Driver Monitoring

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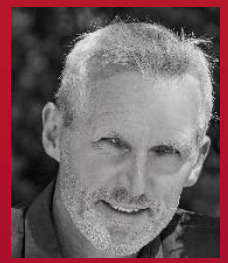

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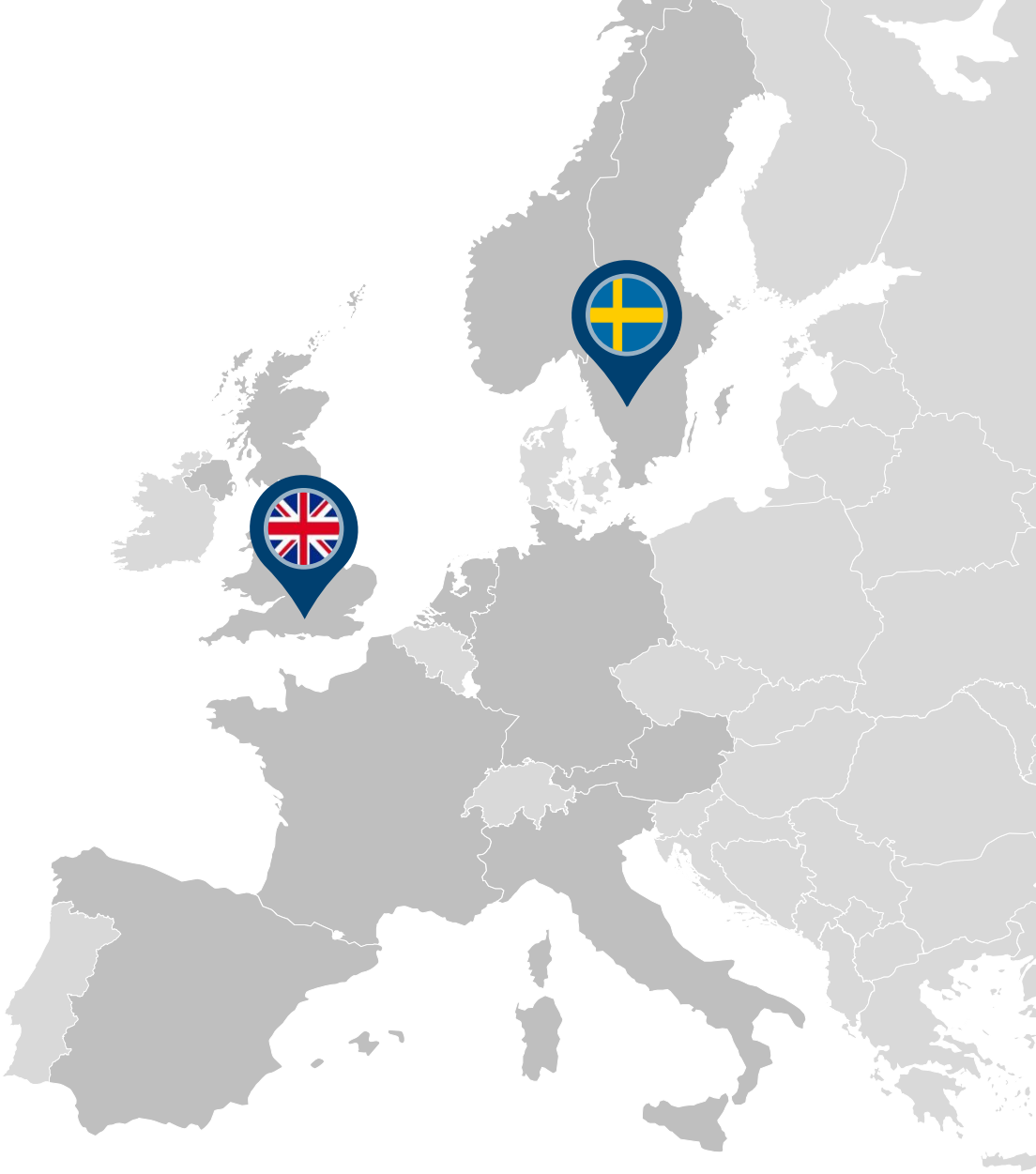
Euro NCAP
founded 1997



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Euro NCAP
partners 2023

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Euro NCAP - some highlights

- 1997 founded
- 2001 first 5 star car
- 2002 seat belt reminder
- 2003 child protection
- 2008 whiplash
- 2011 stability control (ESC) included in rating
- 2012 pedestrian in overall rating
- 2014 auto-brake (AEB) car-to-car
- 2016 AEB pedestrian
- 2018 AEB cyclist
- 2020 front crash compatibility

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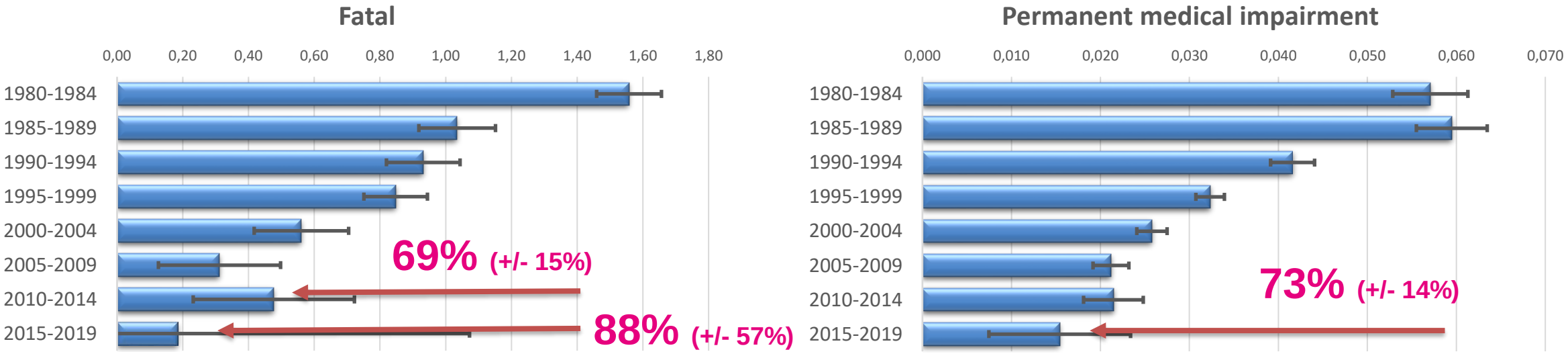
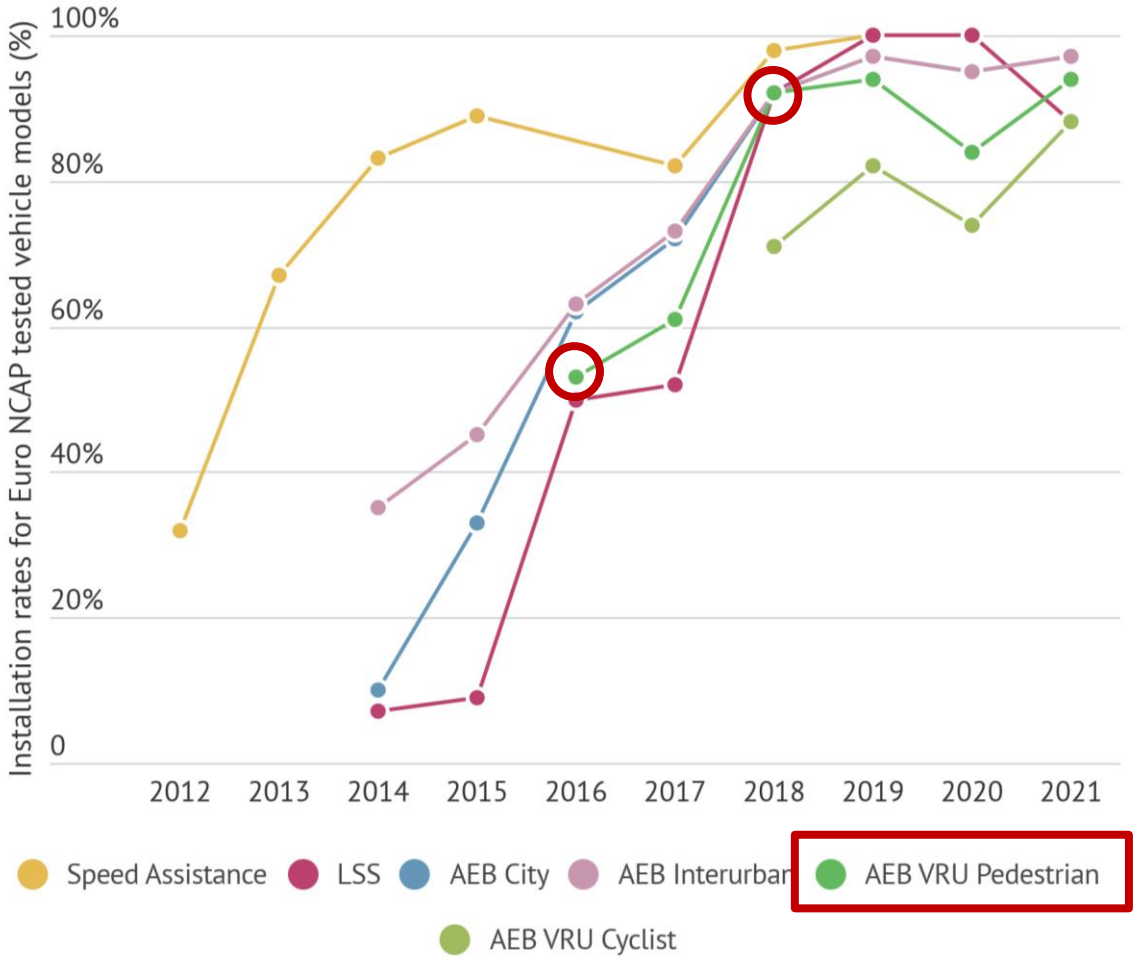
Development in crash safety



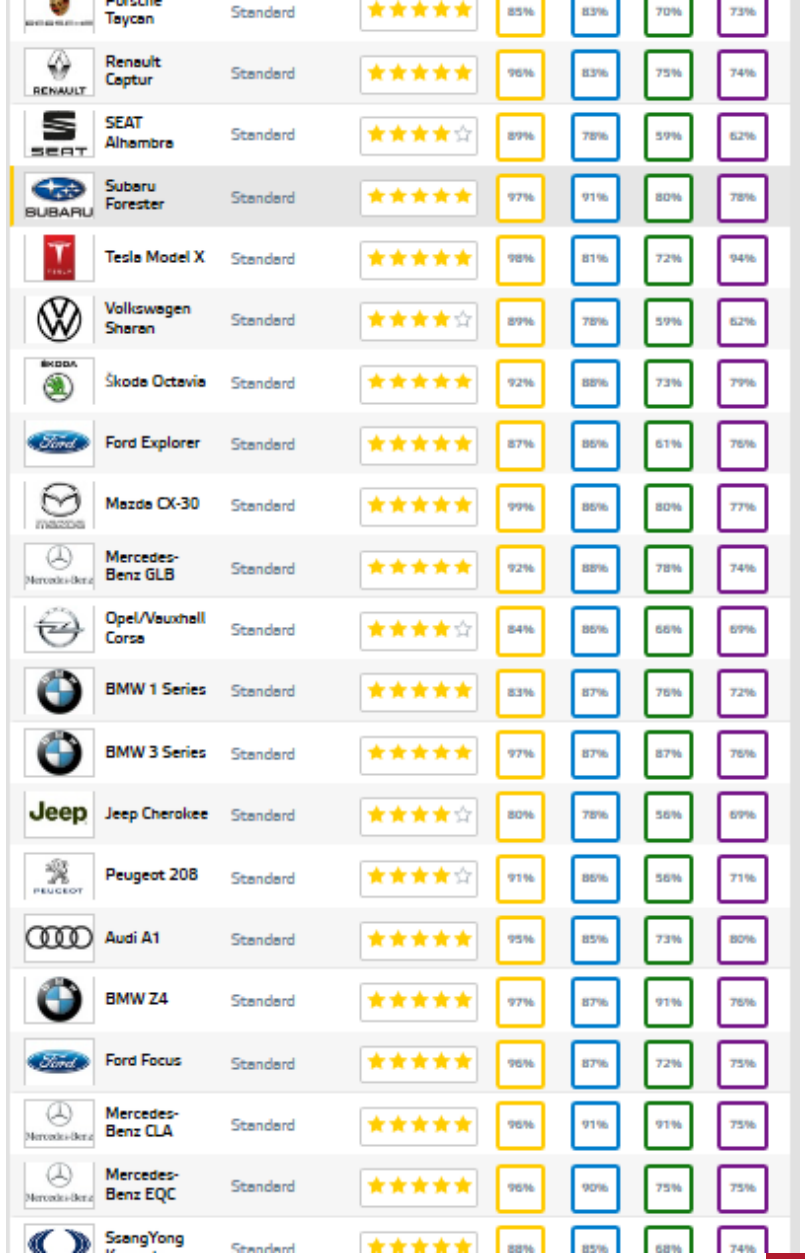
Kullgren et al 2019

System fitment Europe



Euro NCAP 2022

- 65 tested cars
  - 78% 5 stars
  - 22% 4 stars



Porsche Taycan	Standard	★★★★★	85%	83%	70%	73%
Renault Captur	Standard	★★★★★	96%	83%	75%	74%
SEAT Alhambra	Standard	★★★★☆	89%	78%	59%	62%
Subaru Forester	Standard	★★★★★	97%	91%	80%	78%
Tesla Model X	Standard	★★★★★	98%	81%	72%	94%
Volkswagen Sharan	Standard	★★★★☆	89%	78%	59%	62%
Škoda Octavia	Standard	★★★★★	92%	88%	73%	79%
Ford Explorer	Standard	★★★★★	87%	86%	61%	76%
Mazda CX-30	Standard	★★★★★	99%	86%	80%	77%
Mercedes-Benz GLB	Standard	★★★★★	92%	88%	78%	74%
Opel/Vauxhall Corsa	Standard	★★★★☆	84%	86%	66%	69%
BMW 1 Series	Standard	★★★★★	83%	87%	76%	72%
BMW 3 Series	Standard	★★★★★	97%	87%	87%	76%
Jeep Cherokee	Standard	★★★★☆	80%	78%	56%	69%
Peugeot 208	Standard	★★★★☆	91%	86%	56%	71%
Audi A1	Standard	★★★★★	95%	85%	73%	80%
BMW Z4	Standard	★★★★★	97%	87%	91%	76%
Ford Focus	Standard	★★★★★	96%	87%	72%	75%
Mercedes-Benz CLA	Standard	★★★★★	96%	91%	91%	75%
Mercedes-Benz EQC	Standard	★★★★★	96%	90%	75%	75%
SsangYong	Standard	★★★★★	88%	85%	68%	74%

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Accident data

- 29-48 % distraction
- 25 % fatigue
- 6-10% sudden sickness
- 25 % alcohol

Sundfør et al., 2019; Fitzharris et al., 2020; European Commission, 2021, Fitzharris et al., 2020; Trafikanalys, 2021. EC Mobility and Transport, Road Safety website, Avenoso A, ETSC, 2019 IRTAD, 2020

Driver attention

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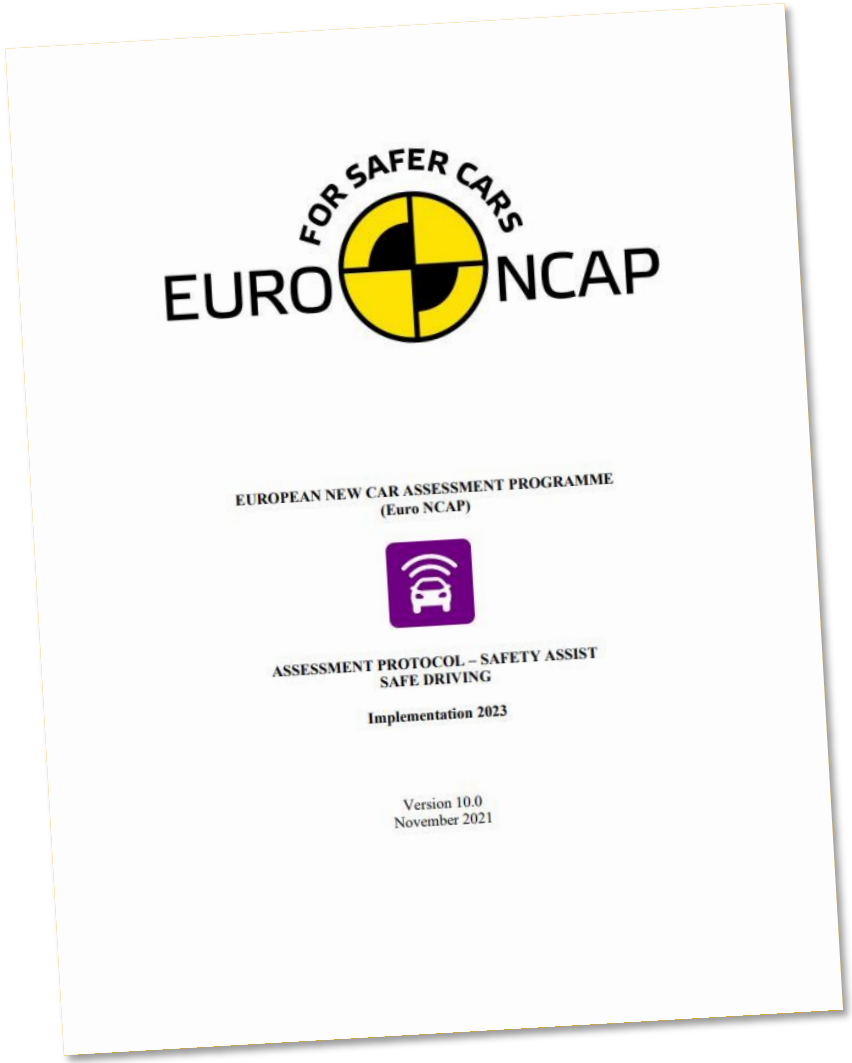
Published at
https://www.euroncap.com/en/for-engineers/protocols/safety-assist/



EUROPEAN NEW CAR ASSESSMENT PROGRAMME
(Euro NCAP)

ASSESSMENT PROTOCOL – SAFETY ASSIST
SAFE DRIVING

Implementation 2023

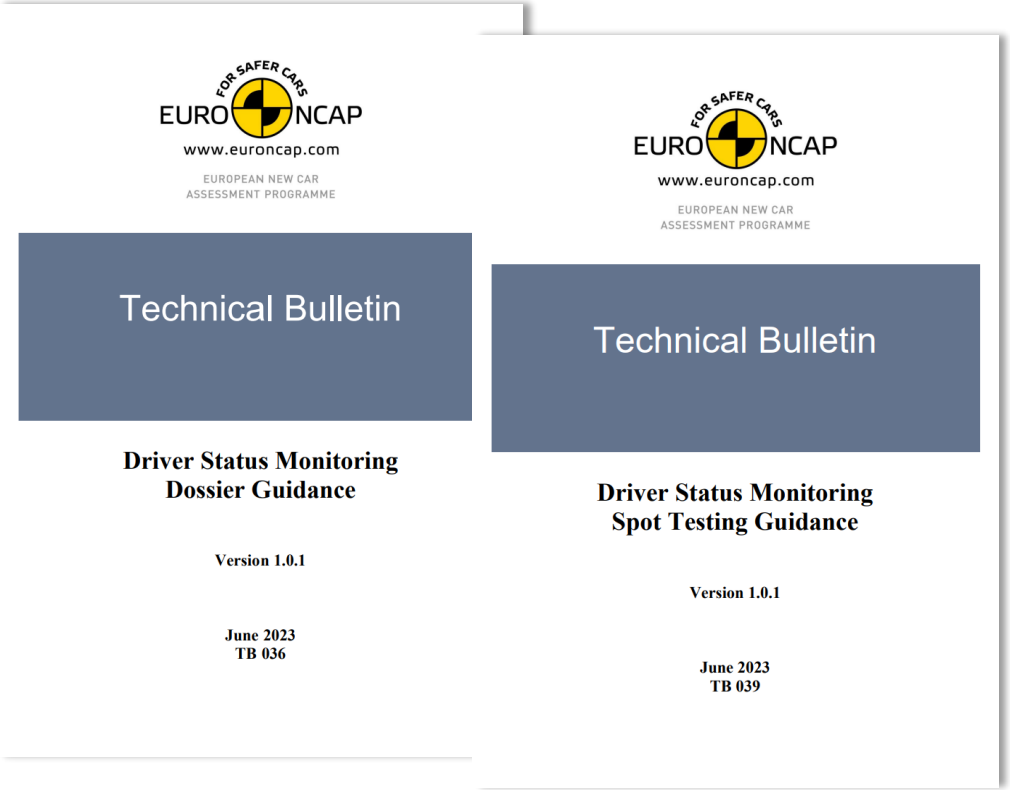
Version 10.0
November 2021

Scoring structure

		Noise Variables	Warning	Intervention
Driver Monitoring	Drowsiness	Pre-Requisite	0.4 Points	0.5 Points
	Distraction		0.5 Points	0.4 Points
	Unresponsive Driver (Sudden sickness)			0.2 Points

Dossier (and testing)

- Euro NCAP requires a dossier from the OEM containing a detailed technical assessment. The dossier should contain:
  - Sensing, evidence sensing system is capable
  - Driver state, demonstrating which elements can be identified
  - Vehicle response, detailing the vehicle response
- Euro NCAP test labs will conduct (spot) testing



System General Requirements

- Default on system
- Active 10km/h and above
- Initial learning phase (1 min) permitted at start of journey

Noise Variables – Drivers – Must

DRIVER	Required Range
Age	16 - 80
Sex	All
Stature	AF05 – AM95
Skin Complexion	Fitzpatrick type 1-6
Eye lid aperture	>6.0mm

Noise Variables – Occlusion - Must

Variable	Required Range
Lighting	Daytime – Night-time
Eyewear	Clear glasses and sunglasses with transmittance >70%
Facial Hair	Short facial hair

Noise Variables – Occlusion –
Inform if degraded

Variable	Required Range
Hands on Wheel	1 hand @12'clock position on wheel
Facial occlusion	Face mask, hats & long head hair obscuring facial features.
Eyewear	Sunglasses with transmittance <15%
Eyelash Makeup	Thick eyelashes
Facial Hair	Large beard occluding face

Noise Variables – Other Behaviours – (Monitoring)

Variable	Required Range
Secondary behaviour	Eating Talking Laughing Singing Smoking/vaping Eye scratching / rubbing Sneezing

Driver State

DISTRACTION	FATIGUE	UNRESPONSIVE DRIVER
Long Distraction	Drowsy	Unresponsive Driver
Short Distraction (multiple) (VATS)	Microsleep	
Phone Usage	Sleep	

Driver States – Distraction

Long Distraction

- A single long duration gaze away from the forward road
- ≥3s (+1 s if compelling evidence)

Short Distraction

- Cumulative 10s in 30s window, 2 s reset
- An approach deemed equivalent by Euro NCAP will be accepted

Phone Use

- Considered specific type of Short distraction.
- Divided between basic and advanced phone use detection

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Driver State – Fatigue

DRIVER	Scenario	Requirements
Drowsy	- E.g. head nodding reflex, eyelids closing slowly	Sleepiness grading (e.g. KSS>7 or equivalent)
Microsleep	- Momentary period of eye closure	Microsleep of duration <3 seconds or non-eye closure microsleep event (eyelid fluttering)
Sleep	- Eyes closed	First warning / intervention required at 3s of driver eyes closed

Driver State – Unresponsive Driver

DRIVER	Scenario	Requirements
Unresponsive Driver	- Prolonged distraction or drowsy behaviours (including sudden sickness) - Not responding to distraction or drowsiness warnings, no driver inputs	MRM escalation to begin if driver fails to respond 3 seconds after warning issued Or OEM more advanced system

Vehicle Response – DISTRACTION

DRIVER	Vehicle response requirement
Partial points awarded for warning	Warning: Vehicle travelling >20 km/h Visual + Audible/Haptic
Partial points awarded for intervention	Intervention Requirements: High Sensitivity – FCW more sensitive After glance away > 1s. or Low level braking intervention or Other interventions considered if OEM provides safety benefit

Vehicle Response – FATIGUE

DRIVER		Vehicle Response Requirement
Drowsy Microsleep Sleep	Partial points awarded for warning	<u>Warning</u> Visual + (Audible orHaptic)
	Partial points awarded for intervention	<u>Intervention</u> Requirements: High sensitivity FCW **and** LDW Until end of journey or Other interventions with OEM evidence

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Vehicle Response – UNRESPONSIVE DRIVER

DRIVER	Requirement
Unresponsive driver	Minimum Risk Maneuver (MRM) escalation to begin if driver fails • to respond 3 seconds after inattention warning issued • or eyes closed 6 s

Assessment Matrix

- Noise variables are Prerequisite for scoring points

Inattention Type		Distraction Scenario	Movement Type	Warning	Intervention	Sub Total	Total
Distraction	Long distraction	Away from road / non driving task	Owl	0.030	0.030	0.060	0.300
			Lizard	0.030	0.030	0.060	
			Body Lean	0.030	0.030	0.060	
		Driving Task	Owl	0.030	0.030	0.060	
			Lizard	0.030	0.030	0.060	
	Short Distraction (VATS)	Away from road / non driving task	Owl	0.030	0.030	0.060	0.300
			Lizard	0.030	0.030	0.060	
		Driving Task	Owl	0.030	0.030	0.060	
			Lizard	0.030	0.030	0.060	
		Away from road (multi-location)	Lizard	0.030	0.030	0.060	
	Phone Use	Basic Phone Use	Owl + Lizard	0.050	0.100	0.150	0.300
		Advanced Phone Use	Lizard	0.050	0.100	0.150	
Fatigue	Drowsy			0.250	0.100	0.350	0.350
	Microsleep			0.200	0.100	0.300	0.300
	Sleep			0.050	0.200	0.250	0.250
Unresponsive Driver					0.200	0.200	0.200
Total							2.000

Dossier (and testing)

- Euro NCAP requires a dossier from the OEM containing a detailed technical assessment. The dossier should contain:
  - Sensing, evidence sensing system is capable
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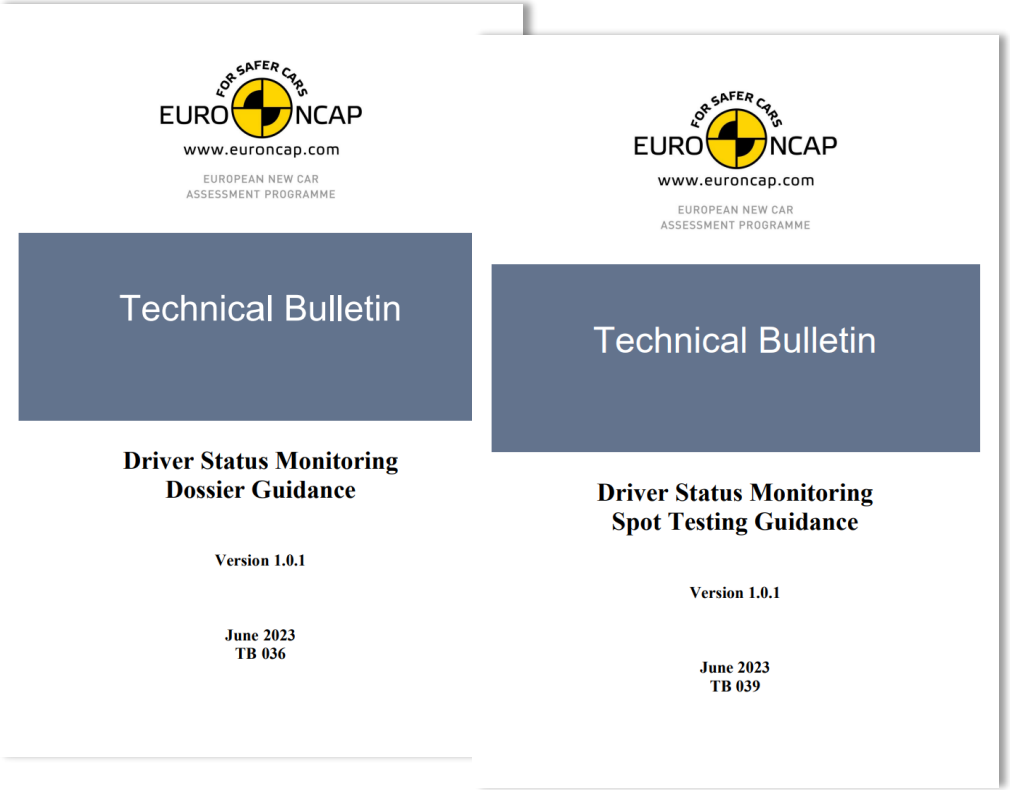
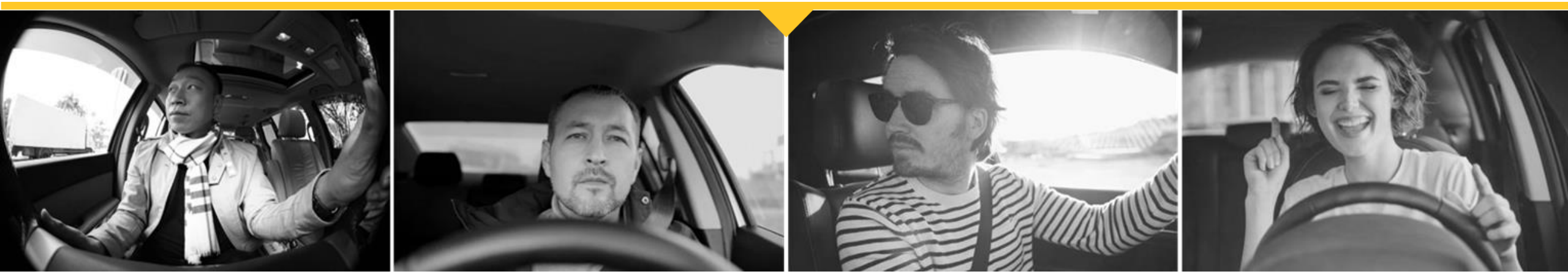
  - Vehicle response, detailing the vehicle response
- Euro NCAP test labs will conduct (spot) testing



Spot testing



2023 DSM Test campaign summary

Lineup

- 2023 Test Campaign: 18 New vehicles
  - 11 equipped with direct driver monitoring
  - 7 equipped with indirect driver monitoring only (drowsiness)
- Highlights
  - Uncommon to consider gaze locations sensitive for FP: conservative approach
  - No unresponsive driver so far

Test & Assessment

Observations & Learnings from first vehicles assessed

- Almost neglectable FCW/LDW Sensitivity change.
  - Possible future requirement, e.g., >20% change vs baseline, otherwise fail
- Distraction time & measurement of gaze away from FW roadview
  - Claimed system latency of up to 1s: Tolerances needed for acceptance criteria (e.g., T_{warn} +0.2s)
  - Long distraction (3+1s.): Additional 1s. only valid with demonstrated safety benefit.
- Non-transient states (e.g., drowsiness)
  - Reconsider the effectiveness of single pop-up warnings/reminders.
  - Vehicle response should be effective and stay active for the remainder of the journey.
  - So far very simplistic implementations to determine drowsiness carried over from DDAW,
    - Questionable real effectiveness
    - Better metric than KSS?

Next steps

- Roadmap **2025-2030**

Published Nov 9, 2022

Safe Driving	Crash Avoidance	Crash Protection	Post-crash
– Speed assistance – Driver & Occupant monitoring – Assisted and automated driving	– Autonomous emergency braking and steering (C2C & VRU) – Lane support	– Occupant protection in front and side crashes – Whiplash injury prevention – Child occupant protection – Pedestrian and cyclist protection	– First and second responder rescue information – Extrication, fire, submergence – Digital emergency services

Vision 2030 rating scheme proposal

Safe Driving		Crash Avoidance		Crash Protection		Post-Crash*	
Occupant Monitoring	**30**	**Frontal Collisions**	**60**	**Frontal Impact**	**40**	**Rescue information**	**40**
- Seatbelt usage	10	- Car	30	- Offset (incl 10 COP)	20	- Rescue sheets	35
- Occupant classification	10	- Pedestrian	10	- Full Width	10	- Rescue Guide	5
- Occupant presence	10	- Cyclist	10	- VT & Sled	10		
		- PTW	10			**Post-Crash intervention**	**25**
Driver Engagement	**30**			**Side Impact**	**35**	- Advanced eCall	20
- Driver Monitoring	25	**Lane change Collisions**	**20**	- MDB (incl 5 COP)	15	- Multi Collision Brake	5
- Driving Controls	5	- Single Vehicle	10	- Pole	10		
- Assisted Engagement	0	- Car	5	- Farside	10	**Extrication**	**35**
		- PTW	5			- Energy Management	20
Vehicle Assistance	**40**			**Whiplash**	**5**	- Occupant Extrication	15
- Speed Assistance	20	**Acceleration prevention**	**20**				
- ACC Performance	10	- Car	5	**Vulnerable Road Users**	**20**		
- Steering Assistance	10	- Pedestrian	5	- Headform	10		
		- Cyclist	5	- Legform	10		
		- PTW	5				
Weight: 20	**100**	**Weight: 20**	**100**	**Weight: 50**	**100**	**Weight: 10**	**100**

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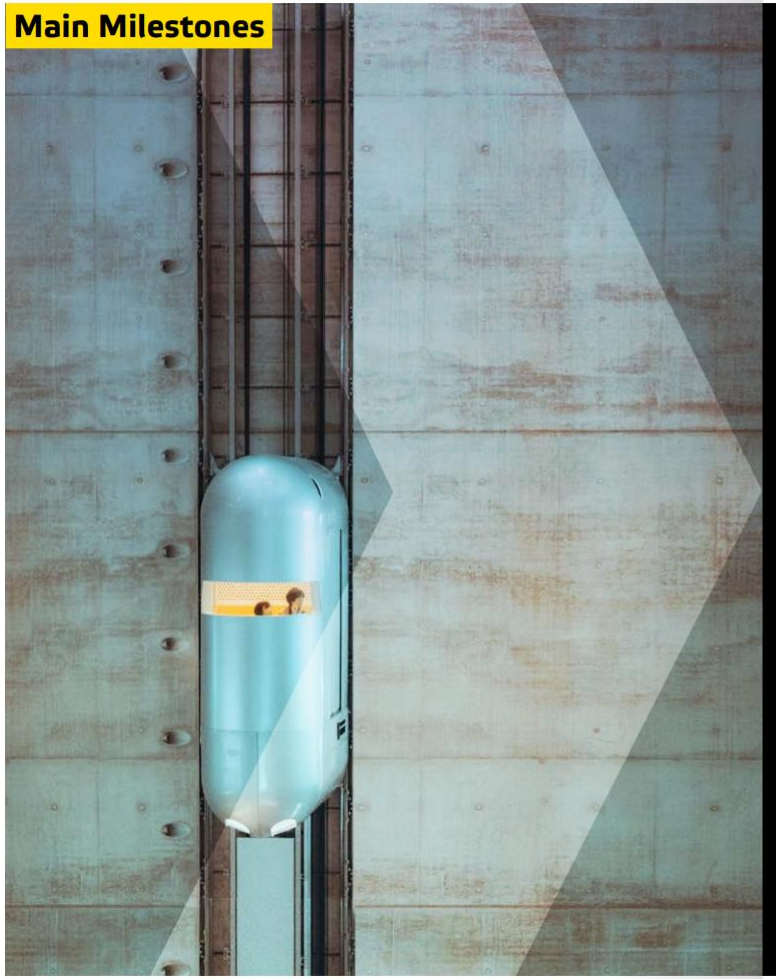
Real integrated safety

Safe Driving	Crash Avoidance	Crash Protection	Post-crash
– Speed assistance – Driver & Occupant monitoring – Assisted and automated driving	– Autonomous emergency braking and steering (C2C & VRU) – Lane support	– Occupant protection in front and side crashes – Whiplash injury prevention – Child occupant protection – Pedestrian and cyclist protection	– First and second responder rescue information – Extrication, fire, submergence – Digital emergency services

Overview



2026 2029 2032

Safe Driving

- M1 Beyond Intelligent speed assistance
- M2 Driver Awareness: impaired driving to cognitive distraction
- M3 AD Grading: Domain extension and driver engagement

Crash Avoidance

- M4: Improved robustness and real-world effectiveness
- M5: Leveraging vehicle connectivity
- M6: Pedal misapplication

Crash Protection

- M7: Senior protection: low severity testing with sled
- M8: Far-side and side pre-crash incentives
- M9: Protection equity through modelling
- M10: Whiplash protection parity
- M11: Passive VRU protection – A-pillar and micro-mobility

Post-Crash Protection

- M12: Next-gen updates including D-call and thermal scanning

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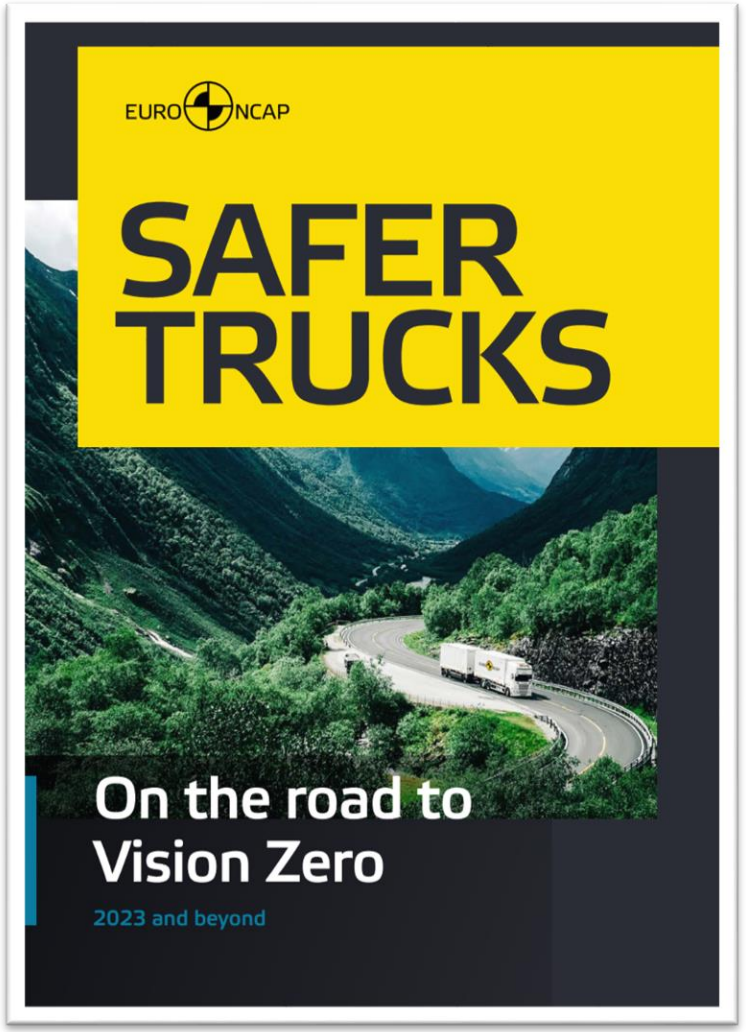
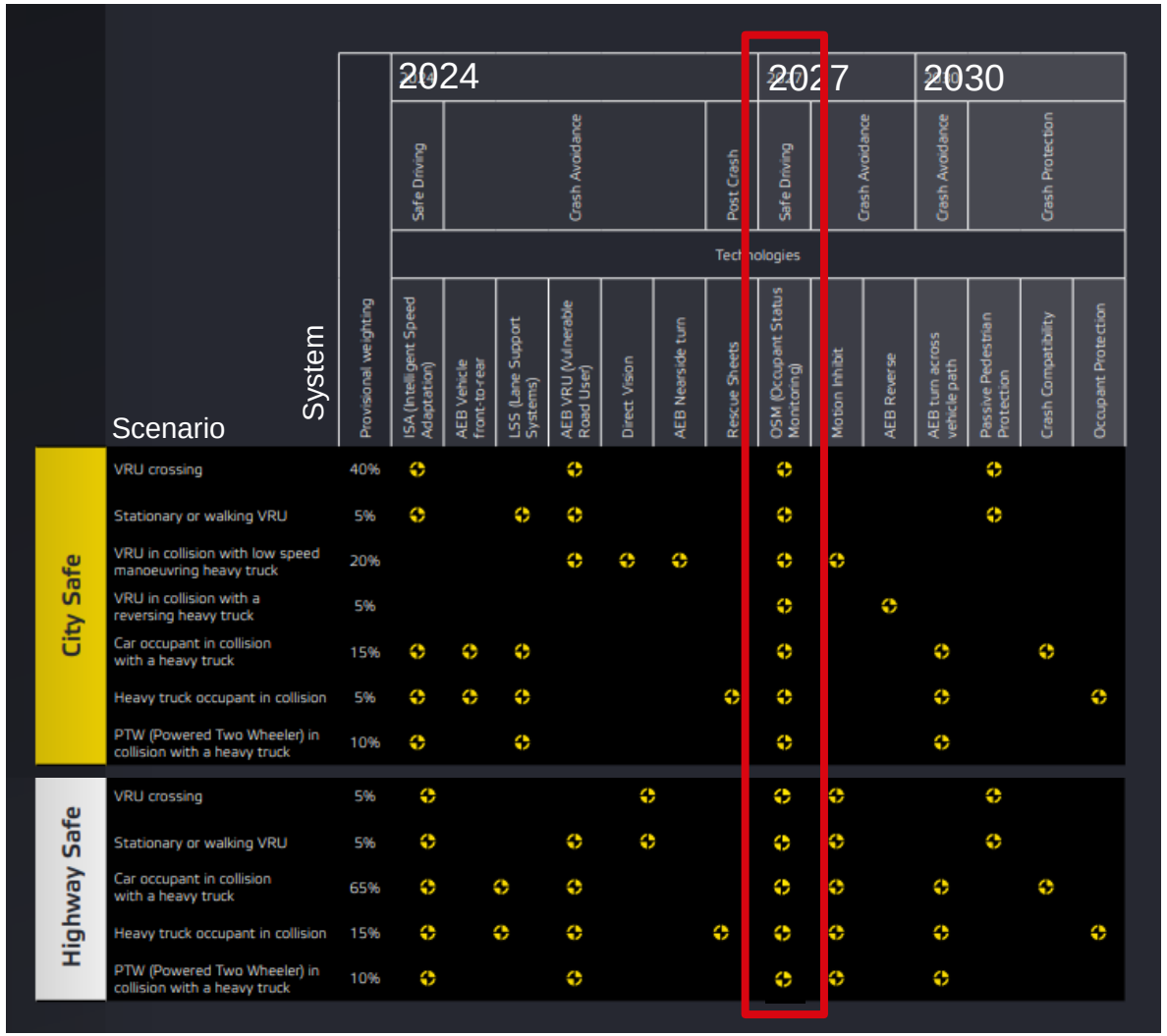
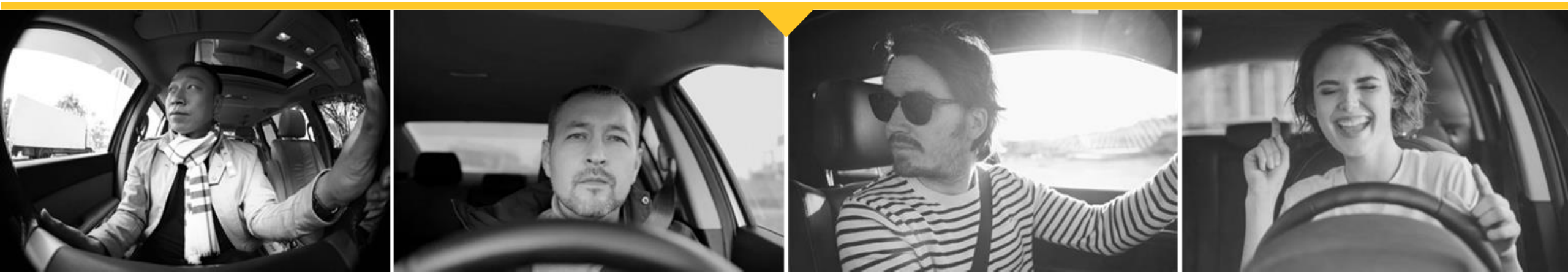
RT ADMINISTRATION

Euro NCAP announces plans for a new Truck Safety rating scheme

12th April 2023

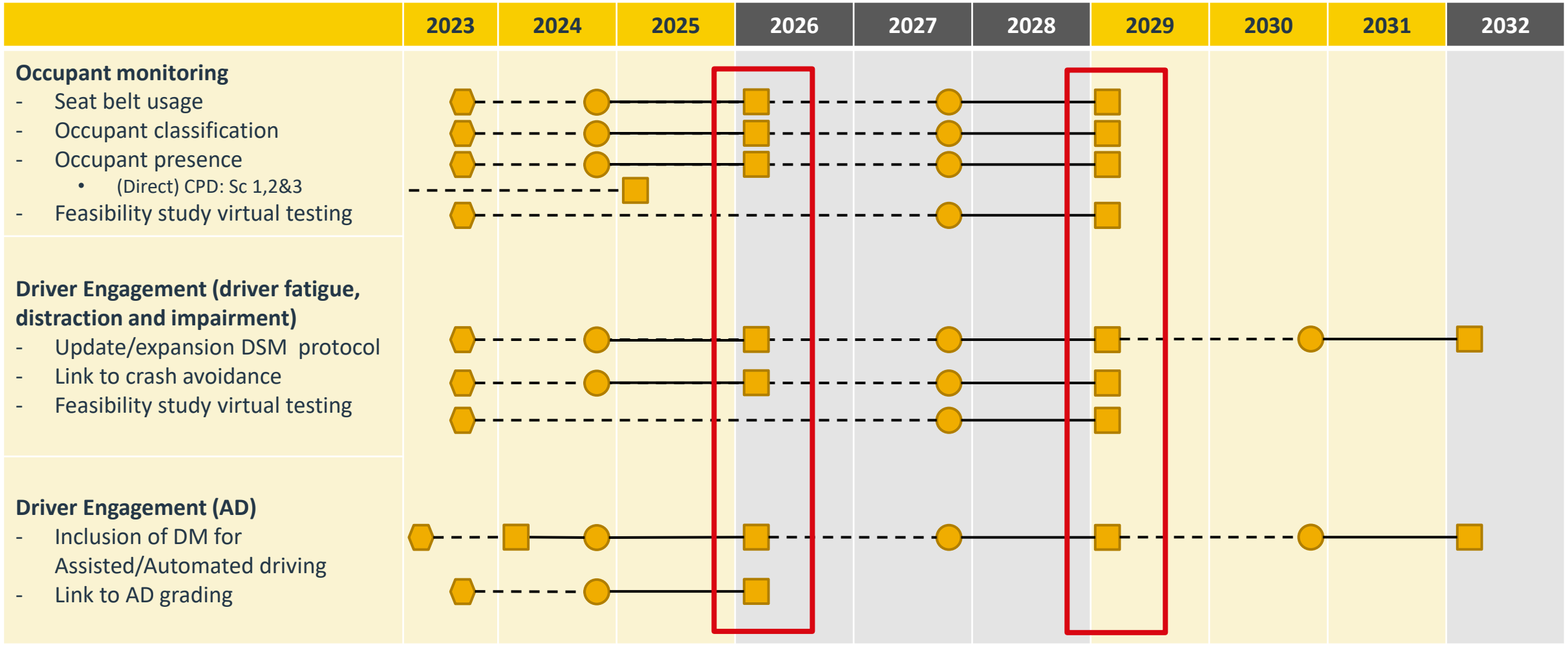



System
Scenario
Provisional weighting
2024
2027
2030
Safe Driving
Crash Avoidance
Post Crash
Safe Driving
Crash Avoidance
Crash Avoidance
Crash Protection
Technologies
ISA (Intelligent Speed Adaptation)
AEB Vehicle front-to-rear
LSS (Lane Support Systems)
AEB VRU (Vulnerable Road User)
Direct Vision
AEB Nearside turn
Rescue Sheets
OSM (Occupant Status Monitoring)
Motion Inhibit
AEB Reverse
AEB turn across vehicle path
Passive Pedestrian Protection
Crash Compatibility
Occupant Protection
City Safe
VRU crossing 40%
Stationary or walking VRU 5%
VRU in collision with low speed manoeuvring heavy truck 20%
VRU in collision with a reversing heavy truck 5%
Car occupant in collision with a heavy truck 15%
Heavy truck occupant in collision 5%
PTW (Powered Two Wheeler) in collision with a heavy truck 10%
Highway Safe
VRU crossing 5%
Stationary or walking VRU 5%
Car occupant in collision with a heavy truck 65%
Heavy truck occupant in collision 15%
PTW (Powered Two Wheeler) in collision with a heavy truck 10%



OSM 2026 and beyond

Time Plan



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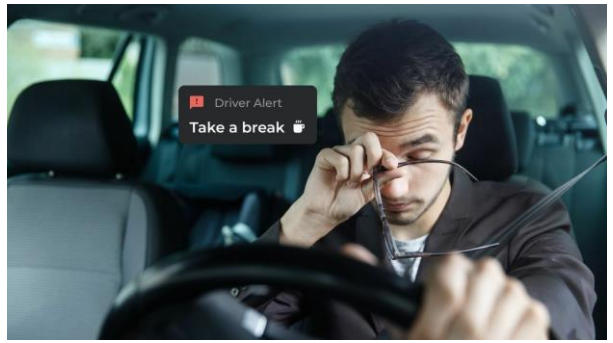
2026 Rating Scheme

Safe Driving	
Occupant Monitoring	**30**
Seatbelt usage	10
Rear seat occupancy detection	**5**
Correct belt routing	**5**
Driver	4
Front passenger(s)	1
Occupant Classification	10
Airbag Deactivation	**4**
Manual	1
Automatic	4
Airbag optimisation for OOP	**2**
Stature classification	**4**
Direct	4
Indirect	1
Occupant Presence	10
CPD	**5**
Post-Crash presence	**5**
Driver Engagement	**30**
Driver Monitoring	25
Distraction / Transient	**15**
Impairment / Non-transient	**10**
Unfit to drive	8
Unresponsive Driver	2

Occupant Status – 2026 and beyond

- Learn from Dossier input - Technology abilities and limitations
- Create protocol with
  - more testable requirements
  - higher and more clear requirements, based on feasibility
- Driving under influence
- Sudden sickness – early signs
- More fool proof seat belt reminder
- Link to other req's:
  - Adaptive ADAS
  - Adaptive restraints
  - D-call
- Cognitive distraction

Driver Engagement



Driver Monitoring (2)

- **Impairment (*Non-Transient*)**

Impaired driving – A driver who is disconnected from the driving task or not in a physical state that is sufficient for safe driving

a) Unfit to drive

✓Scope: Dynamic detection of driving performance and/or driver's state falling out of the 'normal driving' envelope

- Slower reflexes / Poor situational awareness (Fatigue, DUI*),
- Reckless/Dangerous driving (DUI)

} Beyond current fatigue detection to get full score

✓Vehicle response requirements:

- Intervention: 1) Significantly higher sensitive FCW/LDW, 2) Forcing LKA** & ACC activation
- Warning (Fatigue): Harsh acoustic warning at KSS>8, softer warning at KSS≤7

✓Verification

- Spot Check (Fatigue): Representative track procedure (TP) and On-road test (FP)

** DUI not explicitly mentioned in assessment*
*** If previously switched off*

Driver Engagement

Driver Monitoring (3)

- **Impairment (*Non-Transient*)**

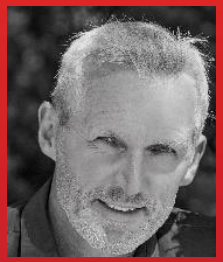
  b) Unresponsive driver

  ✓ Standard RMF (1 point)

  ✓ Quicker RMF (2 points)

Impaired driving – A driver who is disconnected from the driving task or not in a physical state that is sufficient for safe driving

Thanks!
Questions?



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