EURO NCAP

#FORSAFERTRUCKS

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Collision Avoidance
Frontal Collisions

Truck-to-Vehicle

Test Protocol

Implementation November 2024

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

CONTENTS

DEFINITIONS

Throughout this protocol the following terms are used:

Heavy Goods Vehicle (HGV) – a category N2 or N3 vehicle with gross mass exceeding 3,500 kg.

Peak Braking Coefficient (PBC) – the measure of tyre to road surface friction based on the maximum deceleration of a rolling tyre, measured using the American Society for Testing and Materials (ASTM) F 2493-20 (SRTT16) standard reference test tyre, in accordance with ASTM Method E 1337-19 (2019), at a speed of 64.4 km/h, without water delivery. Alternatively, the method as specified in UNECE R13-H.

Autonomous Emergency Braking (AEB) – braking that is applied automatically by the vehicle in response to the detection of a likely collision to reduce the vehicle speed and potentially avoid the collision.

HGV-to-Car Rear Stationary (HCRs) – a collision in which a vehicle travels forwards towards another stationary vehicle and the frontal structure of the vehicle strikes the rear structure of the other.

HGV-to-Car Rear Moving (HCRm) – a collision in which a vehicle travels forwards towards another vehicle that is travelling at constant speed and the frontal structure of the vehicle strikes the rear structure of the other.

HGV-to-Car Rear Braking (HCRb) – a collision in which a vehicle travels forwards towards another vehicle that is travelling at constant speed and then decelerates, and the frontal structure of the vehicle strikes the rear structure of the other.

Vehicle Under Test (VUT) – the vehicle, or vehicle and trailer combination, tested according to this protocol with a pre-crash collision mitigation or avoidance system on board.

Vehicle width – the widest point of the vehicle ignoring the rear-view mirrors/camera monitoring system, sensors, access steps, side marker lamps, tyre pressure indicators, direction indicator lamps, position lamps, flexible mud-guards and the deflected part of the tyre side-walls immediately above the point of contact with the ground.

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

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

T_{AEB} – the time when the AEB system activates. Activation time is determined by identifying the last data point where the filtered acceleration signal is below -1 m/s^2, and then going back to the point in time where the acceleration first crossed -0.3 m/s^2.

T_{impact} – the time at which the profile around the front of the VUT coincides with the square box around the GVT.

V_{impact} – the speed of the VUT at T_{impact}.

V_{rel_impact} – the relative speed between the VUT and GVT at T_{impact} calculated by subtracting the speed of the GVT at T_{impact} from V_{impact}.

1 INTRODUCTION

An analysis of European road traffic crash data (where at least one HGV was involved) revealed that Heavy Goods Vehicle (HGV) front-to-rear collisions account for 9 % of passenger car and Light Commercial Vehicle (LCV or van) occupant fatalities and 17 % of HGV occupant fatalities. Considering all injury severities, those figures increase to 20 % and 49 % respectively.

Typical incidents include the HGV colliding with the rear of slow moving or stationary traffic on highways at high relative speeds because of a range of factors including driver distraction, fatigue or misjudgement. Where the HGV collides with a light vehicle the significant difference in weight means that the light vehicle sees almost all of the change in velocity putting the occupant(s) of that vehicle at extremely high risk. Where the collision partner is a heavy vehicle, the large collision energy presents a risk of serious injury to the HGV driver and the occupants of the struck vehicle(s).

To support the driver in avoiding front-to-rear collisions, vehicle manufactures offer collision avoidance technology that monitors the road and traffic environment and has the ability to warn the driver of an imminent collision, support adequate braking and/or ultimately stop the vehicle by itself. Euro NCAP call this technology Autonomous Emergency Braking (AEB).

Teoh (2021) found that AEB reduced HGV front to rear crashes in the US by 41 %. Sander (2021) similarly found a 37 % reduction in HGV front to rear crashes with AEB on German highways.

Whilst regulation makes AEB a mandatory requirement for new HGVs, Euro NCAP strives to drive performance improvements to ensure robust and effective AEB operation in a broad range of real-world collision types. To this end, the Euro NCAP scheme builds on the regulatory requirement by:

- Incorporating additional challenging real-world collision scenarios with braking lead vehicles and also offset lead vehicles which are only partly obstructing the HGV path. This can particularly occur on highways without 'hard shoulders' where broken down vehicles try to move as far out of the path of other traffic as possible.
- Encouraging full speed range performance by offering maximum reward for avoiding collisions up to the maximum permitted HGV speed of 90 km/h.
- Promoting real-world operation robustness by investigating the AEB system response to modest driver inputs insufficient to avoid the imminent collision

This protocol specifies the HGV AEB test procedures, which are used to evaluate system performance in a repeatable and reproducible manner for the HGV safety rating scheme.

2 REFERENCE SYSTEM

2.1 Convention

For both the VUT and the GVT use the convention specified in ISO 8855:1991 in which the x-axis points towards the front of the vehicle, the y-axis towards the left and the z-axis upwards (right hand system), with the origin at the most forward point on the centreline of the VUT for dynamic data measurements, as shown in Figure 2-1.

Viewed from the origin, roll, pitch and yaw rotate clockwise around the x, y and z axes respectively. Longitudinal refers to the component of the measurement along the x-axis, lateral the component along the y-axis and vertical the component along the z-axis.

This reference system should be used for both left hand drive (LHD) and right hand drive (RHD) vehicles tested. Figure 2-1 shows the near and far side of the vehicle for a left hand drive (LHD) vehicle. The far side always corresponds to the hand of drive, and therefore swaps sides accordingly for a right hand drive (RHD) vehicle.

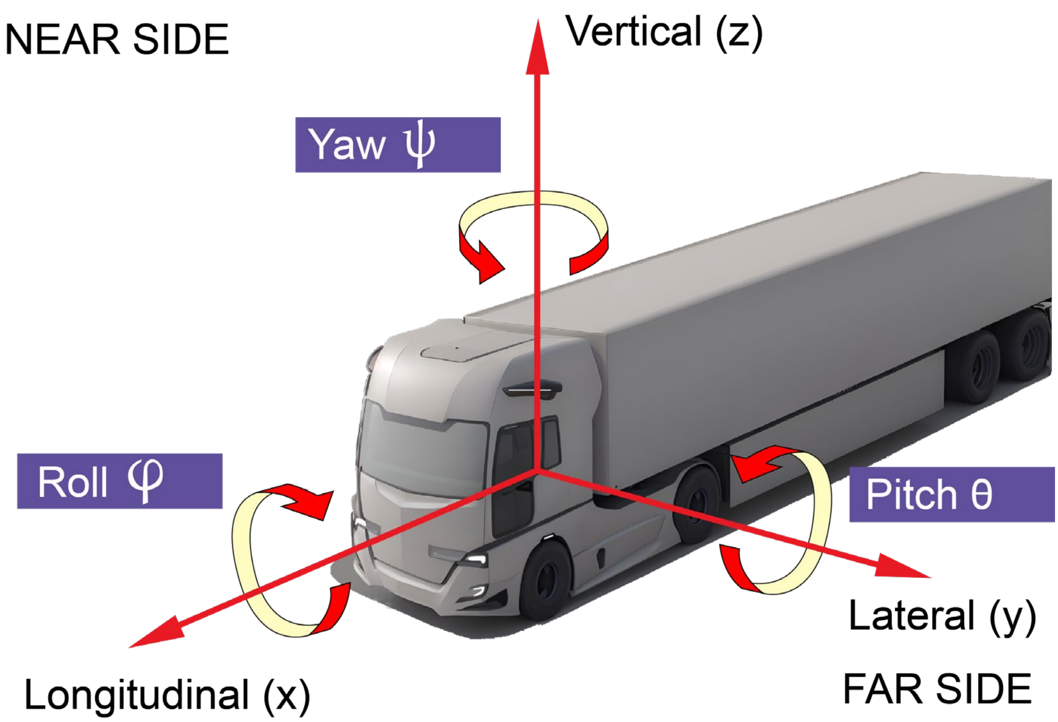

Figure 2-1 Coordinate system and notation (LHD & RHD) and near side – far side for LHD vehicle

2.2 Lateral Path Error

The lateral path error (Y_{VUT} error) is determined as the lateral distance between the centre of the front axle of the VUT when measured in parallel to the intended path, as shown in Figure 2-2.

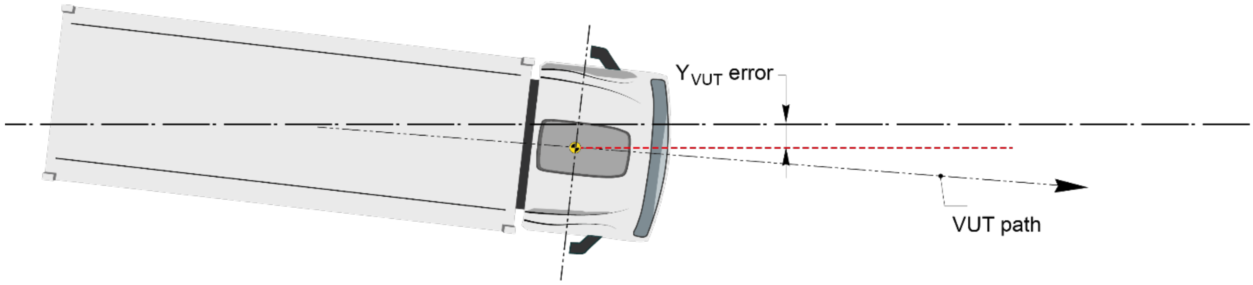

Figure 2-2 Lateral path error

2.3 Impact Location

The impact location is where the rear central reference point of the GVT coincides with the percentage of the width of the VUT, as shown Figure 2-3.

For 0 % overlap, the centreline of the GVT is aligned with the near side of the VUT.

For 50 % overlap, the centreline of the GVT is aligned with the centreline of the VUT.

For 100 % overlap, the centreline of the GVT is aligned with the far side of the VUT.

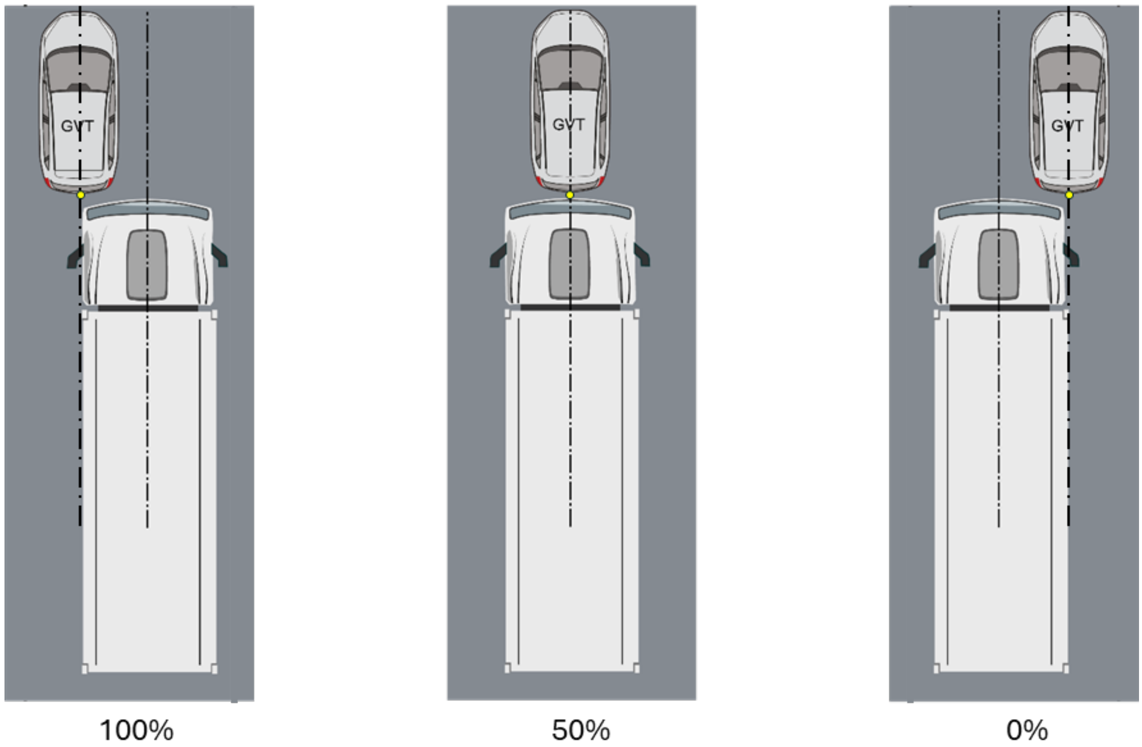

Figure 2-3 Impact location

2.4 Profile for Impact Speed Determination

A virtual profile is defined around the front of the VUT for V_{impact} calculation in case of a collision, determined in accordance with EU Regulation 2021/535 Section F: List of devices and equipment that are not required to be taken into account for the determination of the outermost dimensions. This profile is defined by six straight line segments connecting seven lateral locations that are equally distributed over the vehicle width minus 150 mm on each side, as shown in Figure 2-4.

The foremost point at each lateral location may not necessarily be at the same height. The vehicle manufacturer is requested to provide profile xy coordinates for verification by the test laboratory.

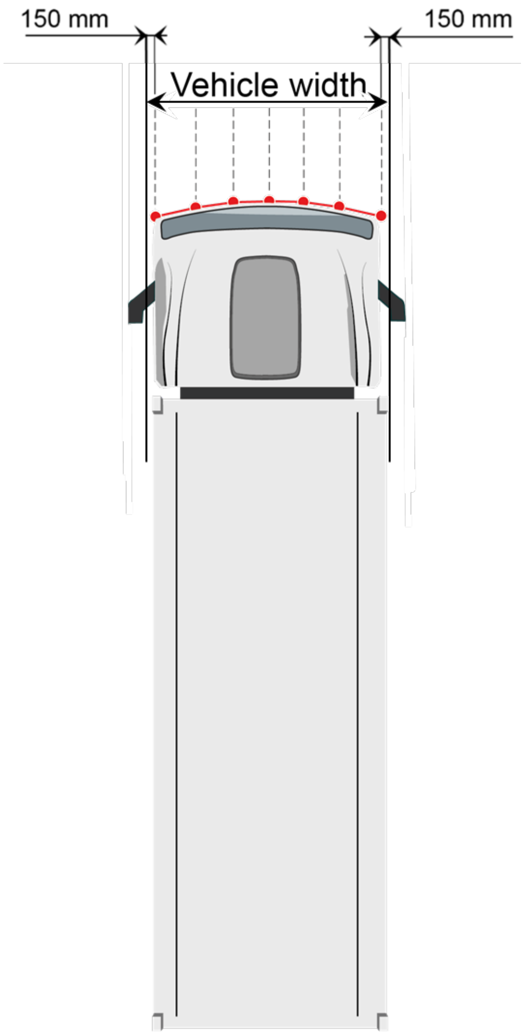

Figure 2-4 Virtual profile around the VUT front end

Around the GVT a virtual box is defined which is used to determine the impact speed. The dimensions of this virtual box are shown in Figure 2-5. For longitudinal scenarios, the reference point of the GVT is the rearmost centre point.

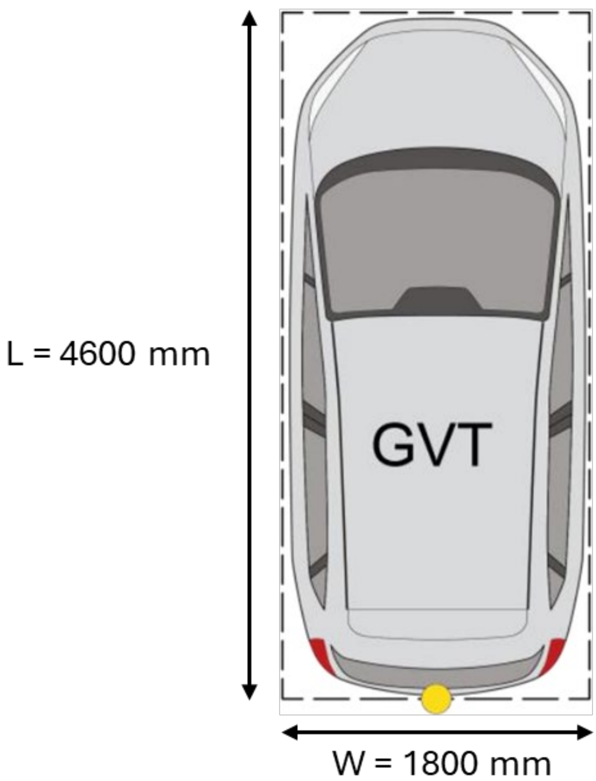

Figure 2-5 Virtual box dimensions around GVT

3 MEASURING EQUIPMENT

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

3.1 Measurements and Variables

Time	**T**
HCRs and HCRm: T_0 equals TTC = 4 s	$\mathbf{T_0}$
HCRb: T_0 when GVT starts the deceleration event	
T_{AEB}, time when AEB activates	$\mathbf{T}_{AEB}$
T_{impact}, time when VUT impacts GVT	$\mathbf{T}_{impact}$
$T_{GVT\_deceleration\_start}$ time when GVT starts decelerating	$T_{GVT\_deceleration\_start}$
(deceleration to be reached in 1.0 s)	
Position of the VUT during the entire test	$\mathbf{X}_{VUT}$, $\mathbf{Y}_{VUT}$
Position of the GVT during the entire test	$\mathbf{X}_{GVT}$, $\mathbf{Y}_{GVT}$
Speed of the VUT during the entire test	$\mathbf{V}_{VUT}$
V_{impact}, VUT speed at T_{impact}	$\mathbf{V}_{impact}$
V_{rel_impact}, V_{impact} minus GVT speed at T_{impact}	$\mathbf{V}_{rel\_impact}$
Speed of the GVT during the entire test	$\mathbf{V}_{GVT}$
Acceleration of the VUT during the entire test	$\mathbf{A}_{VUT}$
Acceleration of the GVT during the entire test	$\mathbf{A}_{GVT}$
Yaw velocity of the VUT during the entire test	$\dot{\Psi}_{VUT}$
Yaw velocity of the GVT during the entire test	$\dot{\Psi}_{GVT}$
Steering wheel velocity of the VUT during the entire test	$\mathbf{\Omega}_{VUT}$

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

3.3 Data Filtering

Filter the measured data as follows:

- Position and speed are not filtered and are used in their raw state
- Acceleration, yaw rate, steering wheel velocity and force are filtered with a 12 pole phaseless Butterworth filter with a cut off frequency of 10 Hz

4 TARGET SYSTEMS

4.1 Global Vehicle Target

Conduct tests in this protocol using the Global Vehicle Target (GVT) as shown in Figure 4-1 below. The GVT replicates the visual, radar and LIDAR attributes of a typical M1 passenger vehicle.

Figure 4-1 Global Vehicle Target (GVT)

To ensure repeatable results the combination of the propulsion system and GVT must meet the requirements as detailed in ISO 19206-3.

Only equipment listed in the current version of TB 029 – Suppliers List may be used for testing. The current version can be found on the Euro NCAP website.

The GVT is designed to work with the following types of sensors:

- Radar (24 and 77 GHz)
- Lidar
- Camera

When a manufacturer believes that the GVT is not suitable for another type of sensor system used by the VUT but not listed above, the manufacturer is asked to contact the Euro NCAP Secretariat.

5 SYSTEM PERFORMANCE DATA

The vehicle manufacturer is requested to provide the Euro NCAP secretariat with colour data (expected impact speeds are not required) detailing the AEB performance of the VUT in the HCRs, HCRm and HCRb scenarios for all impact location and test speed combinations. All data should be supplied by the manufacturer before any testing begins, preferably with delivery of the test vehicle(s).

Data should be provided for each test scenario configuration according to the colour scheme in Figure 5-1 for HCRs 10 to 90 km/h and HCRb 50 km/h and 80 km/h, and Figure 5-2 for HCRm 30 to 90 km/h. In case of the maximum vehicle speed being less than 90 km/h, the manufacturer must advise of this speed and indicate the predicted performance according to the nearest speed colour scheme.

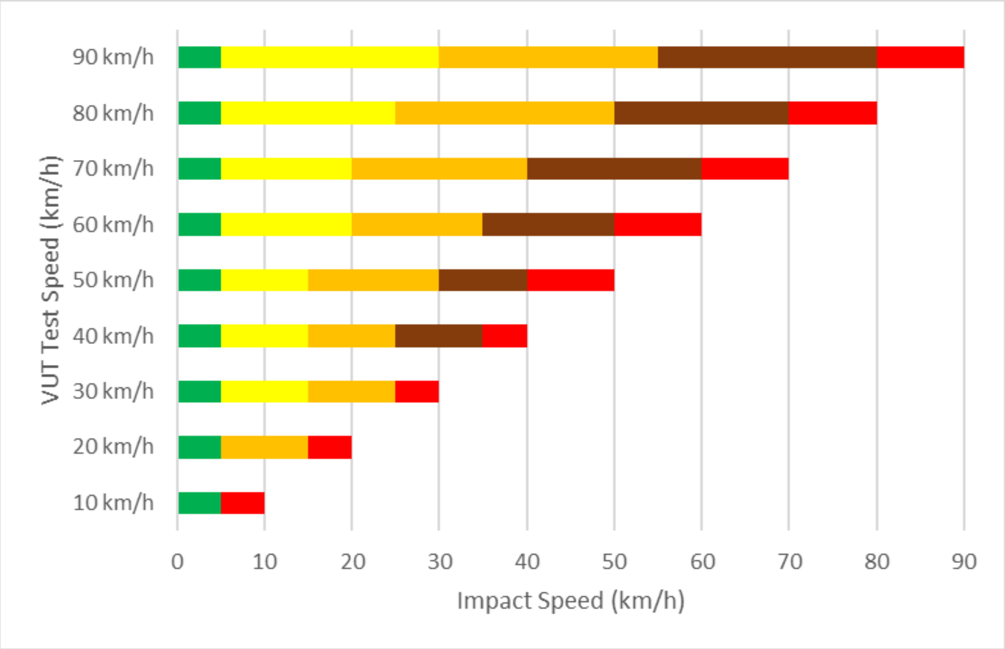

Figure 5-1 HCRs and HCRb predicted performance

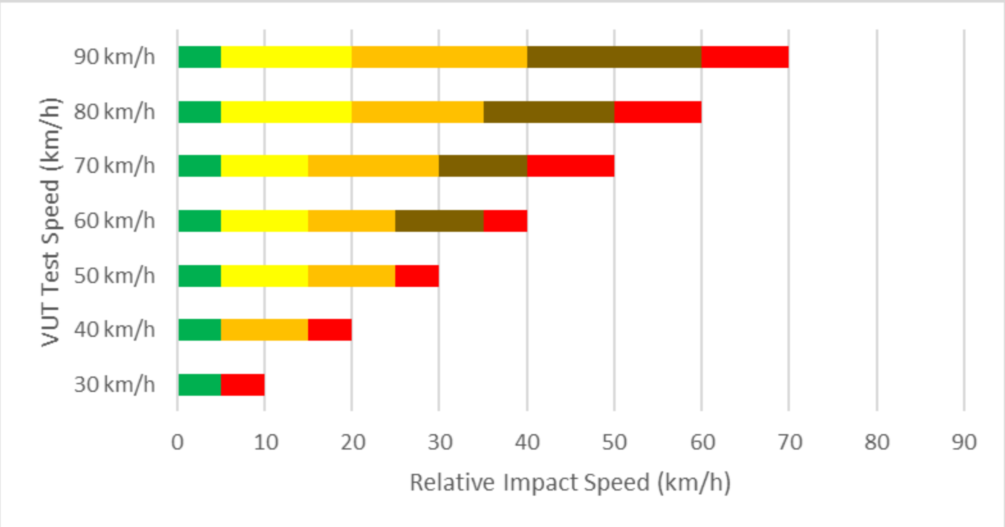

Figure 5-2 HCRm predicted performance

6 TEST CONDITIONS

6.1 Test Track

6.1.1 Paved Surface

Conduct tests on a dry (no visible moisture on the surface), uniform, solid-paved surface with a consistent slope between level and 1 % in all directions. The test surface shall have a minimal peak braking coefficient (PBC) of 0.9.

The surface must be paved and may not contain any irregularities (e.g. large dips or cracks, manhole covers or reflective studs) within a lateral distance of 5.0 m to either side of the centre of the test lane and with a longitudinal distance of 20.0 m ahead of the VUT from the point after the test is complete.

The presence of lane markings is allowed. However, testing may only be conducted in an area where typical road markings depicting a driving lane may not be parallel to the test path within 3.0 m either side. Lines or markings may cross the test path but may not be present in the area where AEB activation is expected.

6.1.2 Weather Conditions

Conduct tests in dry conditions with ambient temperature above 5 °C and below 40 °C.

No precipitation shall be falling and horizontal visibility at ground level shall be greater than 1 km. The mean wind speed measured at a height of at least 1.0 m above the ground shall be less than 6.0 m/s with gusts not exceeding 10.0 m/s to minimise VUT disturbance.

Natural ambient illumination must be homogenous in the test area and in excess of 2,000 lux for daylight testing 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.

Measure and record the following parameters preferably at the commencement of every single test or at least every 30 minutes:

- Ambient temperature in °C
- Track Temperature in °C
- Wind speed in m/s
- Wind direction in azimuth ° and/or compass point direction
- Ambient illumination in Lux

6.1.3 Surroundings

Conduct testing such that there are no other vehicles, highway furniture, obstructions, other objects or persons protruding above the test surface that may give rise to abnormal sensor measurements within a lateral distance of 5.0 m to either side of the test path during the full duration of the test starting at T_0 and within a longitudinal distance 20.0 m ahead of the VUT when the test ends.

Test areas where the VUT needs to pass under overhead signs, bridges, gantries or other significant structures are not permitted.

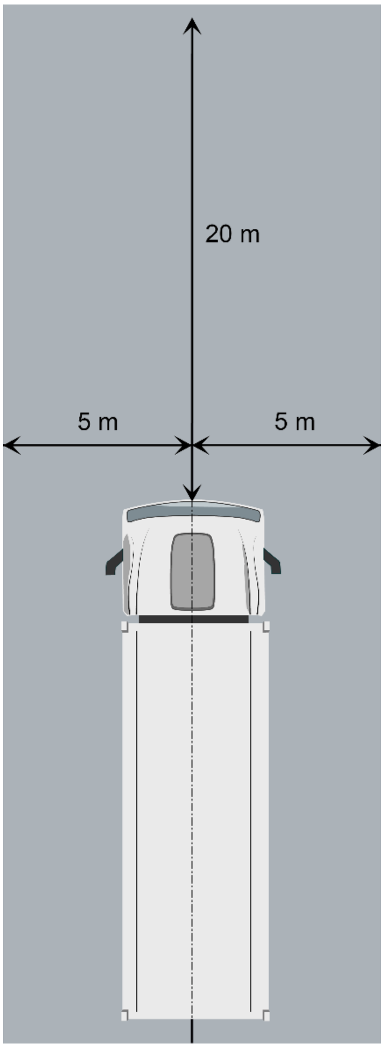

Figure 6-1 Free surroundings

The general view ahead and to either side of the test area shall comprise of a wholly plain man made or natural environment (e.g. further test surface, plain coloured fencing or hoardings, natural vegetation or sky etc.) and must not comprise any highly reflective surfaces or contain any vehicle-like silhouettes that may give rise to abnormal sensor measurements.

6.2 VUT Preparation

Set any driver configurable elements of the system to the middle setting or midpoint and then next latest setting similar to the examples shown in Figure 6-2.

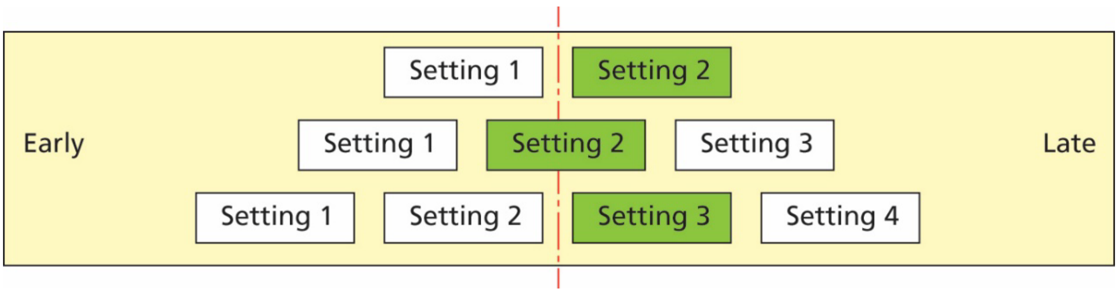

Figure 6-2 System setting for testing

6.2.1 Deployable Pedestrian/VRU Protection Systems

Where the vehicle is equipped with a deployable pedestrian/VRU protection system, this system shall be deactivated before the testing commences.

6.2.2 Trailer for Drawing Vehicles

Where the VUT is designed as a prime mover intended for drawing a trailer, complete testing with the VUT coupled to an appropriate trailer of the following specification:

- Of length and height approaching but not exceeding the maximum permitted by Annex 1 of Directive 96/53/EC
- Equipped with a three axle bogie (lift and/or steer axles are permitted to aid manoeuvrability however all axles must be deployed in their regular operating position during testing)
- Of adequate gross trailer mass to fulfil the gross train mass of the VUT
- With a flat floor i.e. not stepped, gooseneck or double deck
- With curtain side body in plain colour without branding
- Suitable for 5th wheel height of the VUT
- Equipped with disc brakes, an UN ECE Regulation 13 Category 1 Antilock Braking System (ABS) and an Electronic Braking System (EBS)
- Equipped with super single tyres (385/65R22.5) in good condition corresponding to the new original fitment tyres of the make, model, size, speed and load rating as specified by the trailer manufacturer
- Maintained in a fully operational condition in accordance with the manufacturer's documentation and specifications with supporting evidence

Figure 6-3 Example of a suitable trailer for testing

For the purposes of determining drawing vehicle and trailer loading, a nominal trailer mass of 6,700 kg is considered. Weigh the trailer used for testing and account for any variation from the nominal trailer mass when applying the load as illustrated in 6.2.6.

6.2.3 Tyres

Perform the testing with good condition original fitment tyres of the make, model, size, speed and load rating as specified by the vehicle manufacturer. Use inflation pressures corresponding to the manufacturer's instructions for the appropriate loading condition.

Run-in tyres according to the tyre conditioning procedure specified in 7.1.3. After running-in maintain the run-in tyres in the same position on the vehicle for the duration of the testing.

6.2.4 Running Order

Confirm that all VUT safety and operational systems are functioning correctly with no warning messages or indicators displayed to the driver. Rectify any faults before commencing testing.

Set any configurable driving controls to their automatic setting e.g. ride height setting. If an automatic setting is not available, set to a middle setting.

When driven on the test track with the steering control centrally aligned, ensure the VUT exhibits good straight line driving order. In case of unsatisfactory driving order, the test laboratory shall undertake remedial work to return the geometry to within the vehicle manufacturer tolerances and confirm good driving order.

6.2.5 Loading and Vehicle Preparation

Complete testing with the VUT half laden by mass to represent average category N vehicle operation. The procedure to prepare the VUT load requirement for testing is:

- If applicable, fill up the tank with fuel to at least 90% of the tank's capacity of fuel, or in case of large tank capacity, partially fill the tank with adequate fuel to perform the testing, noting the fuel level and the vehicle manufacturer specified tank capacity
- Check that the levels of all fluids are within operating limits and top up where necessary
- Ensure that the VUT has all its bodywork and spare wheel on board, if fitted, along with any equipment or tools supplied. Nothing else should be in the VUT
- Ensure that all tyres are inflated according to the manufacturer's instructions for the appropriate loading condition
- Measure the VUT axle masses (without trailer coupled for a drawing vehicle – unladen test trailer mass to be determined separately) to determine the 'measured kerb mass'
- If applicable, calculate the total mass including full fuel tank (accounting for absent fuel as necessary) and for drawing vehicles, adding the 'nominal trailer mass' in 6.2.3
- The total mass is the 'unladen kerb mass' of the VUT. Record calculation details and this mass in the test details
- Determine the 'maximum permitted mass' for the VUT as the lesser of:
  - The vehicle manufacturers maximum design mass, or
  - The maximum permitted mass of the relevant vehicle or vehicle combination that is legally complaint for international transport under the terms of Annex 1 of Directive 96/53/EC
- Note the 'maximum permitted mass' must include any applicable allowance to compensate for the mass of equipment associated with alternative fuel or zero emission technologies, clearly identified from a section on the vehicle plate titled 96/53/EC article 10b compliant
- Calculate the 'nominal as tested mass' as follows:

  Nominal as tested mass = (unladen kerb mass + maximum permitted mass) / 2

- Calculate the 'load mass' required to achieve the 'nominal as tested mass', accounting for absent fuel, and for drawing vehicles, any difference between the 'nominal trailer mass' and 'actual test trailer mass'

  Load mass = nominal as tested mass - measured kerb mass - actual test trailer mass

- Apply the 'load mass' to the vehicle comprising of the occupant(s), test equipment (i.e. on-board test equipment and instrumentation, associated cables, cabling boxes and power sources) and ballast, density of no less than 1,000 kg/m^3, placed directly on the load bed
- Locate the centre of mass of the ballast centrally within the cargo space (longitudinally and laterally) as far as is as practically possible. Ballast must be securely attached to the VUT and regularly checked during testing to confirm security. If water is used as ballast, it shall be used in full containers to prevent the movement under acceleration
- Measure the VUT axle masses with the occupant(s), test equipment and ballast on board and determine the 'as tested mass', confirming that individual axle weights do not exceed their permitted maximums
- The difference between the 'actual as tested mass' and the 'nominal as tested mass' shall be no more than the lesser of ± 2.5% of the VUT maximum permitted mass or ± 500 kg

Verify the xy coordinates for the virtual front end vehicle contour given by the manufacturer. When the coordinates given are within 10 mm of those measured by the test laboratory, the coordinates as provided by the manufacturer will be used. When the coordinates are not within 10 mm, the coordinates as measured by the laboratory will be used.

7 TEST PROCEDURE

7.1 VUT Pre-test Conditioning

7.1.1 General

A new vehicle is used as delivered to the test laboratory, however a vehicle may have been used for other Euro NCAP Safe Driving and Crash Avoidance tests.

If requested by the vehicle manufacturer and where not already performed for other tests, drive a maximum of 100 km on a mixture of urban and rural roads with other traffic and roadside furniture to ‘calibrate’ the sensor system. Avoid harsh acceleration and braking.

7.1.2 Brakes

Condition the vehicle’s brakes in the following manner (if it has not been done before for another test or in case the laboratory has not performed 100 km of driving) to ensure they are neither brand new nor corroded. Before commencing the next brake conditioning run, confirm the temperature of the hottest brake rotor is less than 400 °C, or wait a minimum of 120 seconds between runs to prevent brake overheating.

- Perform ten stops from a speed of 56 km/h with an average deceleration of approximately 0.2 to 0.3 g
- Immediately following the series of 56 km/h stops, perform three additional stops from a speed of 72 km/h, each time applying sufficient force to the pedal to operate the VUT antilock braking system (ABS) for the majority of each stop
- Immediately following the series of 72 km/h stops, drive the vehicle at a speed of approximately 72 km/h for five minutes to cool the brakes

7.1.3 Tyres

Condition the vehicle’s tyres in the following manner (if it has not been done before for another test or in case the laboratory has not performed 100 km of driving) to remove the mould sheen.

- Drive around a circle of 100 m in diameter at a speed sufficient to generate a lateral acceleration of approximately 0.1 to 0.2 g for three clockwise laps followed by three anticlockwise laps
- Immediately following the circular driving, drive four passes at 56 km/h, performing ten cycles of a sinusoidal steering input in each pass at a frequency of 1 Hz and amplitude sufficient to generate a peak lateral acceleration of approximately 0.1 to 0.2 g
- Make the steering wheel amplitude of the final cycle of the final pass double that of the previous inputs

In case of instability in the sinusoidal driving, reduce the amplitude of the steering input to an appropriately safe level and continue the four passes.

7.1.4 System Check

Before any testing begins, perform a maximum of ten runs at the lowest test speed the system is supposed to work, to ensure proper functioning of the system.

7.2 Test Scenarios

7.2.1 General

The performance of the AEB system is assessed in the HCRs, HCRm and HCRb scenarios as shown in Figure 7-1, Figure 7-2 and Figure 7-3 respectively.

In case of the maximum vehicle operational speed being less than 90 km/h, the laboratory must test up to the maximum vehicle operational speed with a tolerance of -2 km/h.

For testing purposes, assume a straight-line path equivalent to the centreline of the lane in which the collision occurred, hereby known as the test path. Control the VUT with driver inputs or using alternative control systems that can modulate the vehicle controls as necessary to perform the tests.

7.2.2 HGV-to-Car Rear Stationary (HCRs)

The HCRs scenario is a combination of a range of approach speeds in 10 km/h incremental steps and impact locations with a stationary GVT, as shown in Figure 7-1.

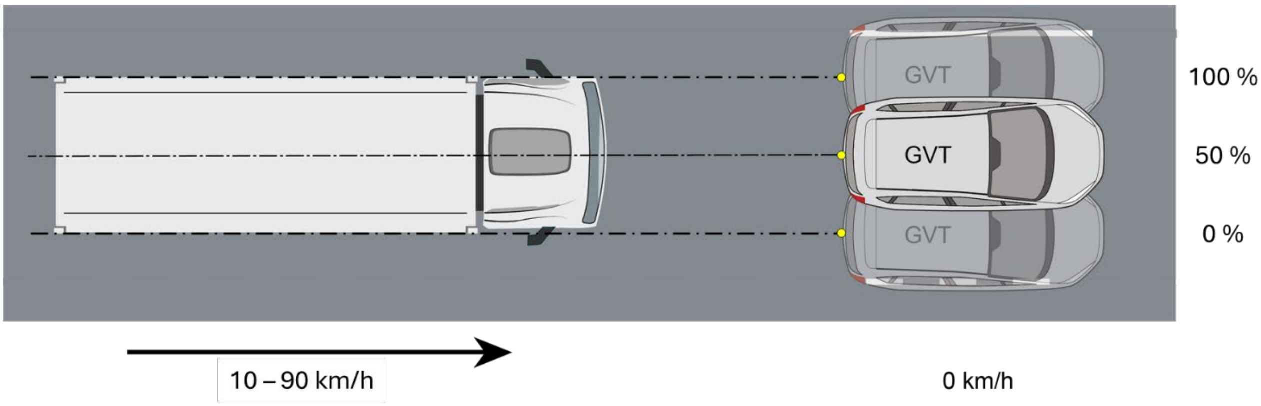

Figure 7-1 HCRs scenario

7.2.3 HGV-to-Car Rear Moving (HCRm)

The HCRm scenario is a combination of a range of approach speeds in 10 km/h incremental steps and impact locations with a GVT travelling at 20 km/h, as shown in Figure 7-2.

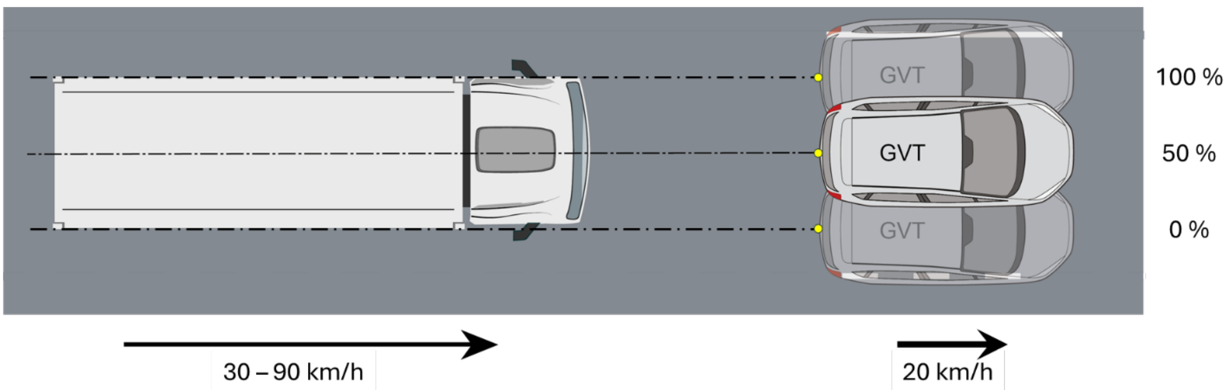

Figure 7-2 HCRm scenario

7.2.4 HGV-to-Car Rear Braking (HCRb)

HCRb tests are performed with the VUT and GVT travelling at fixed speeds of 50 and 80 km/h with a 50 % impact location with the GVT, with all combinations of 2 and 6 m/s^2 deceleration, as shown in Figure 7-3. Two headways are used for each test speed, in the 50km/h tests headways are 12 and 40 m and in the 80 km/h tests headways are 30 and 50 m.

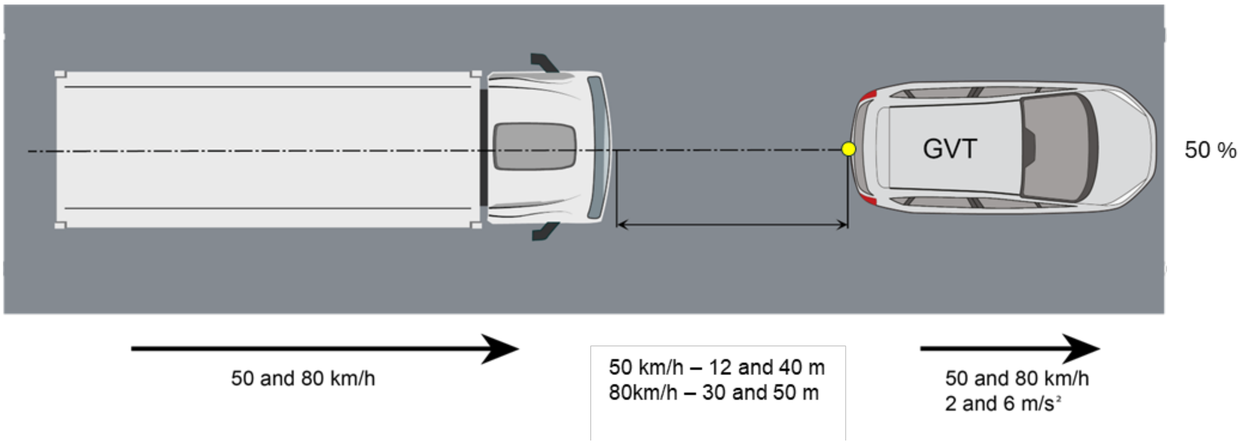

Figure 7-3 HCRb scenario

The desired deceleration of the GVT shall be reached within 1.0 seconds (T_0 + 1.0 s) which after the GVT shall remain within ± 0.5 km/h of the reference speed profile, derived from the desired deceleration, until the GVT speed equals 1.0 km/h.

7.2.5 AEB Sensitivity to Driver Inputs

The AEB sensitivity to driver inputs is evaluated in an HCRs scenario with the VUT and GVT centrally aligned. The test laboratory shall select a VUT test speed at which full deployment of all stages of the AEB results in a collision with the GVT being avoided. The objective is to apply individual modest control inputs that indicate some level of driver activity, but which are of insufficient magnitude to avoid the imminent collision.

Repeat the previously completed AEB HCRs test at the selected test speed. When the AEB reduces the VUT speed to 75 % of the nominal test speed, apply the following driver inputs individually to investigate their effect on AEB system operation. Maintain other control inputs as per normal testing.

- Ramp steering wheel input in a randomly selected direction, starting from the current steering wheel position, increasing at 30 °/s for a duration of 0.5 s and then holding the resultant steering wheel angle
- Ramp accelerator pedal input, starting from the current pedal position, increasing at 30 %/s of total travel for a duration of 0.5 s and then holding the resultant pedal position
- Ramp brake pedal input, starting from the current pedal position, increasing at 30 %/s of total travel for a duration of 0.5 s and then holding the resultant pedal position

7.3 Test Conduct

Before every test run, drive the VUT around a full circular path, and then manoeuvre the VUT into position on the test path. If requested by the OEM an initialisation run may be included before every test run. Bring the VUT to a halt and push the brake pedal through the full extent of travel and release.

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 1000 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 the AEB system in the VUT. Apply only minor steering inputs as necessary to maintain the VUT tracking along the test path.

When the test outcome is collision avoidance or substantial speed reduction, proceed to the next test speed. Stop testing when, for two consecutive test speeds, the speed reduction observed is less than 5 km/h or the relative impact speed is greater than 20 km/h.

Before commencing the next test run, confirm the temperature of the hottest brake rotor is less than 150 °C. It is acceptable to wait for brake cooling to occur between test runs. Forced cooling is permitted with ambient air only.

Between tests, avoid riding the brake pedal and harsh acceleration, braking or turning unless strictly necessary to maintain a safe testing environment.

7.4 Test Execution

Accelerate the VUT and GVT to their respective test speeds.

The test shall start at T_0 (4s TTC) and is valid when all boundary conditions are met between T_0 and T_{AEB} or any other system intervention:

-	Speed of VUT (GPS-speed)	Test speed + 1.0 km/h
-	Speed of GVT (GPS-speed)	Test speed ± 1.0 km/h
-	Lateral deviation from test path for VUT	0 ± 0.10 m
-	Lateral deviation from test path for GVT	0 ± 0.10 m
-	Relative distance between VUT and GVT (HCRb)	12 or 40 m, 30 or 50 m ± 0.5 m
-	Yaw velocity of VUT	0 ± 1.0 °/s
-	Steering wheel velocity	0 ± 20.0 °/s

In case of the unanticipated withdrawal of automatic braking during an AEB system test, investigate the steering wheel velocity after T_{AEB}. If the steering wheel velocity exceeds the 0 ± 20.0 °/s limit after T_{AEB} repeat the test taking measures to maintain the steering wheel velocity within the limit until the end of the test. Note that other testing tolerances remain applicable from T_0 to T_{AEB} only.

The end of a test is considered when one of the following occurs:

- V_{VUT} = 0 km/h
- $V_{VUT} < V_{GVT}$
- T_{impact}

For manual or automatic accelerator control, it must be assured that during automatic braking the accelerator pedal does not result in an override of the system. There shall be no operation of other driving controls during the test e.g. clutch or brake pedal.

If during the execution of a test run it can be confidently predicted that V_{impact} would be in the red colour band for the test speed, it is permitted to end the test and take evasive action to avoid a collision in the interest of preserving the VUT and GVT.

7.5 System Deactivation

Where a means is provided for the driver to deactivate the AEB system, investigate and record the method(s) of deactivating and reactivating the system.