EURO NCAP

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Child Presence Detection Evaluation

Safe Driving

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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).

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INTRODUCTION

The evaluation of direct sensing Child Presence Detection (CPD) systems will be based on information provided by the vehicle manufacturer and laboratory checks.

Euro NCAP reserves the right to check any or all aspects of the CPD system during the vehicle assessment. This includes all system functionality such as sensing, warnings, intervention and HMI.

DEFINITIONS

HF	High Frequency [RADAR]
IR	InfraRed
NIST	National Institute of Standards and Technology
RCS	Radar Cross Section
RF	Radio Frequency
SD	Safe Driving
sRGB	standard RGB (IEC)
UWB	Ultra-Wideband [RADAR]

1 OEM DOSSIER

A dossier from the OEM is required detailing how the CPD system establishes the presence of a child and the sequence, including timing, of subsequent warnings and intervention(s). In order for any CPD points to be awarded, the dossier must contain the information detailed in the following sections and demonstrate that system reacts correctly to the defined scenarios.

It is the OEM's responsibility to provide all of the necessary information required to demonstrate the performance of the system in accordance with the Euro NCAP Occupant Monitoring protocol. Information relating to all of the following sections must be provided in advance of CPD assessment.

The data required in the OEM dossier detailed in this section shall be provided in accordance with the evaluation scenarios detailed in Section 2.

1.1 General system information

Subject	Required information
Sensor type, principle and system architecture	For example Wi-fi, wave radar and frequency, camera etc. Sensor location(s) within the vehicle.
Sensing functionality & occupant classification	For example movement, respiration etc. Systems must be able to react correctly to all possible use cases. It is important to note that test tools must not be the only source of data used during system development. The OEM must demonstrate that the robustness of the system has been evaluated with the use of human surrogates due to the range of respiratory traits that occur in the real world. Include also any classification capability that can differentiate between children and adults. Sensing and decision time to warning activation detailed in Occupant Monitoring protocol. Where machine learning has been used to detect or classify occupants, details of the samples used to develop the system are required (e.g. number of samples taken, occupant ages, size/stature etc) to ensure that children from newborn up to 6YO have been included in the sample.
Coverage areas	For example occupant compartment, particular seat rows, footwells, luggage area and all optional seats. Influence of unoccupied seat range adjustments on detection.
Deactivation – Temporary & long term	Steps for any deactivation and corresponding telltales and their duration. Include any pet or camping modes and how they affect the CPD system.
CPD mobile device applications	Systems offering this functionality will need to be checked, applications must be provided to Euro NCAP and laboratory prior to full scale testing. OTA update possibilities for applications and CPD system.
Testing issues	Systems that do NOT trigger CPD warnings when an adult is present may require additional actions to be performed by the laboratory to represent a child only situation. Detail how the system can be triggered by the laboratory without the use of human subjects.

	If a simulated journey is required prior to triggering of CPD, detail how this should be achieved.

1.2 HMI

Subject	Required information
Warnings	Outline of initial and escalation warning timings and composition e.g. audible and visual. Warning signal description and documentation.
Intervention	Outline of intervention, its functionality and duration. Include details of intervention warnings and timings. Intervention, warning signal description and documentation
Telltales, text and menus	Detail all visual signals/telltales. Including languages detailed in Technical Bulletin G 001.

1.3 Sensing data

Subject	Required information
Sensing system monitoring output(s)	For example respiration, movement or other detected outputs with triggering thresholds and any grey zone information where a threshold has a range. Influence from any external interference e.g. sunlight, electromagnetic or radio waves.
Worst case conditions	Demonstrate detection capabilities in 'worst case' conditions. For example, statures from newborn (4kg/46cm) up to 6YO, with and without limb movement. Where the OEM provides system specific sensing data using test tools, the use of human subjects may be reduced. The availability of standardised test equipment, however, does not preclude car makers or system suppliers from using different surrogates and human subjects in the development of robust and effective child presence detection systems. Identify worst case and include different positions and variations of seats that the child is NOT occupying. E.g. a child seated on position 4 shall be tested with different seat adjustments of position1.
Respiration	The following respiration rates shall be used for sleeping children: Newborn - 30 breaths per minute One year old - 22 breaths per minute Three year old - 20 breaths per minute Six year old - 18 breaths per minute When using human subjects, some realistic variation in breathing rates is acceptable.

Movement	Sleeping shall be considered with only respiratory movement. Limbs and head shall remain still. Presence of childlike manikin, sizes and cases requiring random movement. The following movement is accepted for children in a CRS: Head: Pitch, roll, yaw Upper and lower limbs: Waving, kicking, playing on a mobile phone.
Day and night	Systems that rely on optical sensing methods, such as cameras, require demonstrations to show that occupants can be detected in a range of lighting conditions, for example day and night-time.
Human surrogates	The OEM and/or system supplier is required to provide information detailing the validation of any test tools used. Where tools are used in place of human subjects, validation data is required to demonstrate that the test tool can be used as a suitable human surrogate. If the test tool is already approved by Euro NCAP and listed in Technical Bulletin G 003 it will not be necessary to provide further validation of the tool providing the tool is listed in combination with the corresponding sensor technology used in the vehicle under assessment. A direct comparison between the output recorded with humans and the test tool(s) is required in a vehicle environment. The test scenarios described below shall be replicated along with details of the 'worst case' conditions/subject for the sensing technology. Sensing outputs and system specific data is required from a range of human subjects and must include newborn to 6YO. For example, mm wave radar systems require radar cross section amplitude (RCS). This must be accompanied by age, weight and stature to demonstrate the worst case human for the sensing system. Depending on the parameter and scenario being evaluated, it may be necessary to seat the children, or position the respective test tool(s), in an appropriate CRS. Vehicle assessments will be carried out by the vehicle inspectors and assessed using a number of 'use cases' representing typical conditions, see Section 3.

2 SCENARIOS

The scenarios to be evaluated and child occupant details are below. The assessments may be performed either in-door (parking garage) or outside. However, elements that are necessary to the function of the system should be present, such as phone signals and temperature where applicable.

2.1 Child left behind

Child	
Newborn Maxi Cosi Cabriofix or Pebble 360. Universal CRS, belted installation rearward facing. Maxi Cosi Pebble 360 on FamilyFix 360 base Rearward facing. Installation of child only, CRS (base and shell) already installed in vehicle.	Sleeping under blanket without limb movement with sun shield deployed.
One year old Maxi Cosi Cabriofix or Pebble 360. Universal CRS, belted installation rearward facing. Maxi Cosi Pebble 360 on FamilyFix 360 base Rearward facing. Installation of child only, CRS (base and shell) already installed in vehicle.	Sleeping under blanket without limb movement. Awake under blanket with limb movement.
Three year old Forward facing CRS Cybex Solution T i-Fix, belted installation, forward facing.	Sleeping under blanket without limb movement. Awake under blanket with limb movement.
Six year old Concord Vario XT-5 or Joie Signature i-Spin XL Belted installation, forward facing.	Sleeping without limb movement. Awake with limb movement.

The children shall be placed on designated seating positions. Unoccupied seats shall be varied to identify what is worst case in terms of detection as detailed in Section 1.3.

For systems that do not classify occupants, i.e. those that detect any age of occupant, only data with the newborn is required where that is shown to be the hardest occupant to detect.

2.1.1 Blanket and sun-shade

For the sleeping situations the blanket shall be placed over the child from the shoulders down to cover the feet with arms beneath. For the awake situations, the blanket shall be placed over the child from the chest down to cover the feet with the arms above the material.

The blanket to be used shall be no less than 70cm x 90cm, 300GSM in weight and made from Cotton or Polyester.

A sun-shade shall also be used with rearwards facing CRS that attaches from the carry handle to the seat shell around the head. Alternatively, a shade may be improvised from a cotton cloth placed around the shell of the CRS and covering the opening.

2.2 Gained access

Child	
Three year old No CRS required	Sleeping without limb movement - laid on rear seat. Awake with limb movement - sitting/kneeling in footwell. Front and rear rows.
Six year old No CRS required	Awake with limb movement - child kneeling on both front seats – only required for systems with child/adult classification. Sleeping without limb movement - laid on rear seat.

3 OFFICIAL LABORATORY USE CASE TESTING

3.1 Sensing

Test	Laboratory checks
Newborn sensing – Child forgotten and left behind Use a newborn test tool to **trigger the system.** Maxi Cosi Cabriofix or Pebble 360. Universal CRS, belted installation rearward facing. Maxi Cosi Pebble 360 on FamilyFix 360 base Rearward facing. Installation of child only, CRS (base and shell) already installed in vehicle.	Ensure the CPD system is triggered.
3YO sensing – Child gained access Use a 3YO test tool or human to **trigger the system.** Kneeling in the footwell.	Ensure the CPD system is triggered.
Occupant classification / six year old sensing – Only applicable to system that can differentiate between child and adult occupants. Use a 6YO test tool or human to **trigger the system.** Concord Vario XT-5 or Joie Signature i-Spin XL Belted installation, forward facing.	Ensure that the CPD system is triggered.
Occupant classification / 5th female sensing.	The system is not required to trigger in this scenario.

3.2 CPD on/off

Test	Laboratory checks
Default	Default ON
Temporary deactivation	Check warning/telltale timing both at the time of deactivation and the end of journey. Check trigger event for the display of the warning/telltale at the end of the journey
Other modes Camping and pet	Check any modes for off functionality, the CPD system must not be disabled inadvertently.

3.3 Warnings

Test	Laboratory checks
Trigger the CPD system (no need to be the hardest to detect) and proceed with the full sequence of warnings without any interruption.	Measure all the timings of the warnings and intervention. Detail the composition of the warning and intervention (notification, klaxon, hazard lights, air conditioning...)

3.4 Initial warning delay

Test	Laboratory checks
Apply the procedure given by the OEM to **delay the initial warning.**	The delay can be applied at any time up to the end of the initial warning. Measure all the timings and composition of the subsequent warnings and intervention.

3.5 Initial warning cancellation

Test	Laboratory checks
Apply the procedure given by the OEM to **cancel the initial warning** before the start of the escalation.	Measure all the timings of the warnings and intervention. If the cancellation is made either with or without opening an occupant entry door and the vehicle is locked – Check the escalation warning begins as defined in the protocol either 90s from T0 (locking) or earlier. Intervention (where equipped) must also be triggered as defined in the protocol.

3.6 Escalation warning cancellation

Trigger the CPD warnings up to the start of escalation, then cancel the escalation warning by unlocking the car and/or opening a door. Close door(s) and lock the vehicle again to check a new escalation warning cycle is triggered.

Test	Laboratory checks
Apply the procedure given by the OEM to **cancel the escalation warning.** Lock the vehicle again and check a new escalation warning cycle is triggered.	Measure all the timings of the warnings and intervention. After an escalation warning has been cancelled with a child still present and the vehicle is locked again – Check the escalation warning cycle is triggered within 90 seconds from the time of re-locking.

	Intervention (where equipped) must also be triggered as defined in the protocol.

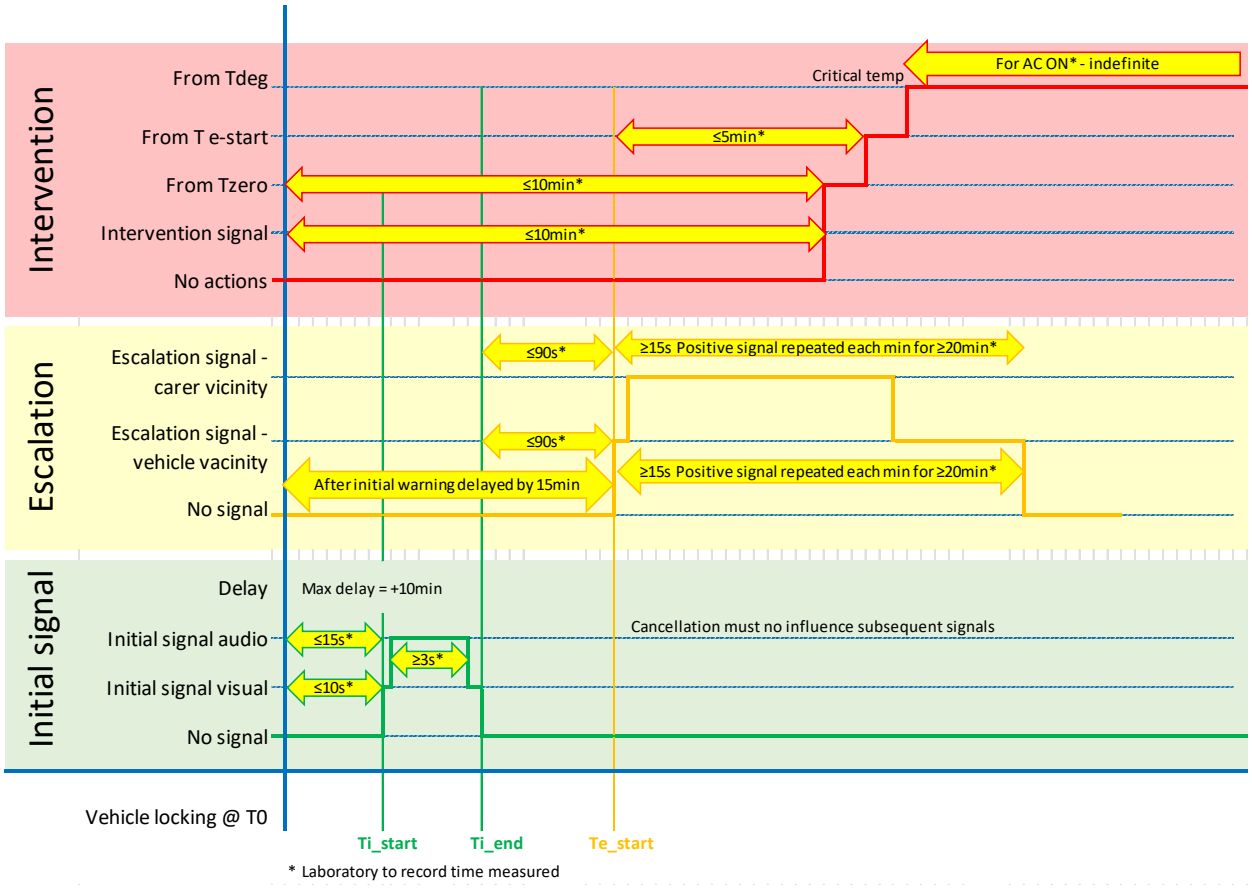
3.7 Gained access

The warning and cancellation requirements applicable to this scenario are detailed in Sections 3.3, 3.5, 3.6.

Test	Laboratory checks
Three year old No CRS required Place a surrogate in an unlocked vehicle, with doors closed but not locked.	Parked vehicle with unlocked doors. Any door may be opened at any time after parking, see Section 3.1.1 of the OM protocol. Test subject is placed in the locations detailed in Section 2.2. The door is closed but with child lock activated. The vehicle must remain unlocked, out of range of keyless entry card/fob.
Six year old No CRS required	Where the system can differentiate between adult and child occupants, repeat the 3YO procedure with the 6YO. This is NOT required if 3YO is harder to detect than 6YO.

3.8 Laboratory outputs

The laboratory shall report the HIM functionality of the CPD system and the different warning(s) and intervention(s). For example, the duration of each phase shall be marked as illustrated below.



4 TEST TOOLS

This section summarises the requirements for human surrogate test tools that can be used to demonstrate CPD sensing functionality. These requirements will also be used to approve test tools for inclusion in the Euro NCAP Technical Bulletin G-003-2. Additionally, all relevant data detailed in G-003-1 must also be provided. Future updates of this Technical Bulletin may include other relevant sizes if the need arises.

The Direct Sensing CPD systems may use a variety of technologies to determine if occupants, such as children, are present:

- Ultrasonic or Radar Sensors: These detect motion (like breathing or small movements) in the back seat, even if the child is asleep.
- Camera-Based Systems: Use image recognition to identify a child or infant seat in the back.

To be accepted as an approved test tool, CPD surrogates must be designed to work with (at least) RADAR and Video based systems. This means CPD test tools must accurately replicate a human being in full 3D form and exhibit lifelike signs of presence across different conditions.

However, the CPD assessment allows for the integration of alternative, innovative sensing technologies. Approved test tools may only be used if they are compatible with the specific sensing technology in question.

A CPD test tool is a measurement instrument that shall be used in a laboratory environment. It shall allow setup and deployment by a single lab operator and make use of power supply, commonly available at test facilities.

The system itself will be resistant to normal operational environmental conditions like temperature, humidity variations and dust. The tool supplier must provide adequate user manual and certification procedures to support accurate and safe use of the equipment.

4.1 Newborn

4.1.1 Physical Dimensions

Dimension	Range	Comment
Weight	4.0kg ± 5%	
Body height	460 ± 10mm	Typical full-term newborn length
Mid-shoulder height	175 ± 10mm	Estimated from neonatal posture
Rump-knee length	110 ± 10mm	Estimated seated length
Knee height	115 ± 10mm	Standing flexed knee height
Upper arm length	85 ± 10mm	Shoulder to elbow
Lower arm length	125 ± 10mm	Elbow to hand
Head length	110 ± 10mm	Back to front of head
Torso depth	75 ± 10mm	Front to back chest depth
Shoulder width	125 ± 10mm	Outer shoulder to shoulder
Head width	85 ± 10mm	Temple to temple
Waist circumference	255 ± 10mm	Around the abdomen
Forearm circumference	80 ± 10mm	Just below elbow
Calf circumference	90 ± 10mm	Thickest part of calf
Ankle circumference	70 ± 10mm	Around ankle joint

Target dimensions for the newborn are derived from NIST-Data (*Physical Characteristics of Children as Related to Death and Injury for Consumer Product Design and Use, UM-HSRI-BI-75-5 Final Report Contract FDA-72-70 May 1975*). The target values below are for 5th percentile newborn (mixed gender) which is considered the most challenging scenario for detection.

Alternative anthropomorphic references may be used provided they are in the public domain and resulting variations to the below target values are limited. It is advisable to cross-check dimensions with *Growth Charts - 2000 CDC Growth Charts - United States* referred to in Euro NCAP protocol.

4.1.2 Respiration

Requirement	Range	Comment
breathing movement	3 mm (peak to peak) ±5%	Measured at the sternum position
breathing volume	18 mm^3 (moving area * amplitude)	In accordance with studies by Doershuk & Matthews (25,31 mm^3) and Krauss and Auld (11,84 mm^3)
breath/respiration frequency	30 Bpm	

4.1.3 State and movement modes

Newborn CPD surrogates must exhibit lifelike signs of presence across different states of consciousness: **Deep Sleep, Sleep, Wake Up and Awake**. These modes are identified by distinct active (body) movements as summarized in the tables below:

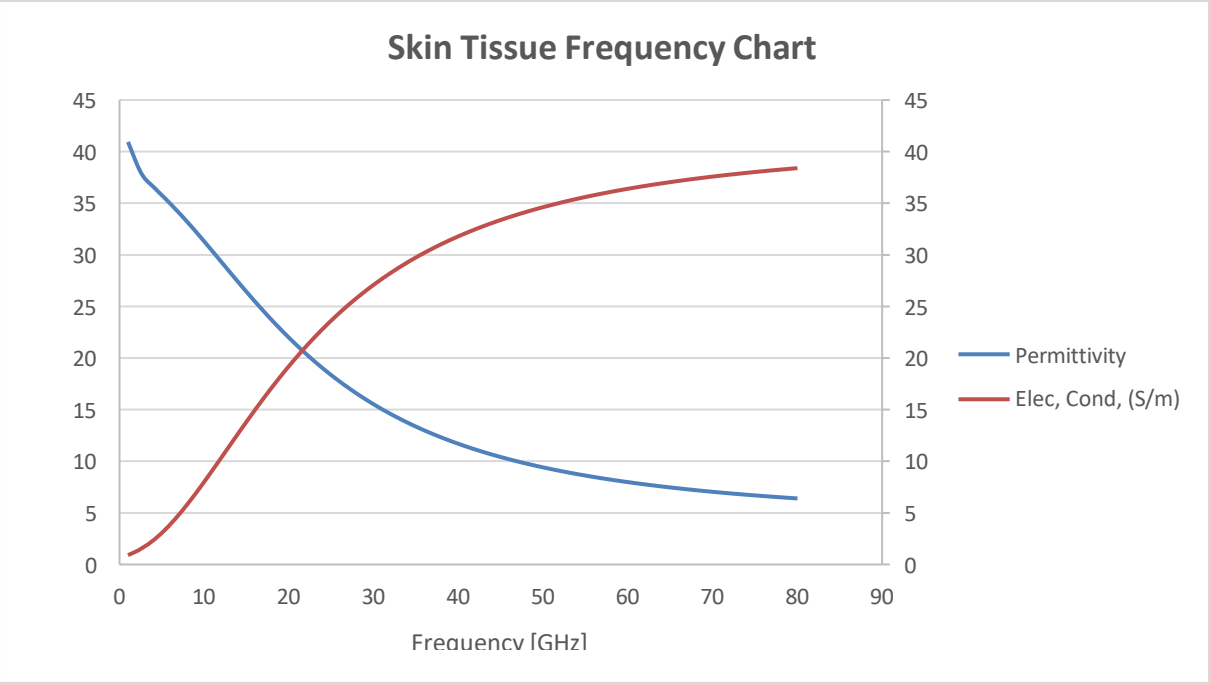
State	Head rotation range	Arm movement range	Leg movement range
Deep sleep	-	-	-
Sleep	-	-10° to +2° deg	-9° to +5° deg
Wake up	-7° to +7° deg	-11° to +7° deg	-11°+5° deg
Awake	-10° to 7° deg	-25° to +2° deg	-15° to +6° deg

4.1.4 Visual and sensor properties

Property	Range	Comment
Visual Properties (sRGB)	Min: (112, 95, 72) Mean: (182, 165, 142) Max: (252, 235, 212)	Matt appearance
Infrared Reflectivity	(850–950 nm): 40–60%	The difference between 45° and 90° IR reflectivity measurements: ≤ 20%
skin material radar frequency response	30% from curves provided by Baumgartner et al, (2024)	The surrogate shall have representative response to (at least) following RADAR sensing technologies - Wi-Fi (2.4 / 5 GHz) - UWB (6–10 GHz) - 24 GHz - HF (60–80 GHz) Transmission through skin material should be less than -30 dB / cm to

		prevent mechanical structures to be visible to RADAR based sensor systems.
Radar Cross Section (RCS)	[14-15] dBsm	

Skin Tissue Frequency Chart



4.1.5 General

The overall adequacy of the CPD newborn surrogate for shall be validated in a **series of in-cabin tests**, varying seating positions, CRS and for different states (deep sleep, sleep, wake up and awake).

The signal outputs may be tailored to the specific type of sensing technology. For example with RADAR systems showing point cloud reflections and comparisons between newborn children and the test surrogate. In addition to validation data from the test tool supplier, Euro NCAP requires the in-cabin demonstration data to be repeated in cooperation with either a vehicle manufacturer or a Tier-1 supplier. The tool supplier requesting approval is responsible for arranging this testing and providing the subsequent test data to Euro NCAP for approval. A statement from the chosen OEM or supplier shall be supplied to detail what testing took place and that there were no issues with the functionality of the target system.