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EUROPEAN NEW CAR
ASSESSMENT PROGRAMME

# Technical Bulletin

# Driver Status Monitoring Spot Testing Guidance

**Version 1.0**

**July 2022**
**TB 039**

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| Title | Driver Status Monitoring – Testing Guidance |
| Version | 1.0 |
| Document Number | TB 039 |
| Author | Euro NCAP |
| Date | July 2022 |
| Related Documents | Euro NCAP Assessment Protocol - SA Safe Driving - v10.1 |
| Status | Information |
| Application Date | 1st January 2023 |

# Preface

DISCLAIMER: Euro NCAP has taken all reasonable care to ensure that the information published in this document 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).

**EUROPEAN NEW CAR ASSESSMENT PROGRAMME (Euro NCAP)**

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# 1 INTRODUCTION

The assessment of Driver Status Monitoring (DSM) systems is detailed in the Euro NCAP Assessment Protocol – Safety Assist, Safe Driving. This assessment is based on information provided to Euro NCAP by the vehicle manufacturer along with spot testing that is conducted by the Euro NCAP laboratories.

Euro NCAP requires the vehicle manufacturer to provide a dossier that contains sufficient technical detail of all DSM assessment areas. This Technical Bulletin specifies the complementary spot testing for DSM testing. The dossier must be provided to the Euro NCAP Secretariat before any testing begins.

## 2 DEFINITIONS

Throughout this protocol the following terms are used:

**Driver State Monitoring (DSM)** – Driver State Monitoring system that is able to (in)directly determine the state of the driver

**Direct monitoring –** Where driver state determination is supported by sensor(s) directly observing the driver.

**Indirect monitoring –** Where driver state determination is achieved indirectly through means other than sensor(s) directly observing the driver (e.g steering input).

**Impaired driving** – A driver who is disconnected from the driving task or not in a physical state that is sufficient for safe driving, either due to distraction, fatigue or sickness.

**Distraction** – Anything (e.g. secondary tasks) that reduces the driver's focus on the primary task of driving/controlling the vehicle.

- **Long distraction –** A single long duration distraction which takes the driver's gaze away from the forward road view.
- **Short distraction / Visual Attention Time Sharing (VATS) –** Repeated short duration gazes away from the forward road view, which cumulatively reduce the driver's awareness of the driving situation, until their attention returns to the driving task for long enough for them to fully assess the driving situation.
- **Phone use –** A subset of short distraction (VATS) where the object the driver's attention is shared with is their mobile phone.

**Fatigue** – State of the driver where he/she is not awake enough to properly perform the driving task

- **Drowsy –** State of the driver where tiredness has an adverse effect of the driver's ability to focus on the driving task.
- **Microsleep –** A microsleep is a temporary episode of sleep which may last up to several seconds.
- **Sleep –** In this assessment sleep is considered as when a driver has been in a state of unconsciousness due to fatigue for a period of greater than a few seconds.

**Unresponsive driver –** Where a driver becomes unresponsive during driving, likely due to an onset of sudden sickness or extreme fatigue.

**Impaired driving vehicle response** – Warning and/or adapted vehicle mode after an impaired driving has been detected

- **Impaired driving warning** – Warning issued in case the system determines an impaired driver
- **High sensitivity mode** – A more sensitive and earlier warning and/or

intervention of Safety Assist systems to compensate for the driver state

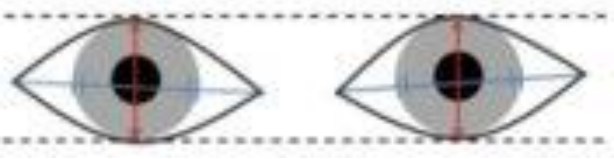
- **Minimum Risk Manoeuvre (MRM)** – Emergency manoeuvre where the vehicle will either come to a controlled stop or speed of <10km/h without input from the driver.

**Owl type movement** – A shifting of visual attention away from the road and forward-facing position that is primarily achieved by head rotation followed by the eyes.

**Lizard type movement** – A movement in which the driver focuses on a task by moving primarily their eyeline away from the road with their head/face remaining in the forward-facing position.

**Degraded system** – A direct driver monitoring system is considered degraded in this assessment when an entire subsystem becomes fully unavailable. E.g. A direct driver monitoring system which uses head pose tracking and eye tracking would be considered degraded if eye tracking became fully unavailable therefore preventing the system identifying any lizard type movements.

**Eye lid aperture –** Distance between the point where the straight line drawn in the y-axis direction from the midpoint of line segment connecting the outer and inner corners of the driver's eye overlaps the lower edge of the upper eyelid and upper edge of the lower eyelid. Measured when driver is awake and attentive.



**In-vehicle infotainment (IVI) system -** The area containing the infotainment system and/or vehicle controls, typically located centrally ahead of the front row seating in the conventional passenger car layout.

**Adaptive Cruise Control (ACC) –** Cruise control that adjusts vehicle speed adaptively to a forward vehicle by using information regarding distance to forward vehicle, motion of the subject vehicle, and driver commands.

**Forward Collision Warning (FCW)** – an audio-visual warning that is provided automatically by the vehicle in response to the detection of a likely collision to alert the driver.

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

## 3 MEASURING EQUIPMENT

Sample and record all video data at a frequency of at least 25Hz.

### 3.1 Measurements and Variables

| | |
|---|---|
| **T** | Time |
| $\mathbf{T}_0$ | Start of test ($T_{away}$ – 4.0s or $T_{close}$ – 4.0s) |
| $\mathbf{T}_{away}$ | Time of first eye movement looking away from forward road view ahead |
| $\mathbf{T}_{gaze}$ | Time of glance first landing on gaze location |
| $\mathbf{T}_{close}$ | Time of first continuous eyes closed (no eye visible) |
| $\mathbf{T}_{warn}$ | Time of first instance of audio/visual warning |
| $\mathbf{T}_{FCW}$ | Time where FCW activates with attentive driver |
| $\mathbf{T}_{FCW\_inatt}$ | Time where FCW activates with inattentive driver |
| $\mathbf{T}_{LDW}$ | Time where LDW activates with attentive driver |
| $\mathbf{T}_{LDW\_inatt}$ | Time where LDW activates with inattentive driver |

### 3.2 Measuring Equipment

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

- VUT speed to 0.1km/h
- Driver gaze location
- In-vehicle warning(s)

# 4 TEST CONDITIONS

## 4.1 Test Track

Conduct tests on a uniform, solid-paved surface.

The presence of lane markings is allowed for DSM testing. The lane for the VUT and GVT will have a width of 3.5 to 3.7m. The lane markings on these lanes need to conform to one of the lane markings as defined in UNECE Regulation 130.

## 4.2 Weather Conditions

For DSM testing, 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 GVT disturbance in tests where applicable.

Natural ambient illumination must be homogenous 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.

## 4.3 Vehicle Preparation

Fit the on-board test equipment and instrumentation in the vehicle to observe the driver application of the test scenario and the relative timing of the DSM response. Also fit any associated cables, cabling boxes and power sources.

# 5 TEST PROCEDURE

## 5.1 VUT Pre-test Conditioning

A new car is used as delivered to the test laboratory.

If requested by the vehicle manufacturer, drive a maximum of 100km on a mixture of urban and rural roads with other traffic and roadside furniture to ‘calibrate’ the sensor system for the collision avoidance technology (FCW and LDW). Avoid harsh acceleration and braking.

Where assessing FCW and/or LDW optimisation, perform a maximum of ten runs at the lowest speed the systems are supposed to work, to ensure proper functioning of the systems ahead of investigating timing optimisation with driver inattention.

## 5.2 Test Scenarios

The performance of the system is assessed in different scenarios. For distraction the scenarios are considered in the following sections.

### 5.2.1 Distraction

Where applicable, Owl (head movement), Lizard (eye movement) and body lean

looking behaviours are used to assess detection of driver distraction in three main areas – long distraction, short distraction (VATS) and phone use.

5.2.1.1 Long Distraction

A long distraction is considered a single long duration driver gaze away from the forward road to one consistent location of ≥ 3 seconds.

5.2.1.2 Short Distraction (VATS)

A short distraction (or visual attention time sharing) event is considered to be repeated glances away from the forward road view either repeated towards one location, or to multiple different locations. A short distraction event is a build-up of multiple glances away from the forward road view and is considered to end when the driver's attention returns to the forward road view for a period long enough for the driver to fully interpret the road situation.

5.2.1.3 Phone Use

Phone use is considered to be a specific type of short distraction (or visual attention time sharing) event where the driver's repeated gaze is towards their mobile phone.

For fatigue the scenarios are considered in these sections:

5.2.2 **Fatigue**

Fatigue is a typical behaviour that builds up over time. Euro NCAP rewards detection of and response to different stages of fatigue: Drowsiness, Microsleep, and Sleep.

5.2.2.1 Drowsiness

State of the driver where tiredness has an adverse effect of the driver's ability to focus on the driving task.

5.2.2.2 Microsleep

A common symptom of a microsleep is an eye closure of < 3s although Euro NCAP recognises that non-eye closure microsleep events are possible.

5.2.2.3 Sleep

A driver is considered to be asleep in this assessment when displaying a continued eye closure >3 seconds.

For unresponsive driver the scenario is considered in this section:

5.2.2.4 **Unresponsive Driver**

Where a driver becomes unresponsive during driving, likely due to a sudden onset of sickness. It is likely, but not certain, that initially an unresponsive driver will be determined as either distracted or asleep.

## 5.3 Test Conduct

The test driver shall have attributes in the required range of the variables specified in section 3.5.2.1 of the Safety Assist Safe Driving test protocol.

Adjust seating position and driving controls to a comfortable position for the driver to safely drive the vehicle and allow the DSM a clear view of the driver's face.

Before initiating testing, drive the vehicle for at least 1 minute fully attentive at a speed of ≥10km/h to allow the DSM time to identify the driver and enable the system. In case a fault is reported, make adjustments and repeat the process to enable the system.

Check that the system is default ON at the start of every journey and that deactivation of the system should not be possible with a momentary single push of a button. The test driver should record the actions required to deactivate the DSM system.

If the vehicle has a driver attentiveness status system, ensure the system registers a fully attentive driver before initiating each test.

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 1500 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 DSM system in the VUT.

## 5.4 Test Execution

Drive the test vehicle in a straight line at a speed in the range of 20 to 80km/h.

Between $T_0$ and $T_{away}$ the driver must be fully attentive with eyes on the forward road view.

### 5.4.1 Distraction

5.4.1.1 Owl long distraction – The driver should maintain consistent body posture (not relaxing or elevating), with head turning directly to the gaze location at a natural rate of movement. Maintain gaze at the location for up to a maximum of 5 seconds. Return gaze directly to the forward road view after the warning is issued.

5.4.1.2 Owl short distraction – The driver should maintain consistent body posture (not relaxing or elevating), with head turning to gaze location and back to the forward road at a natural rate of movement and for a cumulative 10 seconds within a 30 second time period where the time period is reset if the driver's glance returns to the forward road view for a period of ≥ 2 seconds. Alternatively, the laboratory should confirm the other intervention described by the OEM in the dossier.

5.4.1.3 Owl phone use – The driver should maintain consistent body posture (not relaxing or elevating), with head turning to gaze location and back to the forward road at a natural rate of movement and for a cumulative 10 seconds within a 30 second time period where the time period is reset if the driver's glance returns to the forward road view for a period of ≥ 2 seconds. Alternatively, the laboratory should confirm the other

intervention described by the OEM in the dossier.

5.4.1.4 A maximum time of 0.48 seconds (12 frames @ 25Hz) is permitted to perform the owl gaze transition.

5.4.1.5 Lizard long distraction – The driver should maintain consistent body posture (not relaxing or elevating) and head position, with eyes moving to gaze location at a natural rate of movement. Maintain gaze at the location for up to a maximum of 5 seconds. Return gaze directly to the forward road view after the warning is issued.

5.4.1.6 Lizard short distraction – The driver should maintain consistent body posture (not relaxing or elevating) and head position, with eyes moving to gaze location and back to the forward road at a natural rate of movement and for a cumulative 10 seconds within a 30 second time period where the time period is reset if the driver's glance returns to the forward road view for a period of ≥ 2 seconds. Alternatively, the laboratory should confirm the other intervention described by the OEM in the dossier.

5.4.1.7 Lizard phone use – The driver should maintain consistent body posture (not relaxing or elevating) and head position, with eyes moving to gaze location and back to the forward road at a natural rate of movement and for a cumulative 10 seconds within a 30 second time period where the time period is reset if the driver's glance returns to the forward road view for a period of ≥ 2 seconds. Alternatively, the laboratory should confirm the other intervention described by the OEM in the dossier.

5.4.1.8 A maximum time of 0.16 seconds (4 frames @ 25Hz) is permitted to perform the lizard gaze transition.

5.4.1.9 Body lean rear passenger – movement should be carried out as if shifting visual attention away from the road and forward-facing position to view over their shoulder to focus on opposite side rear head restraint.

5.4.1.10 Keeping both hands on the steering wheel, the driver should rotate upper body posture with head turning in owl-like movement to view opposite side rear head restraint at a natural rate of movement. Maintain gaze at the location for up to a maximum of 5 seconds. Return gaze directly to the forward road view after the warning is issued.

5.4.1.11 Body lean passenger footwell – movement should be carried out as if shifting visual attention away from the road and forward-facing position to reach down to the passenger footwell.

5.4.1.12 Keeping their driver-side hand on the steering wheel, the driver should lean upper body posture with head turning in owl-like movement and reach down towards the centre of the passenger footwell with their passenger side arm at a natural rate of movement. Maintain gaze at the location for up to a maximum of 5 seconds. Return gaze directly to the forward road view after the warning is issued.

5.4.1.13 A maximum time of 1.0 second (25 frames @ 25Hz) is permitted to perform the body lean transition.

### 5.4.2 **Fatigue**

#### 5.4.2.1 Drowsiness

For the drowsiness scenario the vehicle manufacturer must supply a dossier detailing how their vehicle responds. Euro NCAP reserve the right to practically investigate the DSM system performance to verify the information in the dossier.

#### 5.4.2.2 Microsleep

The driver should maintain consistent body posture (not relaxing or elevating) and head position, with eyes closed for a maximum of 4 seconds. Return gaze directly to the forward road view after the warning is issued.

**or**

Using an alternative driver microsleep test method as illustrated by the OEM in the dossier, and considered acceptable and practicable by Euro NCAP.

#### 5.4.2.3 Sleep

The driver should maintain consistent body posture (not relaxing or elevating) and head position, with eyes closed for a maximum of 7 seconds. Return gaze directly to the forward road view after the warning is issued.

**or**

Using an alternative driver sleep test method as illustrated by the OEM in the dossier, and considered acceptable and practicable by Euro NCAP.

### 5.4.3 **Unresponsive Driver**

#### 5.4.3.1 Sleep Option

The driver should maintain consistent body posture (not relaxing or elevating) and head nodding forwards, with eyes closed for a minimum of 6 seconds to initiate the minimum risk manoeuvre.

**or**

Using an alternative sleep-like unresponsive driver test method as illustrated by the OEM in the dossier, and considered acceptable and practicable by Euro NCAP.

#### 5.4.3.2 Distraction Option

The driver should maintain consistent body posture (not relaxing or elevating), with head turning to driver lap gaze location at a natural rate of movement and hold gaze in the location for a minimum of 6 seconds to initiate the minimum risk manoeuvre.

**or**

Using an alternative distraction-like unresponsive driver test method as illustrated by the OEM in the dossier, and considered acceptable and practicable by Euro NCAP.

5.4.4 **Hand on Steering Wheel Test**

The driver should obstruct the view of an instrument cluster mounted DSM system from identifying the driver by placing their hand and gripping the upper portion of the steering wheel and hold the position for at least 10 seconds.

5.4.5 **FCW Timing**

To assess for an advanced FCW timing according to driver state, perform testing to investigate in the baseline attentive state, and the distracted and fatigued states.

Test in accordance with the AEB test protocol in the CCRs 100% overlap scenario 50km/h test.

Determine the FCW timing for 3 runs under each of the attentive, distracted, and fatigued driver states where tested as per the Collision Avoidance assessment protocol.

5.4.5.1 **Baseline Attentive Tests**

The driver should be fully attentive to the forward-facing road on the approach to the GVT and not display any signs of distraction, fatigue, or unresponsiveness.

5.4.5.2 **Distraction**

Using a test case which was previously assessed as functional, the driver should perform distraction scenario(s) using an owl and/or a lizard glance to confirm system functionality.

Long Distraction – On the approach to the stationary GVT, the driver should look at gaze location at TTC = 4 seconds.

5.4.5.3 **Fatigue**

Using a test case which was previously assessed as functional, the driver should perform fatigue scenario(s) using microsleep and/or sleep behaviour to confirm system functionality.

5.4.5.4 Microsleep – On the approach to the stationary GVT, the driver should maintain consistent body posture (not relaxing or elevating) and head position, with eyes closed @ TTC = $T_{FCW}$ + 3 seconds + 1 second

**or**

Using an alternative driver microsleep test method as illustrated by the OEM in the dossier, and considered acceptable and practicable by Euro NCAP.

5.4.5.5 Sleep – On the approach to the stationary GVT, the driver should maintain consistent

body posture (not relaxing or elevating) and head position, with eyes closed for 6 seconds @ TTC = $T_{FCW}$ + 6 seconds + 1 second.

**or**

Using an alternative driver sleep test method as illustrated by the OEM in the dossier, and considered acceptable and practicable by Euro NCAP.

### 5.4.6 LDW Timing

To assess for an advanced LDW timing according to driver state, perform testing to investigate in the baseline attentive state and the fatigued states.

Test in accordance with the LSS test protocol in the single dashed or solid line scenario with a lateral velocity in the range of 0.6 to 1.0m/s. Alternatively, this testing can be carried out entering an s-bend. It is permitted for this test to be manually driven.

Determine the LDW timing for 3 runs under each of the attentive and fatigued driver states where tested as per the LSS test protocol.

#### 5.4.6.1 Baseline Attentive Tests

The driver should be fully attentive to the forward-facing road on the approach to the LDW test and not display any signs of distraction, fatigue, or unresponsiveness.

#### 5.4.6.2 Fatigued

Using a test case which was previously assessed as functional, the driver should perform fatigue scenario(s) using microsleep and/or sleep behaviour to confirm system functionality.

5.4.6.3 Microsleep – On the approach to the LDW test, the driver should maintain consistent body posture (not relaxing or elevating) and head position, with eyes closed @ TTC = $T_{LDW}$ + 3 seconds + 1 second

or

Using an alternative driver microsleep test method as illustrated by the OEM in the dossier, and considered acceptable and practicable by Euro NCAP.

5.4.6.4 Sleep – On the approach to the LDW test, the driver should maintain consistent body posture (not relaxing or elevating) and head position, with eyes closed for 6 seconds @ TTC = $T_{LDW}$ + 6 seconds + 1 second.

or

Using an alternative driver sleep test method as illustrated by the OEM in the dossier, and considered acceptable and practicable by Euro NCAP.

### 5.4.7 Spot Testing

The Euro NCAP Secretariat will review the DSM dossier provided by the OEM and will ask the test laboratory to spot check a number of Distraction, Fatigue and Unresponsive Driver situations before awarding the points.

Spot checks carried out for the distraction type, distraction scenario, and movement type where system performance is claimed in the OEM dossier.

Based on DSM dossier provided by the OEM, driver selects:

#### 5.4.7.1 Distraction

- Long Distraction – driver performs all movement types claimed to function in each long distraction scenario, randomly selecting half of the gaze locations for spot testing.
- For each distraction scenario and movement type, use dissimilar gaze locations where possible to broaden the assessment.

| Distraction Type | Distraction Scenario | Movement Type | Gaze Location |
|---|---|---|---|
| Long Distraction | Away from forward road / non-driving task | Owl | Driver side window<br>Passenger side window<br>Passenger footwell<br>Passenger face<br>In-vehicle infotainment system |
| | | Lizard | In-vehicle infotainment system<br>Glovebox |
| | | Body Lean | Passenger footwell<br>Rear passenger |
| | Driving Task | Owl | Rear view mirror<br>Passenger side mirror<br>Driver side mirror |
| | | Lizard | Instrument Cluster<br>Driver side mirror<br>Rear view mirror |

#### 5.4.7.2 Occlusions – Long Distraction

Occlusions for owl and lizard only.

Using 3 test cases which were previously assessed as functional, the driver should repeat the testing with a different occlusion for each case.

Based on DSM dossier provided by the OEM, driver selects:

- Short Distraction - driver performs all movement types claimed to function in each short distraction scenario, spot testing half of the gaze locations.
- For each distraction scenario and movement type, use dissimilar gaze locations where possible to broaden the assessment.

| Distraction Type | Distraction Scenario | Movement Type | Gaze Location |
|---|---|---|---|
| Short Distraction (VATS) | Away from forward road / non-driving task | Owl | In-vehicle infotainment system<br>Passenger side window<br>Passenger footwell |
| | | Lizard | Driver side window<br>In-vehicle infotainment system<br>Passenger footwell |
| | Driving Task | Owl | Rear view mirror<br>Passenger side mirror<br>Driver side mirror |
| | | Lizard | Instrument Cluster<br>Driver side mirror<br>Rear view mirror |
| | Away from road (multi-location) | Lizard | Any combination of non-driving task locations |

### 5.4.7.3 Occlusions – Short Distraction

Using 3 test cases which were previously assessed as functional, the driver should repeat the testing with a different occlusion accessory for each case as referenced in Annex 1.

Based on DSM dossier provided by the OEM, driver selects:

- Phone use – driver performs all movement types claimed to function in each phone use scenario, spot testing half of the gaze locations.
- For each distraction scenario and movement type, use dissimilar gaze locations where possible to broaden the assessment.

| Distraction Type | Distraction Scenario | Movement Type | Gaze Location |
|---|---|---|---|
| Phone use | Phone Use Detection - Basic | Owl | Driver knee driver side<br>Driver knee passenger side<br>Driver lap<br>Phone mounted on dashboard driver side<br>Phone in OEM designed charge port or dedicated phone holding position |
| | | Lizard | Driver knee driver side<br>Driver knee passenger side<br>Driver lap<br>Phone mounted on dashboard driver side<br>Phone held in 9-11 o'clock region on wheel (uppermost position below windscreen view and outside of cluster view)<br>Phone held centre of steering wheel (below cluster view)<br>Phone in charge port or dedicated phone holding position within vehicle |
| | Phone Use Detection - Advanced | Lizard | Phone held in view of windscreen<br>Phone held in view of instrument cluster<br>Phone mounted in forward view of windscreen |

5.4.7.4 **Occlusions – Phone Use**

Using 3 test cases which were previously assessed as functional, the driver should repeat the testing with a randomly selected, different occlusion accessory for each case.

5.4.7.5 **Fatigue** – driver performs microsleep and sleep, resulting in 2 tests (Drowsy not to be tested).

Using the test cases which were previously assessed as functional, the driver should repeat the testing with a different occlusion accessory for each case.

5.4.7.6 **Unresponsive Driver** – driver performs 1 unresponsive driver test.

If the test case proves functional, the driver should repeat the testing with a different occlusion accessory.

# 6 Annex 1 – Occlusion Accessories

Cap – baseball cap with large, curved peak at the front, designed to provide shade over the user's eyes.

Hat – brimless cap that fits the head closely that does not cover any predominant facial feature.

Sunglasses – Shaded wayfarer style glasses with a <15% transmittance (or EN1836 category 3)


Facemask – Type 2R Certified EN14683 facemask, generally manufactured with blue cloth. To be worn covering the chin, mouth the nose, not obscuring the eyes.

# 7 Annex 2 – Gaze Locations

Images with stickers in each gaze location to show exact position.

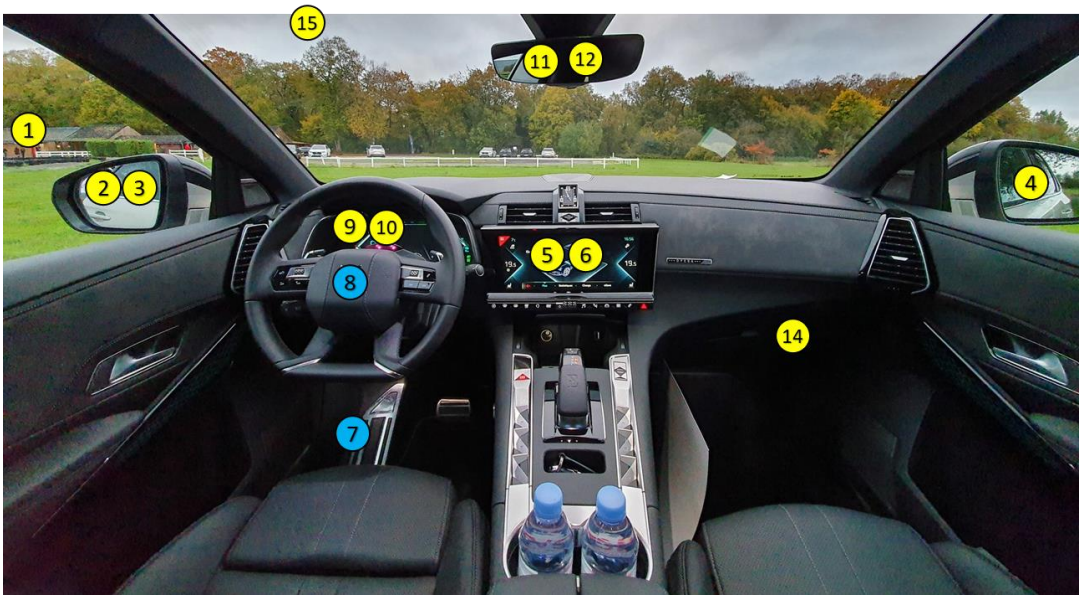



**Figure 7-1 Example of different gaze locations © UTAC , DS**