www.euroncap.com

EUROPEAN NEW CAR
ASSESSMENT PROGRAMME

Technical Bulletin

Driver Status Monitoring Dossier Guidance

Version 1.0.1

June 2023
TB 036

Title	Driver Status Monitoring – Dossier Guidance
Version	1.0.1
Document Number	TB 036
Author	Euro NCAP
Date	June 2023
Related Documents	Euro NCAP Assessment Protocol - SA Safe Driving - v10.2
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)

Table of Contents

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 Original Equipment Manufacturer (OEM) along with spot testing that is conducted by the Euro NCAP laboratories.

Euro NCAP requires the OEM to provide a dossier, that contains sufficient technical detail of all DSM assessment areas. This must be provided to the Euro NCAP Secretariat before any testing begins.

This Technical Bulletin is supplementary to the assessment protocol and provides guidance regarding the structure and content required in the dossier. The dossier must contain a full and comprehensive description of the DSM system detailing all hardware, its capabilities and justification to demonstrate that the system covers a wide variety of the driver population and is robust. Further details of how this can be achieved is detailed in the subsequent sections of this Technical Bulletin.

NOTES:

- The prerequisites for scoring in the DSM assessment are detailed in Section 3.3 of the Safe Driving protocol. The information provided by the OEM may consist of a range of formats including flowcharts, photographs, videos, plots and written descriptions of the system functionality.
- The information in this document is for guidance only and only complements the assessment protocol. If any information is missing or contradicting the information in the assessment protocol, it is the responsibility of the OEM to ensure that the information required in the assessment protocol is provided.

2. Driver Status Monitoring Dossier Guidance

The dossier must contain all of the sections detailed below and be structured in the same order. Where a system does not have a particular functionality, the related chapter must not be skipped and the reasoning behind this absence should be elaborated.

Table of contents:

Note: include references to and location of supporting documentation (pictures, videos etc)

2.1 System overview

This section is intended to summarise the main system functionalities as well as reflecting that it meets the general requirements specified in the protocol. It shall include, but is not limited to, the items detailed in
Table 2-1.

Table 2-1 Sample of the OSM system overview

[Vehicle Make] – [Model] : [System Name]	
System Features & Functionality	Result
Default ON at the start of every journey	☐Yes ☐No
Fitted as standard equipment	☐Yes ☐No
Number of steps required to deactivate the system	
Monitoring type	☐Direct ☐Indirect
Operational speed range (Direct monitoring systems) [km/h]	
Operational speed range (Indirect monitoring systems) [km/h]	
Fatigue Detection	☐Yes ☐No
Distraction Detection	☐Yes ☐No
Unresponsive Driver	☐Yes ☐No
Sudden Sickness detection (For information)	☐Yes ☐No
Driver Under Influence detection (For information)	☐Yes ☐No
Cognitive Distraction detection (For information)	☐Yes ☐No

To be included:

- Schematics, pictures, videos, etc. to detail the type of sensor(s) involved in the system, their location in the vehicle, their function/role, and all their relevant specifications (e.g. camera Field of View). Furthermore, if applicable, provide a list of the constituent elements of indirect monitoring (e.g. steering input, vehicle dynamics), and indicate in detail how their data feed complement/contribute to the overall system performance.
- For direct monitoring systems, specify in a drawing all the delimited areas/regions in the vehicle interior (from the driver's perspective) at least for each of the gaze locations specified in the protocol, and if applicable, additional areas/regions which the system takes into account to assess driver distraction.
- Details regarding the warning(s) to indicate the constituent components, i.e. audible, visual and haptic components along with their location and duration.

2.2 Predicted DSM score

The OEM shall reflect a predicted score for the DSM based on system performance across the different test cases, as reflected in Table 2-2.

Table 2-2 Predicted DSM score

		Distraction Scenario	Movement Type	Predicted score			
				Warning	Intervention	Sub Total	Total
Distraction	Long Distraction	Away from road / non driving task	Owl				
			Lizard				
			Body Lean				
		Driving task	Owl				
			Lizard				
	Short Distraction (VATS)	Away from road / non driving task	Owl				
			Lizard				
		Driving task	Owl				
			Lizard				
		Away from road (multi-location)	Lizard				
	Phone Use	Phone Use Detection - Basic	Owl + Lizard				
		Phone Use Detection - Advanced	Lizard				
Fatigue	Drowsiness						
	Microsleep						
	Sleep						
Unresponsive Driver							
Total							

2.3 Noise variables

This chapter shall provide a quick overview of the system capabilities with regard to Noise Variables requirements, whereas further detail is given in the following subchapters. Table 2-3 Summary of noise variables specified in the protocol and it serves as a guidance to check that they have been addressed in the dossier.

Table 2-3 Summary of noise variables (checklist) – For direct monitoring systems only

Category	Noise variable	Addressed in dossier (Checklist)	System Requirement
Driver	Age	☑	Must
	Sex	☑	
	Stature	☑	
	Skin complexion	☑	
	Eye lid aperture	☑	
Occlusion	Lighting	☑	
	Eyewear	☑	
	Facial Hair (short)	☑	
	Hand on Wheel	☑	Inform driver if degraded
	Facial occlusion	☑	
	Eyewear	☑	
	Eyelash Makeup	☑	
	Facial Hair (long)	☑	
Driver behaviours	Eating	☑	Information only: *(indicate system performance degradation for each of the behaviour variables)*
	Talking	☑	
	Laughing	☑	
	Singing	☑	
	Smoking & vaping	☑	
	Eye scratching & rubbing	☑	
	Sneezing	☑	

To be included:
A matrix which for all noise variables listed in Table 2-3 (as well as the addressed noise variable combinations) reflects at a glance:

- The system capabilities/performance (e.g. true positive ratio and false positive ratio)
- Quick statement of system reaction when impaired (totally or partially)

2.3.1 Driver

The dossier shall include evidence that the system is capable of monitoring a driver population that falls within the required ranges of all the variables reflected in Table 2-4.

Table 2-4 Driver noise variables

DRIVER Noise variables	
VARIABLE	**REQUIRED RANGE**
Age	Youth (16-18) – aged (≥80)
Sex	All
Stature	Adult Female 5th%-ile – Adult Male 95th%-ile
Skin complexion	Fitzpatrick Skin Type (1 - 6)
Eyelid aperture	From 6.0mm up to 14.0mm
Requirement: Must	

To be included:
Evidence demonstrating the system performance against a dataset which includes the range of population variables in Table 2-4 (using real human-beings with the required physical properties).

2.3.2 Occlusion

2.3.2.1 Prerequisite

The dossier shall include evidence showing that the DSM system performance is not degraded when put under the variables and ranges summarised in Table 2-5 . Note that it is not required to demonstrate all occlusion variable combinations.

Table 2-5 Occlusion elements and ranges (Prerequisite)

OCCLUSION Noise variables (Prerequisite)	
VARIABLE	**REQUIRED RANGE**
Lighting	Daytime – night-time (lux levels specified in the protocol)
Eyewear	Clear glasses and sunglasses (transmittance specified in the protocol)
Facial hair	Short facial hair (length specified in the protocol)
Requirement: Must	

To be included:
Evidence demonstrating the system performance against a dataset which includes all the required variables in Table 2-5, with a reasonable sampling of combinations, but with no need to report against each variable separately. This is to be reported with a standard test subject and with 2 or more subjects near the extremes of the values reflected in Table 2-4. See reporting options on 2.7 KPI Reporting.

2.3.2.2 Inform if degraded

The dossier must provide evidence reflecting the system performance (and eventually, system reaction upon impairment) when facing the 'Inform if degraded' elements and ranges listed in Table 2-6. Note that it is not required to demonstrate all occlusion variable combinations.

The "Inform if degraded" assessment shall be made during normal driving (i.e. not during a distraction or fatigue sequence). It is allowed to use synthetic data acquired with driving simulator, providing this data is representative and high quality.

Table 2-6 Occlusion elements and ranges (Inform if degraded)

OCCLUSION Noise variables (Inform if degraded)	
VARIABLE	**REQUIRED RANGE**
Hand on wheel	One hand on wheel at 12 o'clock position
Facial occlusion	Face-mask, hats, long head hair fringe obscuring eyes
Eyewear	Sunglasses with a <15% transmittance
Eyelash makeup	Thick eyelash make-up
Facial hair	Long facial hair (>150mm in length)
Requirement: Inform if degraded	

To be included:
Evidence demonstrating the system performance against a dataset which includes all the required variables in Table 2-6, with a reasonable sampling of combinations, but with no need to report against each variable separately. This is to be reported with a standard test subject and with 2 or more subjects near the extremes of the values reflected in Table 2-4. See reporting options on 2.7 KPI Reporting.

Infographics (e.g. schematics, videos…) illustrating the warning/information type, with supporting evidence that these are issued no later than the required time after the system is impaired.

Details, with justification, as to why a particular situation (combination of noise variables) leads to performance degradation (total or partial).

Similarly, where a system is able to perform under conditions beyond the required noise variables identified by Euro NCAP, the OEM is encouraged to include details of where this is the case and illustrate the system capabilities.

2.3.3 Driver Behaviours monitoring

The dossier shall describe if and how the DSM system performance is affected by the driver behaviours shown in
Table 2-7.
This is for monitoring purposes only, hence there are no performance requirements.

Table 2-7 Driver behaviour elements

Driver Behaviours
Eating
Talking
Laughing
Singing
Smoking / vaping
Eye scratching / rubbing
Sneezing
Requirement: Monitoring (No performance requirement)

To be included

- List of driver behaviours that affect the system performance (including but not limited to all the elements reflected in Table 2-7).
- Evidence demonstrating performance degradation of the system when put against the listed driver behaviours. This is to be reported with a standard test subject as a minimum (optionally with 2 or more subjects near the extremes of the values reflected in Table 2-4). See reporting options on 2.7 KPI Reporting.

2.4 Detection of driver status

The driver status may fall into ‘distracted’, ‘fatigued’, and ‘unresponsive’ minimum categories (Table 2-8). If alternative or additional inputs are deemed necessary for the system to classify the driver status, the dossier shall include a section describing such inputs and justifying the safety benefits.

Table 2-8 Detection of driver status

Distraction	Fatigue	Unresponsive driver
Long Distraction	Drowsiness	e.g. Sudden Sickness
Short Distraction (VATS)	Microsleep	
Phone Usage	Sleep	

2.4.1 Distraction

The dossier shall include evidence that the system is able to classify a driver as ‘distracted’, as well as how the system differentiates such distraction (Long Distraction / Short Distraction), in each of the scenario, movement type and gaze location combination shown in the protocol.

Table 2-9 Distraction scenarios (summary)

Driver Status	Scenario	Movement	Gaze locations
Long Distraction	Away from forward road, non-driving task	Owl Lizard Body Lean	Various
	Driving task		
Short Multiple Distraction (VATS)	Away from forward road (one location)		
	Driving task		
	Away from road (multiple locations)		
Phone Usage	Basic Phone Detection		
	Advanced Phone Detection		

To be included:

- Video showing driver classification & system status in all the driver distraction elements listed in Table 2-9, ideally reflecting live system parameters (Figure 2-1)
- Minimum operational requirements above which the system is able to classify a driver as distracted (as per the elements listed in Table 2-9).
- Detail and justification of any alternative system input(s) / strategies other than gaze location to assess distraction, if applicable (e.g. combination with steering input).
- Description of OEM-specific identification of the timing the distraction is being counted from.

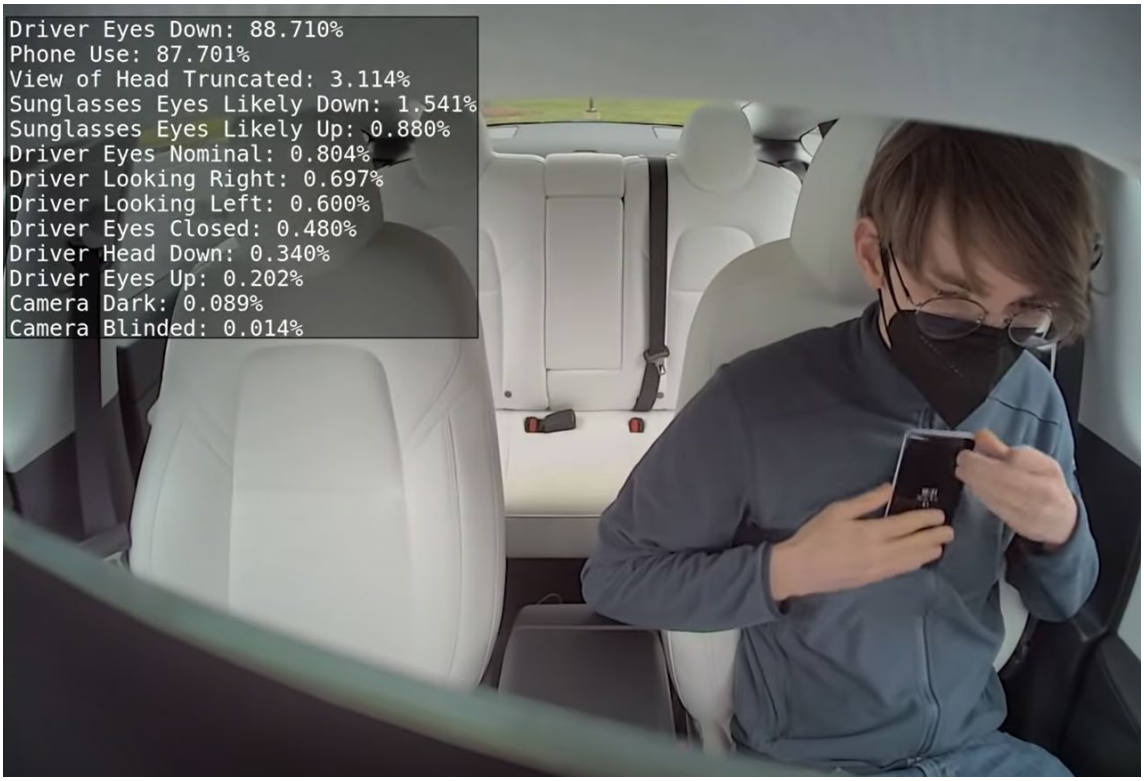

Figure 2-1 Live system parameters embedded in video (Source: YouTube – Tesla)

2.4.2 Fatigue

The dossier shall include evidence that the system is able to classify different stages of driver fatigue (drowsiness, microsleep, sleep) and the system requirements to achieve such classification. In the case of the OEM not being able to satisfy the driver's fatigue classification, or the approach being different / going beyond the requirements (specified in the protocol), the dossier shall reflect a description and justification for such lack of performance or alternative approach.

Table 2-10 Fatigue status

Driver status	Requirements
Drowsiness	Driver reaches ~~(at least)~~ KSS level >7
Microsleep	Eye closure duration <3s seconds
	Slowed reflexes, frequent nodding (or other behaviours declared by the manufacturer to correlate to microsleep)
Sleep	Eye closure >3 seconds

To be included:

- Video showing driver classification & system status in all required driver fatigue status (Drowsiness, Microsleep, Sleep), ideally reflecting live system parameters (Figure 2-1).
- Minimum system requirements to achieve driver fatigue status classification.
- Detail and justification of any alternative system input(s) / strategies other than the ones indicated (e.g. KSS scale for Drowsiness, eye closure for Microsleep…), if applicable.

2.4.3 Unresponsive driver

The dossier shall include evidence that the system is able to classify the driver under 'Sudden Sickness' and the minimum system requirements to achieve such classification. If the OEM uses more advanced systems using different/ additional inputs to determine the driver is unresponsive (as specified in the protocol), these should be detailed in the dossier.

Table 2-11 Unresponsive driver conditions

Driver Status	Requirements
Unresponsive Driver	Driver who either does not return their gaze to the forward road view within the required time after the inattention warning being issued, **or**
	Driver whose gaze has been away from the forward road view, or eyes has been closed for more than the required time.

To be included:

- Video showing driver classification & system status in the indicated scenarios described in Table 2-15, ideally reflecting live system parameters (Figure 2-1).
- Minimum system requirements to achieve unresponsive driver status classification.
- Detail and justification of any alternative system input(s) / strategies other than the ones indicated, if applicable.

2.5 Vehicle response requirements

The dossier shall describe with detail the vehicle response (warnings / system intervention) for each of the inattention categories specified in the protocol (Table 2-12), providing for each of them additional supporting information in the form of pictures, schematics, videos, etc. Further details on how to approach high sensitivity FCW and/or LDW (if chosen as a system intervention strategy) are specified in the protocol.

Table 2-12 Inattention categories for which vehicle response is required

Distraction	Fatigue	Unresponsive driver
Long Distraction	Drowsiness	Sudden Sickness (Example)
Short Distraction (VATS)	Microsleep	
Phone Usage	Sleep	

2.5.1 Distraction

Table 2-13 Vehicle response requirements - Distraction

Driver Status	Warning Requirements	Intervention Requirements
Long Distraction	Immediate visual + (haptic or audible) warning issued when: - Vehicle speed 20km/h **and** - Driver is classified as distracted (either for long distraction, VATS or phone usage)	- High sensitivity FCW setting, activated ≤1 second of continuous gaze away from forward road view **or** - Low level braking intervention, beginning immediately after the driver is classified as distracted **or** - Any other intervention that the OEM considers to be appropriate.
Short Multiple Distraction (VATS)		
Phone Usage		

To be included:

- Description and infographics (e.g. schematics, pictures…) illustrating the intervention approach used.
- Video showing driver, system status and system response for each of the distraction scenarios, evidencing that the system intervenes at the right time.
- If a different approach other than the ones indicated is used, details on the alternative approach and the evidence of the safety benefits of its implementation shall be included.

2.5.2 Fatigue

Table 2-14 Vehicle response requirements - Fatigue

Driver status	Warning Requirements	Intervention Requirements
Drowsiness	Immediate visual + (haptic or audible)	- High sensitivity FCW **and** LDW setting, to be activated immediately after driver is classified as drowsy **or** - Any other intervention that the OEM considers to be appropriate.
Microsleep		
Sleep		

To be included:

- Description and infographics (e.g. schematics, pictures…) illustrating the intervention approach used.
- Video showing driver, system status and system response for each of the fatigue scenarios, evidencing the appropriate system intervention.
  If a different approach other than the ones indicated is used, details on the alternative approach and the justification behind it shall be included.

2.5.3 Unresponsive driver

Table 2-15 Vehicle response – Unresponsive driver

Driver status	Intervention Requirements
Unresponsive Driver	A minimum risk manoeuvre, meeting the requirements of UNECE R79 risk mitigation function, should be initiated, where the distinct warning phase begins <1 second after a driver is classified as unresponsive.

To be included:

- Description and infographics (e.g. schematics, pictures…) illustrating the details of the minimum risk manoeuvre.
- Video showing driver, system status and system response, evidencing that the system initiates the minimum risk manoeuvre at the right time.
- If a different approach other than the minimum risk manoeuvre as described in UN R79 is used, details on the alternative approach and the justification behind it shall be included.

Note: include references to and location of supporting documentation (pictures, videos etc)

2.6 Validation method / test campaign

This section shall describe the approach and process followed by the OEM in validating the system performance. This section will help illustrate the degree of effort which was put into validating the system performance, and whether the system was aimed to accomplish minimum protocol requirements, or intended to go beyond them.

To be included (but not limited to):

Preliminary study/research taken into account (e.g. accidentology, test campaigns, own fleet data…), type of validation method used (e.g. physical, simulation) and details about each method, noise variables taken into account during testing (e.g. driving conditions, lighting conditions, driver gender/ethnicity, sensor partial/total blindness…), test population sample.

2.7 KPI Reporting

2.7.1 Average and Standard Deviation True Positive Ratio

In this approach, performance for each detection requirement is provided based on testing against data which includes all the noise factors required by the protocol (I.e. OEMs provide evidence of performance in the *presence* of noise factors).

It consists of:

- Report the test case count for each detection requirement.
- Report the average and standard deviation of the true positive rate for each detection requirement, across all subjects in the dataset.
- Report the content of the dataset used to measure performance, with categories for all the demographic aspects and noise factors specified in the protocol.

To illustrate the approach, an example of 20 subjects covering the demographic requirements is given to populate the performance in each of the 43 required distraction cases (fatigue cases shall be included as well on top of distraction cases). Additionally, an example of the case count used for each distraction case in the presence of the specified noise factors is given.

2.7.1.1 Dataset demographics

The following example illustrates the used subject count for the required demographic requirements. A table with fatigue requirements shall also be provided.

Property		Subject Count	Proportion	System Requirement
Stature	0-5	1	5%	Must Support
	6-94	18	90%	Must Support
	95-100	1	5%	Must Support
Sex	Male	12	60%	Must Support
	Female	8	40%	Must Support
Age	16-18	1	5%	Must Support
	19-79	18	90%	Must Support
	80+	1	5%	Must Support
Complexion	I	6	30%	Must Support
	II	5	25%	Must Support
	III	2	10%	Must Support
	IV	4	20%	Must Support
	V	1	5%	Must Support
	VI	2	10%	Must Support
Eyelid Aperture	0-6	3	15%	Must Support
	7-11	16	80%	Must Support
	12+	1	5%	Must Support
Total		**20**	**100%**	

2.7.1.2 Dataset Noise Factors

The following example shows a small dataset satisfying noise factor requirements. There are 43 unique distraction cases considering all specified glance targets. There are 20 subjects. If each subject records every case once, there are 860 cases total.

Property		Case Count	Proportion	System Requirement
Occlusion				
Lighting	<1 Lux	43	5%	Must Support
	2-100k	774	90%	Must Support
	>100k	43	5%	Must Support
Eyewear	None	716	83%	Must Support
	Benign	129	15%	Must Support
	Blocking	15	2%	Inform If Degraded
Facial Hair	None	688	80%	Must Support
	Short (<20mm)	129	15%	Must Support
	Long (>150mm)	43	5%	Inform If Degraded
Hand Position	Blocking	39	5%	Inform If Degraded
	Non-blocking	821	95%	Must Support
Facial Occlusion	None	731	85%	Must Support
	Face Masks	43	5%	Inform If Degraded
	Hat	43	5%	Inform If Degraded
	Long Hair	43	5%	Inform If Degraded
Eye Makeup	None/Light	817	95%	Must Support
	Heavy	43	5%	Inform If Degraded
Secondary Behaviors				
Eating		43	5%	Information Only
Talking		43	5%	Information Only
Laughing		43	5%	Information Only
Singing		43	5%	Information Only
Smoking/Vaping		43	5%	Information Only
Eye Scratching		43	5%	Information Only
Sneezing		43	5%	Information Only
Total		**860**	**100%**	

2.7.1.3 Performance

The following example illustrates the number of cases tested to generate the associated TPR average and standard deviation. The example reflects only the 43 required distraction cases (it shall be further expanded with fatigue cases).

TPR = true positive rate. For noise factors rated "must support", true positive means detecting distraction. For those rated "inform if degraded" true positive means detecting distraction or correctly reporting degraded. Each subject will have a different TPR, resulting in a standard deviation and average TPR across all subjects in the dataset.

Behavior	Glance Target	Glance Behavior	Glance Target	Test Case Count	TPR Average Across Subjects (%)	TPR Standard Deviation Across Subjects (%)
Long Distraction	Non-Driving Task	Owl	Driver Side Window	100		
			Passenger Side Window			
			Passenger Footwell			
			Passenger Face			
			IVI Display			
		Lizard	IVI Display	40		
			Glovebox			
		Body Lean	Passenger Footwell	40		
			Rear Passenger			
	Driving Task	Owl	Rear Mirror	60		
			Passenger Side Mirror			
			Driver Side Mirror			
		Lizard	Instrument Cluster	60		
			Driver Side Mirror			
			Rear Mirror			
Short Distraction (VATS)	Driving Task	Owl	Rear Mirror	60		
			Passenger Side Mirror			
			Driver Side Mirror			
		Lizard	Instrument Cluster	60		
			Driver Side Mirror			
			Rear Mirror			
	Away From Road (Single Target)	Owl	IVI Display	60		
			Passenger Side Window			
			Passenger Footwell			

		Lizard	Driver Side Window	60		
			IVI Display			
			Passenger Footwell			
	Away From Road (Multiple Targets)	Lizard	Any	20		
Phone Use	Basic (Visual Distraction)	Owl	Driver Side Knee	100		
			Passenger Side Knee			
			Driver Lap			
			Driver Side Dashboard			
			OEM Charging dock			
		Lizard	Driver Side Knee	140		
			Passenger Side Knee			
			Driver Lap			
			Driver Side Dashboard			
			Upper Wheel Rim			
			Center Steering Wheel			
			OEM Charging dock			
	Advanced (Cognitive Distraction)	Lizard	Held At On Road	60		
			Held At Instrument Cluster			
			Forward view of Windscreen			

2.7.2 Standard test subject + 2 Extreme test subjects of driving population

Where required, the OEM shall evidence the performance of the DSM when put under occlusion variables, by using a KPI per used test subject (or group of test subjects):

- Standard test subject: falling within driving population range of Table 2-4
- Extreme test subject #1: extreme (upper) of driving population range Table 2-4
- Extreme test subject #2: extreme (lower) of driving population range Table 2-4