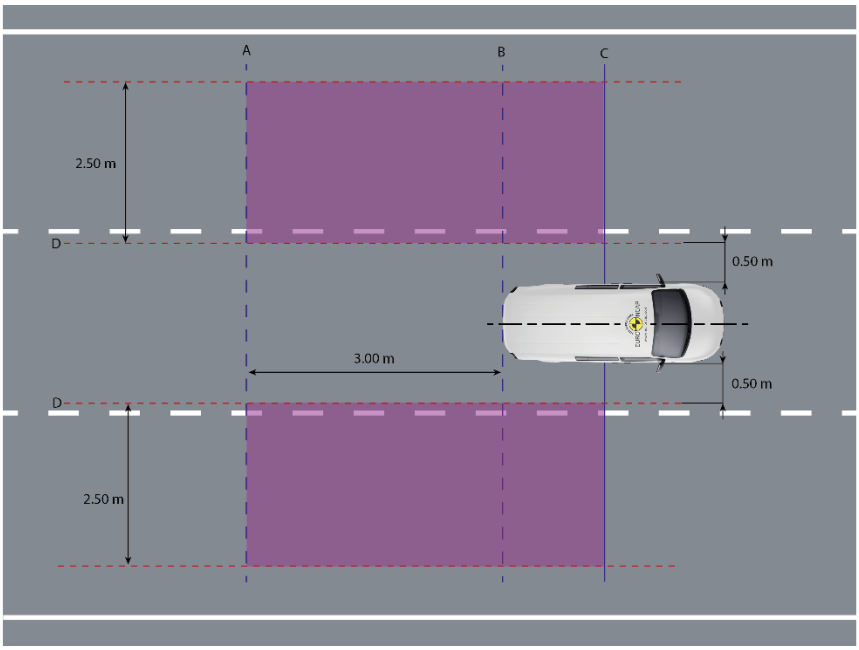


Figure 5-1 Blind spot monitoring scenario assessment

5.2.2 Car & PTW

5.2.2.1 ELK Oncoming & Overtaking

For all ELK Van-to-Car & Van-to-Motorcyclist Oncoming and Overtaking tests with an oncoming or overtaking vehicle, the assessment criteria used is “no impact”, meaning that the VUT is not allowed to contact* the overtaking or oncoming vehicle target at any time during the test.

** For the motorcyclist test scenarios, the lateral separation between the VUT and the Oncoming or Overtaking EMT must be >0.3m.*

The points for ELK Oncoming and ELK Overtaking Unintentional may be achieved using a system where LKA dashed line is implemented as an ELK functionality (default-on) and the LKA dashed line tests fulfils all LKA dashed lane criteria, provided that either:

- The system features a Driver Intention Monitoring (DIM) with subsequent suppression of undesired intervention, OR
- The steering torque applied by the driver to override the system is <=3.5 Nm

For both cases, the OEM shall provide a dossier that includes a system overview and compelling evidence demonstrating how the system is effective at eliminating or mitigating driver acceptance issues associated with lateral control.

For the evaluation of Driver Intention Monitoring (DIM) system, Euro NCAP requires a dossier from the OEM containing a detailed technical assessment. The dossier shall contain, as minimum:

1. Overview of the DIM System operating principle and its strategy/logic to determine driver ‘intention’, including a list of the Indirect/Direct input variables and their inter-dependency for suppressing undesired LKA interventions.
2. System Failsafe strategies in which DIM system is overruled e.g.,
   - To avoid a crash with a threat on a collision course
   - When a driver is deemed incapacitated
3. Information describing naturalistic driving in which lane marking crossing/lane changing manoeuvring typically occurs for the vehicle, and associated driver indicator usage
4. Evidence of the effectiveness of the system at suppressing undesirable LKA interventions and promoting driver acceptance
5. Any other information the OEM deems relevant to support their application

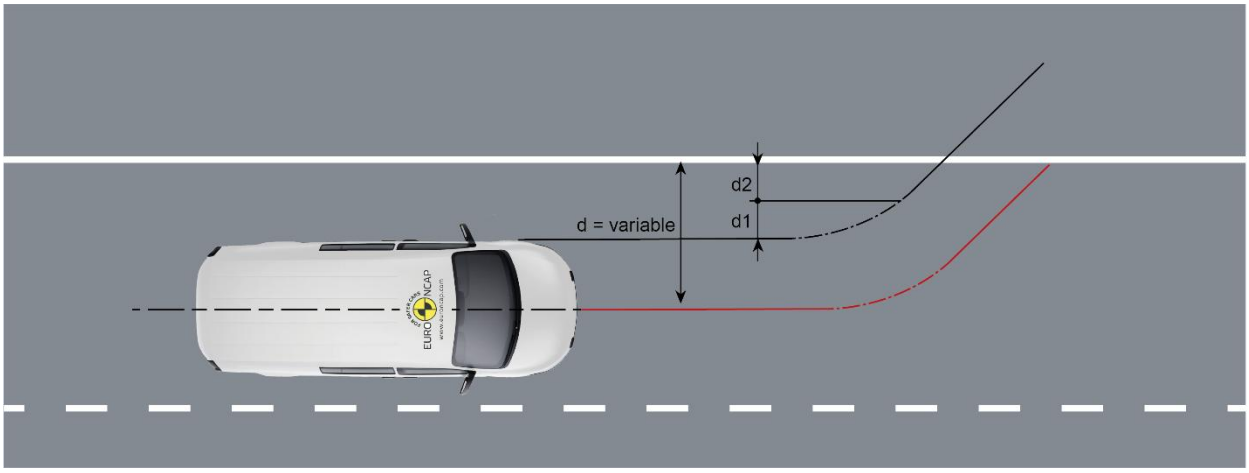
5.3 Scoring

The available points per scenario are awarded based on a pass/fail basis where all grid cells within each scenario shall be a pass.

APPENDIX A LANE DEPARTURE PARAMETERS

The following chapters indicate the lane departure parameters across scenarios, where the lateral offset d from the lane marking or road edge:

- d = d1 + d2 + Half of the vehicle width (m)
- d1: Lateral distance travelled during curve establishing yaw angle (m)
- d2: Lateral distance travelled during V_{lat} steady state (m)



A.1 ELK-RE, ELK-SL, LKA, LDW

Path for conventional system:

Vlat,VUT [m/s]	**R [m]**	**Ψ_{VUT} [°]**	**d1 [m]**	**d2 [m]**
0.2	1200	0.57	0.06	0.70
0.3		0.86	0.14	0.90
0.4		1.15	0.24	0.80
0.5		1.43	0.38	0.75
0.6		1.72	0.54	0.60
0.7		2.01	0.74	0.53
0.8		2.29	0.96	0.40
0.9		2.58	1.22	0.23
1.0		2.87	1.50	0.00

Paths for Driver Intention Monitoring (DIM) system implemented alongside LKA and/or LDW:

Vlat,VUT [m/s]	**R [m]**	**Ψ_{VUT} [°]**	**d1 [m]**	**d2 [m]**

0.2	1200	0.57	0.06	0.70
0.3		0.86	0.14	0.90
0.4		1.15	0.24	0.80
0.5	800	1.43	0.25	1.00
0.6		1.72	0.36	1.20
0.7		2.01	0.49	1.40
0.8		2.29	0.64	1.60
0.9		2.58	0.81	1.80
1.0		2.87	1.00	2.00

A.2 ELK Oncoming

VUT@ 72km/h	$Vlat_{VUT}$ [m/s]	R [m]	Ψ_{VUT} [°]	d1	d2
Unintentional	0.2	1200	0.57	0.06	0.70
	0.3		0.86	0.14	0.90
	0.4		1.15	0.24	0.80
	0.5		1.43	0.38	0.75
	0.6		1.72	0.54	0.60

A.3 ELK Overtaking

VUT@ 50km/h	$Vlat_{VUT}$ [m/s]	R [m]	Ψ_{VUT} [°]	d1	d2
Unintentional	0.2	1200	0.83	0.12	0.64
	0.3		1.24	0.28	0.76
	0.4		1.65	0.50	0.54
	0.5		2.06	0.78	0.35
	0.6		2.48	1.12	0.02
Intentional	0.5	400	2.06	0.26	0.74
	0.6		2.48	0.37	0.59

	0.7		2.89	0.51	0.51

VUT@ 72km/h	**$Vlat_{VUT}$ [m/s]**	**R [m]**	**Ψ_{VUT} [°]**	**d1**	**d2**
Unintentional	0.2	1200	0.57	0.06	0.70
	0.3		0.86	0.14	0.90
	0.4		1.15	0.24	0.80
	0.5		1.43	0.38	0.75
	0.6		1.72	0.54	0.60
Intentional	0.5	800	1.43	0.25	0.75
	0.6		1.72	0.36	0.60
	0.7		2.01	0.49	0.53