

EUROPEAN NEW CAR ASSESSMENT PROGRAMME (Euro NCAP)



FAR SIDE OCCUPANT TEST & ASSESSMENT PROCEDURE

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Where text is contained within square brackets this denotes that the procedure being discussed is currently being trialled in Euro NCAP. Its incorporation in the Test Protocol will be reviewed at a later date.

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).

1 INTRODUCTION

- 1.1 This protocol details the assessments to be performed in far side occupant protection that contribute to the side impact part of the adult occupant protection rating.
- 1.2 The far side occupant test data will be supplied to Euro NCAP by the vehicle manufacturer.
- 1.3 A monitoring phase will be undertaken between January 2018 and December 2019, with the far side assessment becoming an integral part of the rating for all vehicles launch in 2020 onwards.
- 1.4 It is a requirement that this data will be provided to the Secretariat for all ratings published from January 2018 onwards.
- 1.5 Where no far side occupant data is supplied by the OEM during the monitoring phase, the optional pole test data will not be accepted by Euro NCAP and the pole score will be 0 points. From 2020 onwards, far side occupant protection and pole test will be scored separately.
- 1.6 Far side test data will only be accepted in the form of physical sled tests; full scale tests and CAE data will not be accepted.

2 PREREQUISITES

- 2.1 In both the AE-MDB and pole impacts, the structural performance of the door, it's attachments to the body, the roof/cant rail and sill must be structurally 'stable' to provide confidence in the position intrusion lines. Full or partial detachment of door latches/hinges, fully opened doors or structural failures of the roof/cant rail and sill will preclude the acceptance of far side assessment data.
- 2.2 Any of the following post test conditions will disqualify the vehicle from any rewards in far side occupant protection.
- 2.2.1 Where the total score of the AE-MDB and pole impacts is below [10.0] points (out of 12). Applicable from 2020 onwards.
- 2.2.2 Restraint system failures in either the AE-MDB or pole impacts that are intended for far side occupant protection. For example, incorrect deployment of centre (occupant to occupant) airbags.

3 HARDWARE SETUP

3.1 General

- 3.1.1 An acceleration based sled rig is to be used along with a 'body in white' (BIW) of the car model being assessed.
- 3.1.2 The BIW shall be mounted with the centreline at $75^{\circ} \pm 3^{\circ}$ towards the direction of travel.
- 3.1.3 A BIW that is of a pre-production state will be accepted provided that it is shown to be representative of series production and that any differences have no influence on the far side assessment.
- 3.1.4 All features which may influence occupant kinematics and protection must be installed in the BIW.
- 3.1.5 The BIW may be from either a right or left hand drive vehicle.
- 3.1.6 For the purpose of this assessment, the 'far side occupant' is on the driver's side of the vehicle which is also the non struck side. The struck side is the passenger's side of the vehicle.
- 3.1.7 One WorldSID 50th male dummy will be seated on the far side of the vehicle.
- 3.1.8 The assessment shall be performed on the specification of equipment fitted to the best selling variant. This includes, but is not limited to, the transmission, front seats, restraints and interior trim/centre console.
- 3.1.9 The seats of the best selling variant (as per AE-MDB and pole impacts) will be used in the BIW.
- 3.2 Body preparation
- 3.2.1 The bodyshell shall be mounted on the sled such that there will be no permanent deformation of the body or its mounts during the tests.
- 3.2.2 Struck side intrusion will not be replicated on the BIW.
- 3.2.3 Driver and/or passenger doors will not be required.
- 3.2.4 Structures forwards of the A-pillar and windscreen cowl and rearward of the B-pillar may be removed from the BIW as long as the stability is not compromised
- 3.2.5 Reinforcement of the BIW is recommended but not required provided the BIW is sufficiently stable. The following areas are suggested:

B-pillar Seatbelt mountings ("D"-loop & Retractor) Driver's seat plinth Windscreen and roof

3.2.6 To ensure a clear view on dummy kinematics, vehicles with removable roofs, panels or movable sunshine roofs shall be tested without the roof or with them in the open position.

Where there is a fixed roof above the front row seats, it shall be cut away between the cant rails and rearwards of the windscreen surround. Reinforcement should subsequently be applied laterally across the BIW.

3.2.7 Sufficient spacers shall be fitted in the gaps between the struck side (B-pillar or other structure) and passenger seat, the passenger seat and centre console to stabilize the front passenger seat. This represents the behaviour of the struck side seat and centre console due to crash induced intrusion and deformation. An example how this can be done is shown in the picture below.

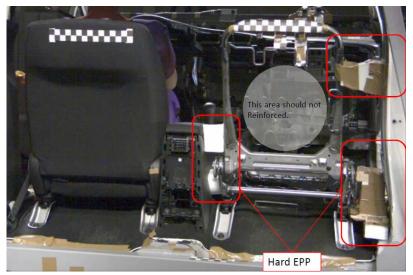


Figure 1: Seat spacers (seat fabric removed for visualisation only)

- 3.2.8 The spacers shall have the stiffness characteristics from expanded polypropylene (EPP60) or stiffer with compression properties of about 340KPa for 25% of compression (determined according to ISO 844).
- 3.2.9 Interior components required for testing will include, but are not limited to:
 - Driver and passenger front seats.
 - Full tunnel/centre console components consisting of the full tunnel trim, hand brake assembly, storage compartments.
 - Full facia assembly consisting of the facia, steering column and steering wheel. Infotainment systems may be omitted if appropriate.
 - Seat belt/pretensioner and anchorage attachments.
 - Struck side internal door trim assembly (if doors installed).
- 3.2.10 If fitted, the struck side door trim shall be painted white (or similar) to contrast with the passenger's seat.
- 3.3 Active restraints
- 3.3.1 Active restraint systems shall be standard equipment and identical to those used in the Euro NCAP impact tests.
- 3.3.2 Triggering of pretensioners will be accepted on the sled if the difference in deployment time from the official tests is no greater than +/-[2]ms. Where the difference is greater than 2ms, data must be supplied showing that this did not affect the result.
- 3.3.3 Triggering of other active restraints, such as the side curtain and seat mounted airbags, will not be permitted unless it can be shown that these systems have been designed as a countermeasure intended to lower the risk of far side occupant injury. For example, a head curtain airbag that extends beneath the door level, or a seat mounted airbag that can remain sufficiently inflated for the required length of time to limit occupant excursion.

- 3.4 Vehicle markings
- 3.4.1 A chequered or similar grid measuring 50x50mm shall be rigidly mounted to the BIW directly behind, but not attached to the front seats in a way that does not result in interference during the test.
- 3.4.2 Three vertical and parallel excursion lines will be marked in the BIW for both sled test scenarios
 - Maximum intrusion line (red)

This line is marking the maximum post test intruding point of the interior door panel from AE-MDB (60km/h) and 75° pole impacts respectively. The method to determine the maximum deformation is detailed in Appendix II. During the monitoring phase (2018-2019), intrusion lines defined from CAE simulation will be accepted if there is no data available from an AE-MDB 60km/h test. In this case, simulation data shall also be provided from a 50km/h AE-MDB test as a reference.

Peak intrusion values will be compared to those observed in the official tests, a suitable tolerance is required and will be established using data observed in the monitoring phase.

- Head excursion higher performance limit (yellow) Struck side [seat centreline]
- Occupant interaction limit (green)
 250mm inboard from the struck side seat centreline
- 3.4.3 In addition to the three excursion line, the vehicle centreline will be marked in blue
- 3.4.4 All markings must be extended onto the chequered grid board positioned behind the front seats.

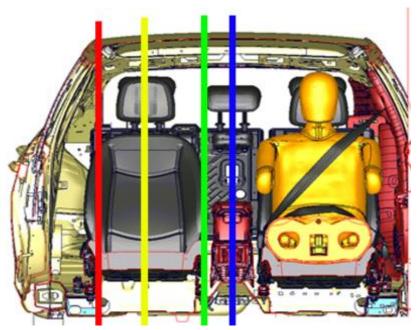


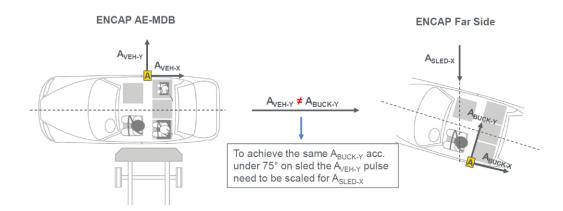
Figure 2: Vehicle markings

4 TEST PROGRAMME

4.1 Sled Acceleration Pulses

- 4.1.1 Two sled tests are required for far side occupant evaluation.
- 4.1.2 One test shall be performed using a representative 60km/h AE-MDB to car non struck side B-pillar pulse. The sled pulse shall be a scaled B-pillar pulse as measured in the AE-MDB test and pole test due to the angled test sled set-up. To ensure a similar B-pillar pulse in the sled test the following scaling is applied:

 $A_{X,SLED} = A_{Y,VEHICLE(AE-MDB)} \times 1.035$ $A_{X,SLED} = A_{Y,VEHICLE(POLE)} \times 1.035$



- 4.1.3 One test shall be performed using a representative 32km/h 75° pole test non struck side B-pillar pulse.
- 4.1.4 During the monitoring phase (2018-2019), 60km/h pulse data defined from CAE simulation will be accepted if there is no data available from a physical test. In this case, simulation data shall also be provided from a 50km/h AE-MDB test as a reference.
- 4.1.5 All pulses shall be from the non-struck side, B-pillar base and filtered at CFC60.
- 4.1.6 In house test vehicle variants may differ slightly from the official model tested by Euro NCAP e.g. engine etc. This is so that testing can be performed in advance of the official Euro NCAP tests.
- 4.1.7 The suitability of the correlation between the vehicle and sled pulses will be checked according to the method detailed in Appendix 1.

4.2 Dummy and instrumentation

- 4.2.1 A WorldSID 50th percentile male test dummy shall be used in the front driver's position. It shall conform to the specification detailed in ISO 15830, parts 1-5.
- 4.2.2 The WorldSID dummy shall be equipped with the half arm assembly on both sides.
- 4.2.3 The dummy shall be clothed in a sleeveless suit, either ref W50-80200 or a modified version of the sleeved suit with sleeves removed according to Humanetics procedure.
- 4.2.4 The dummy shall have a stabilised temperature in the range of 20.6°C to 22.2°C. A copy of the temperature readings is to be supplied as part of the standard output of the test.
- 4.2.5 Data processing shall be in accordance with Technical Bulletin 021.
- 4.2.6 The WorldSID dummy shall be instrumented to record the channels listed below. Additional channels may be recorded. In-dummy data acquisition system is recommended and in case of 45 or more channels it is required.

Location	ntion Parameter		Channel count
Head	Linear acceleration, Ax, Ay, Az	250g	3
Head	Angular velocity, ωx, ωy, ωz	4000deg/sec	3
Upper neck	Forces and moments Fx, Fy, Fz, Mx, My, Mz	5kN, 300Nm	6
Shoulder – Joint	Forces, Fx, Fy, Fz	8kN	3
Shoulder – Rib	Displacement & rotation	100mm	2
Thorax - Upper rib	Displacement & rotation	100mm	2
Thorax - Mid rib	Displacement & rotation	100mm	2
Thorax - Lower rib	Displacement & rotation	100mm	2
Thoracic temperature	Temperature	30°C	1
Abdomen - Upper rib	Displacement & rotation	100mm	2
Abdomen - Lower rib	Displacement & rotation	100mm	2
	Acceleration, Ax, Ay, Az	200g	3
Spine - T12	Forces Fx, Fy, Fz,	5kN	3
	Moments, Mx, My, Mz	300Nm	3
Dalwis	Acceleration, Ax, Ay, Az	200g	3
Pelvis	Pubic force	5kN	1
	Total Channels		41

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4.3 Sled Instrumentation

Location	Parameter	Minimum Amplitude	No of channels
B-Post non-struck side (BIW coordinates)	Accelerations, A _x , A _y	150g	2
Sled	Accelerations, A _x	150g	1
Driver Seatbelt Shoulder Section	Force, F _{diagonal}	16kN	1
Digital contact switch between thorax and centre console	Time, ms	NA	1
	Total vehicle channels		5

4.4 Passenger compartment adjustments

- 4.4.1 Passenger compartment adjustments used in the BIW will be as per the relevant passenger compartment adjustments detailed in the AE-MDB side impact test protocol (where relevant).
- 4.4.2 The driver and passenger seat fore/aft and seat back angles will be positioned identically. Where a vehicle has different seat travel between the driver and passenger side, the passenger seat travel will be positioned as close as possible to that of the driver and the seat back angle will also be the same as that of the driver.
- 4.4.3 Vehicles equipped with adjustable arm-rests will have them positioned in the 'not in use' position.
- 4.4.4 The parking brake shall be in the disengaged position and the gear lever in D or in a gear position.

4.5 Driver dummy positioning

4.5.1 The dummy shall be installed on the driver's seat (non struck side) in accordance with the H-point manikin and dummy positioning procedures detailed in the AE-MDB side impact test protocol.

- 4.6 Dummy painting & Markings
- 4.6.1 The dummy shall have masking tape placed on the areas to be painted using the sizes detailed below. The tape should be completely covered with the following coloured paints. The paint should be applied close to the time of the test to ensure that the paint will still be wet on impact.

Driver

Head inboard (Paint ta	Red		
Head CoG inboard (ci	ircle)		Yellow
Head top along mid sa	agittal p	lane	Green
Shoulder/		Arm	Blue
2nd Thorax	Rib	Green	
3rd Thorax	Rib	Red	
1st Abdomen	Rib	Blue	
2nd Abdomen	Rib	Green	
Pelvis			Orange

NOTE: The tape should be completely covered with the coloured paints specified, with the exception of the driver head which should have only the outer edge of the tape painted.

Tape Sizes:

Head = 100mm square, centreline of head with lower edge at CoG.

Head = 200mm x 20mm strip, centre located at head CoG

Arm = 25mm x 150mm, starting at bottom edge of shoulder fixing hole. Ribs = 25mm x 150mm strip, starting at the rearmost point at seat back.

Pelvis = 50mm x 100mm, centred on hip joint point.



Figure 3: Dummy painting

- 4.6.2 The dummy shall have two markers at the front of the dummy head for video analysis. They will be positioned on the head front mould split line at:
 - Centre of Gravity
 - 100mm below Centre of Gravity

4.7 Pre-test measurements

4.7.1 To ensure repeatability of dummy seating & positioning - take detailed static 3D measurements of dummy and vehicle interior after the dummy settling and positioning procedures have been carried out.

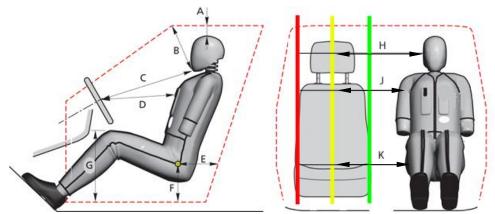


Figure 4: Pre test measurements

Driver me	Driver measurements		
В	Chin/windscreen joint		
С	Chin/centre of the steering		
D*	Thorax strap/centre of the steering wheel		
Е	Hip-joint point/inside opening of the door (horizontal), manikin and dummy		
F	Hip-joint point/inside opening of the door (vertical), manikin and dummy		
G	Knee/floor covering (vertical)		
Н	Head to seat centreline		
J	Shoulder to seat centreline		
K	Hip-joint point to seat centreline		

^{*} Horizontal distance from steering wheel centre

5 PHOTOGRAPHIC RECORD

- 5.1 Insufficient high speed or still photography could result in the data not being accepted by the Euro NCAP Secretariat.
- 5.2 It is essential that the onboard cameras are attached to the sled in a way that minimises relative motion during the test.
- 5.3 Sufficient lighting must also be provided to ensure that the maximum head excursion can be clearly seen on the high speed film.
- 5.4 High speed film
- 5.4.1 High speed film, 1000fps minimum, is required for both tests. The following specification shall be used:

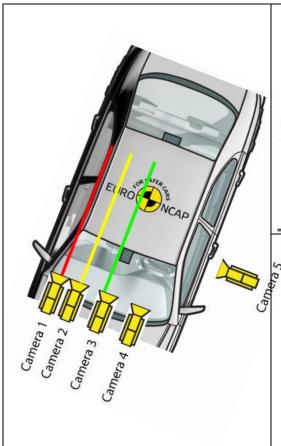
x Format: MP4 or AVI.

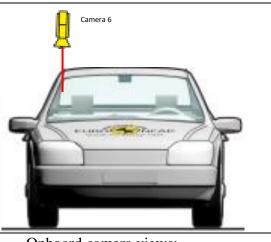
x Codec: H.264, Data/Bit rate: 2 Mbps. x Resolution: Native camera resolutions.

x Frame rate: 1000 fps.

x Must include burnt in timers

- 5.4.2 Sled mounted high speed cameras shall be used to record the whole of the relevant scene.
- 5.4.3 Care should be taken to ensure that camera placement for cameras 1,2, 3 and 4 is directly in line with the corresponding performance line and also parallel to the vehicle centre line. Where the camera positions are overlapping, the highest priority should be given to camera 1.





Onboard camera views:

- 1. Front, red line
- 2. Front, yellow line
- 3. Front, green line.
- 4. Front, driver pre-test
- 5. Side, driver pre-test pelvis to head
- 6. Plan, red line

Offboard camera views:

- 7. Front, parallel to vehicle CL
- 8. Front, perpendicular to direction of travel



Camera: 1

Description:

Front view centred to intrusion limit, as low as possible capturing max head excursion.

Parallel to vehicle centreline.



Camera: 2

Description:

Front view centred to higher performance excursion limit (seat centreline), as low as possible.
Parallel to vehicle centreline.



Camera: 3

Description:

Front view centred to occupant interaction limit, as low as possible.

Parallel to vehicle centreline.



Camera: 4

Description:

Front view centred to driver seat centreline.

Parallel to vehicle centreline.



Camera: 5

Description:

side view of driver centred to middle of door aperture, door waist height.

Perpendicular to vehicle centreline.



Camera: 6

Description:
plan view for X/Y
excursion centred on
intrusion limit.
In vertical Z plane.



Camera: 7
Description:
Front, parallel to vehicle centreline.



Camera: 8

Description:
Front, perpendicular to direction of travel

5.5 Still photography

5.5.1 Pre and post test still photography is required to clearly show the sled set-up and BIW construction. Still photographs should show the fixings of the body in white to the sled, in particular the steering column, facia/tunnel mounting and the appropriate body reinforcements before and after the series of tests.

No.	Pre	Post	View	
1.	1. • Top view of full BIW		Top view of full BIW	
2.	•	•	Front view of full BIW	
3.	•	•	Rear view of full BIW	
4.	•	•	Side view of full BIW	
5.	•	•	Driver's side view of BIW at 45 ° to front	
6.	6. • Passenger's side view of BIW at 45 ° to front		Passenger's side view of BIW at 45 ° to front	
7.	7. • Side view of driver from outside			
8.	8. • Side view of driver from inside (including paint)			
9.	9. • Front view of driver			
10.	•	•	Rear view of spacers in position	
After dummy removal:				
11.		•	Paint transfer to centre console	
12.	12. • Paint transfer to passenger's side door/airbags (if applicable)			

6 DATA PROCESSING AND REPORTING

- 6.1 Data processing
- 6.1.1 Data processing and assessment criteria calculation shall be supplied to Euro NCAP in ISO-MME format in accordance with Technical Bulletin 021.
- 6.2 Reporting
- 6.2.1 The key deliverables will be as follows:
 - Reference pulse data in ISO MME format, as detailed in Section 4.1.
 - BIW & test set-up data, as detailed in Section 4.
 - All sensor outputs in ISO MME format.
 - All sensor curves plotted in a single PDF file (sled and ATD).
 - High speed film (min. 1000fps) Section 5.4.
 - Photos, as detailed in Section 5.5

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7 FAR SIDE OCCUPANT ASSESSMENTS

7.1 Criteria and limit values

The basic assessment criteria used for both impact scenarios, with the upper and lower performance limits for each parameter, are summarised below. The assessments are divided into four individual body regions, the head, neck, chest & abdomen and pelvis & lumbar spine. A maximum of four points are available for the head, neck, chest & abdomen. Where multiple criteria exist for an individual body region, the lowest scoring parameter is used to determine the performance of that region. A maximum of 12 points will be available for each impact scenario.

For dummy injury criteria, a sliding scale system of points scoring has been used to calculate points for each measured criterion. This involves two limits for each parameter, a more demanding limit (higher performance), below which a maximum score is obtained and a less demanding limit (lower performance), beyond which no points are scored. Where a value falls between the two limits, the score is calculated by linear interpolation. A sliding scale is NOT applicable to head excursion.

For both impact scenarios, capping is applied to the head, chest and abdomen.

	Criteria	Performance limits			Points
	Criteria	Higher	Lower	Capping	Points
Head	HIC ₁₅ (with hard contact)	500	700	700	
	Resultant 3ms acceleration	72g	80g	80g	1 points
	Excursion		yellow line	red line	4 points
	SUFEHM		monitoring		
Neck	Tension Fz		3.74kN		
	Lateral flexion Mx		[50Nm]		4 points
	Extension negative My		[50Nm]		
Chest &	Chest lateral compression	28mm	50mm	50mm	1 points
Abdomen	Abdomen lateral compression	[47]mm	[65]mm	[65]mm	4 points
TOTAL					12 points

A hard contact is assumed if the peak resultant head acceleration exceeds 80g or if there is other evidence of hard contact.

7.1.1 Modifiers

	Criteria	Performance limits	
Pelvis &	Pubic symphysis	2.8kN	
Lumbar	Lumbar Fy	[2.0]kN	1 mainta
	Lumbar Fz	[2.84]kN	-4 points
	Lumbar Mx	[100]Nm	

7.1.2 Occupant to occupant interaction limit

Where the head exceeds the occupant interaction limit (green line), the score of the test in which this occurred will be reduced by [50%]. This score reduction can be avoided in case the OEM provides compelling data that demonstrates that in both loadcases the countermeasure implemented avoids occupant-to-occupant interaction without jeopardising the protection of other body regions.

The data provided to Euro NCAP should contain, but is not limited to:

- Evidence showing triggering strategy and trigger times
- Physical test data including dummy numbers, for both driver and passenger, from a full scale and/or sled test confirming the system functionality
- Supporting CAE data demonstrating robustness of the system

7.2 Scoring (from 2020)

The far side score is the sum of the scores from both impact scenarios. The final score from the far side occupant assessments will be scaled down to a maximum of 4 points in the AOP total.

Appendix I

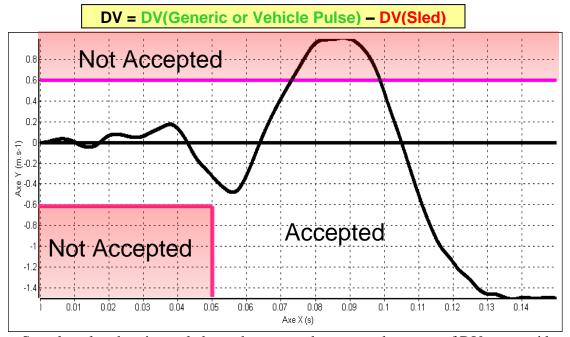
The pulse performed on the sled facility should be close to or more severe as the full scale test pulse. To validate this point, the following process should be used:

- Change the orientation to have sled pulse and generic pulse in globally positive values
- Calculate by integration the Delta V from generic pulse DV1(t), setting the initial velocity to 0
- Calculate by integration the Delta V from sled test DV2(t), setting the initial velocity to 0
- Calculate the difference DV = DV1 DV2
- Calculate by integration of DV1 the X displacement from generic pulse DX1(t), setting the initial value to 0
- Calculate by integration of DV2 the X displacement from sled test DX2(t), setting the initial value to 0
- Calculate the difference DX(t) = DX1(t) DX2(t)
- Calculate DX at 120 ms

Requirement #1:

- If all the DV values up to 120 ms are in the zone as shown below, requirement #1 is OK check requirement #2
- o If some DV values up to 120 ms are outside the zone, requirement #1 is not OK

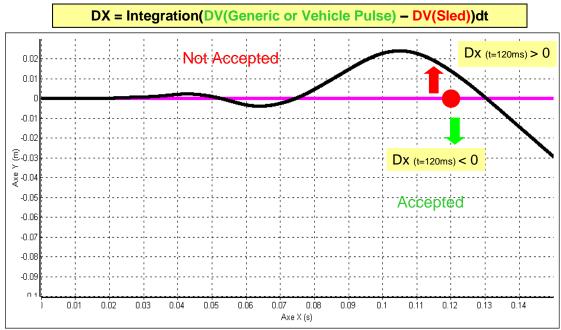
→ sled test is less severe than the test pulse and cannot be accepted



Sample pulse showing a sled test that cannot be accepted as parts of DV are outside the acceptable zone

Requirement #2:

- o If DX value at [120] ms is negative, requirement #2 is OK
 - → sled test is accepted for knee mapping
- o If DX value at [120] ms is positive, requirement #2 is not OK
 - → sled test cannot be accepted



Sample picture shows a sled test that cannot be accepted as DX is positive @ 120ms

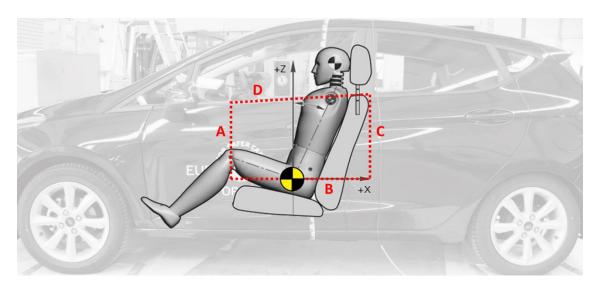
Appendix II

To determine the excursion lines the following method is to be followed. In this method the following definitions are used:

Intrusion area

The intrusion area is the external area limited by the following lines:

Line	Description	
A	Vertical line at x-position 700mm forward of the R-point	
В	Horizontal line at z-position of R-point	
С	Vertical line at x-position at the back of headrest stems	
D	Door waist line	



Maximum intrusion

The maximum intrusion is determined by the most inboard structure within the intrusion area. To find this point of maximum intrusion, scanning the zone is recommended.