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EUROPEAN NEW CAR
ASSESSMENT PROGRAMME

Technical Bulletin

Extension of the Euro NCAP Protocols for the evaluation of Energy Equivalent Speed (EES) values

Version 1.0.1

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Preface

DISCLAIMER: Euro NCAP has taken all reasonable care to ensure that the information published in this document is accurate and reflects the technical decisions taken by the organisation. In the unlikely event that this protocol contains a typographical error or any other inaccuracy, Euro NCAP reserves the right to make corrections and determine the assessment and subsequent result of the affected requirement(s).

This document should always be used in conjunction with the current testing protocols for the Front MPDB, Front FW, Side Barrier and Side Pole tests.

EUROPEAN NEW CAR ASSESSMENT PROGRAMME (Euro NCAP)

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1. Introduction

From the start, Euro NCAP test protocols have included requirements for intrusion measurements. For the EES setup (Energy Equivalent Speed) it is important to accurately measure the deformation of the impact zones to generate the corresponding EES values for each impact scenario. In the end, this is needed to fulfil the calculation requirements of the EES model.

Euro NCAP involves several laboratories that each may have their own internal procedures, quality standards and equipment. In order to improve the consistency of material supplied by the laboratories, all measurement requirements previously specified by Euro NCAP have been brought together, reviewed and updated. This document summarizes the most recent specifications that are compulsory for all official Euro NCAP tests at the accredited Euro NCAP test laboratories.

2. General Requirements

2.1 Measurement Equipment

2.1.1 For measuring the deformation of the MPDB (ODB), Full Width and Side MDB Impact a 3D measuring system shall be used (e.g. 3D measurement arm with attachable scan module). This system must be capable of recording three dimensional co-ordinates of single points, as well as clouds of points (scanner). A tolerance of +/- 1mm is applicable to such a system.

2.1.2 For measuring the deformation of the Side Pole Impact three 3m rulers shall be used. A tolerance of +/- 1cm is applicable to this measurement method.

2.1.3 In addition to the standard accelerometers, a triaxial gyro sensor has to be mounted on a rigid surface in the vehicle trunk. The sensor shall have a range of at least 900°/second.

2.1.4 Overview of required measurements:

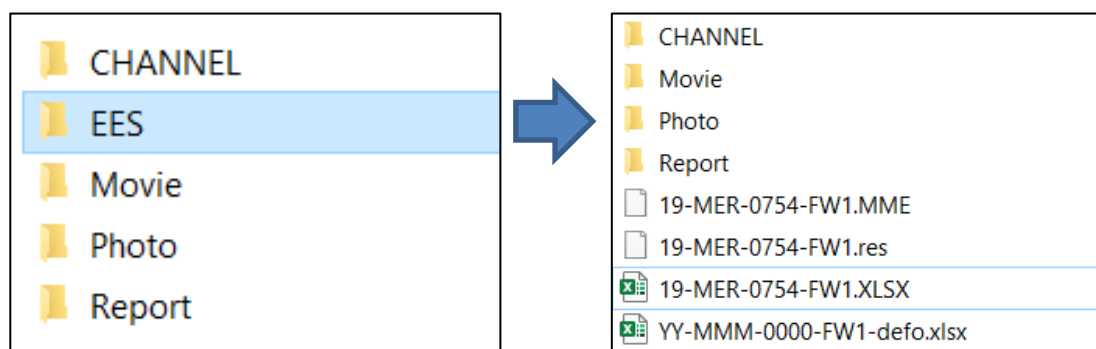
	Dynamic		Static	
	Accelerometer	Angular velocity	3D scan	Simple measurement
	Standard EN sensor			
MPDB/ODB	X	X	(X)	X
AE-MDB	X	X	X	
Pole Side Impact	X		(X)	X
Full Width	X		(X)	X
Pedestrian				X

X Mandatory

(X) Optional: It is acceptable to extract the required measurement points from a 3D scan

2.2 Upload Files/Digital Data Format

2.2.1 Measurement Data shall be stored in the common folder structure as illustrated in the following figures:

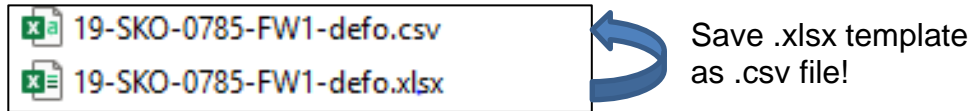


a) Crash Test Data (MME-Files)

For calculation of the measurement data of each crash test impact scenario use macros provided by X-Crash. The filename consists of the test number. The macro creates two files in following formats: .mme and .res.

b) Deformation Measurement (CSV-File)

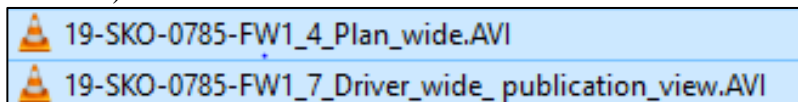
To determine the intrusion in each crash test please follow the measurement instruction as shown in Sections 3 to 6.



2.2.2 Media Files

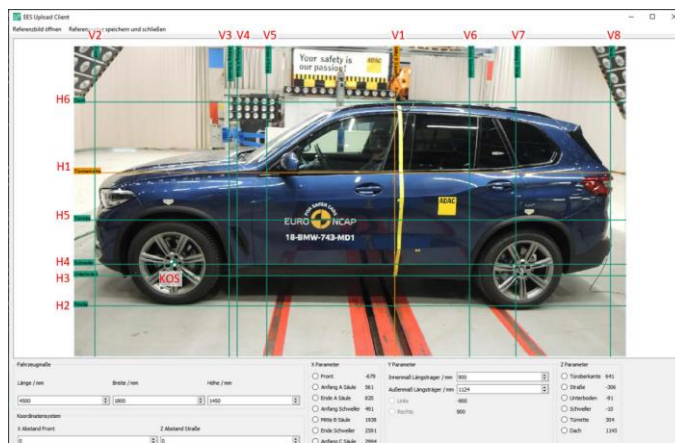
a) Videos

Video Data will be automatically integrated in the EES tool by uploading the MME-File (please consider the correct filenames according to Euro NCAP Film and Photo Protocol). For evaluation reasons two videos are needed:



b) Photos

To set up the reference grid in the EES Upload Client a side view of the vehicle under testing from before (!) the crash test is necessary. Therefore, please use a photo with an orthogonal view of the left side of the vehicle (in driving direction, independently of driver position).



Additionally, for evaluation reasons please provide at least three photos of the deformation zone at different angles after crash.

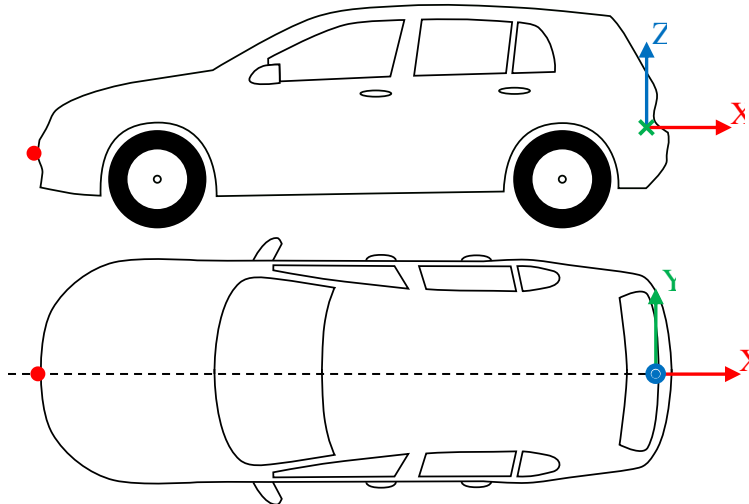


3. Frontal MPDB Impact

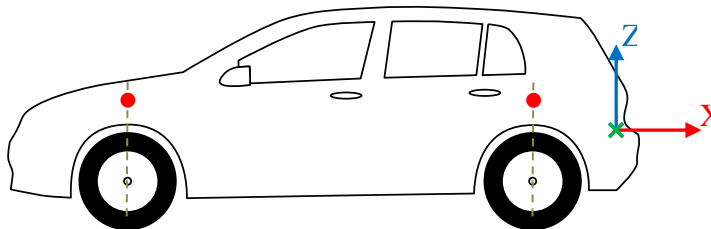
3.1 Before Test

3.1.1 This measurement shall be performed together with the intrusion measurements according to the MPDB frontal impact testing protocol (Section 2.1), using the same axis system.

3.1.2 Determine and measure the reference point. This is the most forward point on the bumper in the centreline of the vehicle.



3.1.3 Measure the point on the wheel arch in the same transverse plane as the wheel centres. Do this for all four wheels.



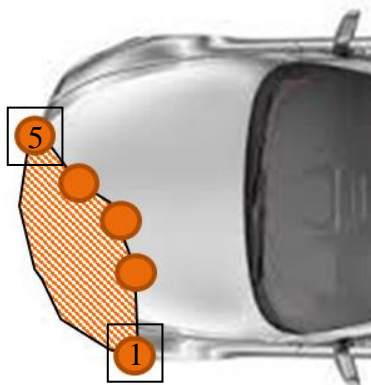
3.1.4 The points measured in 3.1.2 and 3.1.3 are references (“most forward point” and “ride height” of the vehicle) required for aligning the measurements of MPDB frontal, Full width frontal and AE-MDB side impact to the original vehicle geometry. If the same origin is used for all tests, the points in 3.1.2 and 3.1.3 only have to be measured on one single vehicle.

3.2 After Test

3.2.1 Measure the beginning and the end of the deformation in x-direction, here the height should be approximately in the middle of the chassis beam.

3.2.2 Measure the deepest deformation at the outer body skin of the vehicle (beginning of deformation, mark 1 at the front left tyre) in x-direction and the ‘end’ of deformation in y-direction (mark 5 in x-direction ↔ smallest deformation should usually end in front of the longitudinal beam).

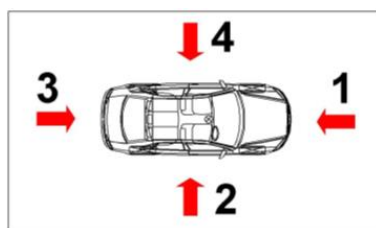
3.2.3 Measure three freely selectable deformation points (striking points like kinks or bumps) in almost equal distances in between mark 1 and 5. Please consider as well compressed bumper parts as expected in a real accident scenario.



- 3.2.4 The measured values should be exported to the assessment file (.csv-format). Please note, that there is one additional column in the template to set limits for the calculation model (mark 6: $x_6 = 0$ mm and $y_6 = y_5 + 100$ mm).

1	0	185	550	780	1200	1300
500	700	500	425	380	160	0

deformation
endpoint



Content of CSV-file:

1;0;520;780;1050;1400;
460;610;580;650;330;0;

VDI2 position of
impact zone

Column coordinates
(grid position)

Row coordinates
(grid position)

Impact values for
equivalent position

- 3.2.5 Please see also Appendix I for special cases of deformation, e. g. broken cross member, lost front tyre, cutting of longitudinal beam after removing barrier, etc.

4. Frontal Full Width Impact

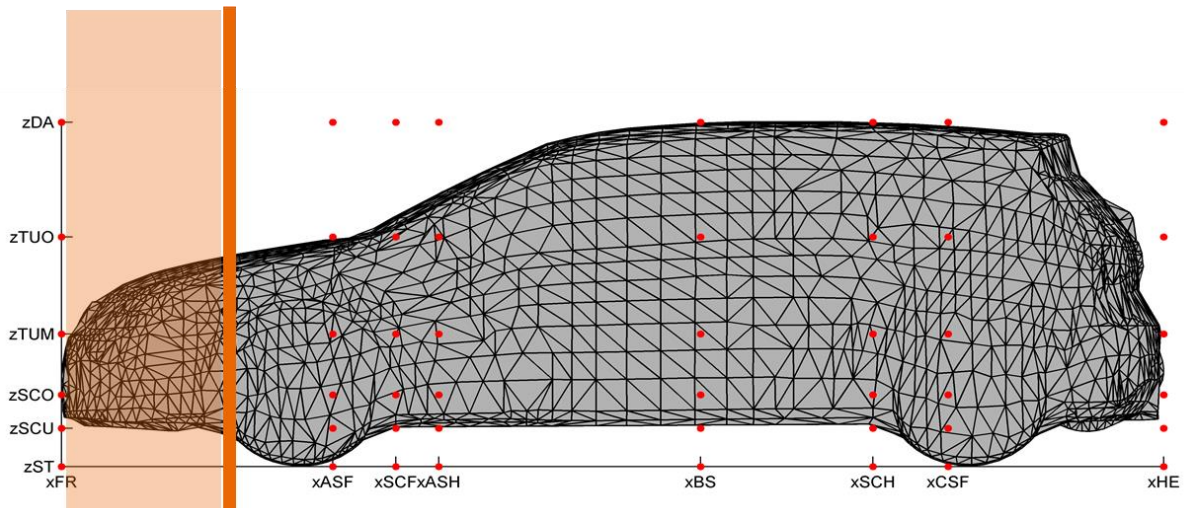
4.1 Before Test

4.1.1 Please refer to Section 3.1 and if necessary, repeat steps 3.1.1 to 3.1.3.

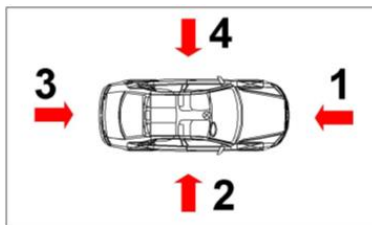
4.2 After Test

4.2.1 Measure the beginning and the end of the deformation in x-direction, here the height is negligible.

4.2.2 Measure the deepest deformation at one single point of the outer body skin of the car. Please consider as well compressed bumper parts as expected in a real accident scenario.



4.2.3 Finally, the measured value should be exported to the assessment file (.csv-format).



VDI2 position of impact zone

Column coordinates (grid position)

Row coordinates (grid position)

Impact values for equivalent position

Content of CSV-file:

1;0;
0;545;

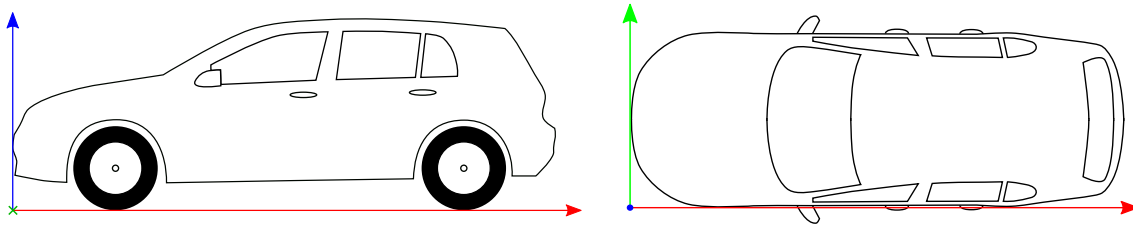
5. Side AE-MDB Impact

- 5.1 The following procedure describes the standard measurements for the MDB side impact. For laboratories that are able to perform the advanced measurement procedure (see Appendix II) can be performed instead
- 5.2 Before Test
- 5.2.1 For the pre- and post-crash measurements of the side MDB vehicle, the following coordinate system shall be used:

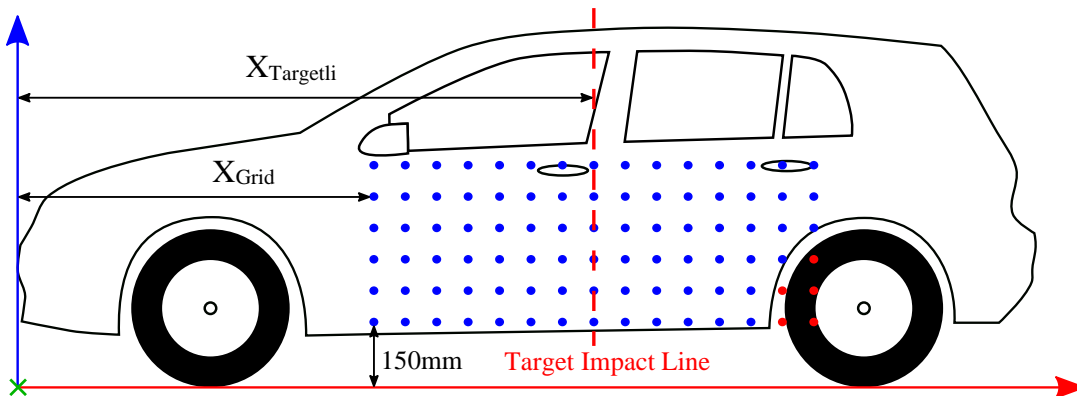
X = 0 in the most forward point of the car (measured pre-crash in the MPDB measurement)

Y-axis is the lateral axis of the vehicle

X-Y-plane is the ground, considering the design ride heights. It may be necessary to calculate the correct ground level, using the design ride heights from the pedestrian tests and the wheel arch points measured in 3.1.3.



- 5.2.2 Ensure that the vehicle is loaded, so that the ride heights are the same as under test conditions.
- 5.2.3 Create a grid of points (2100x750mm) with an equal distance of 150mm on the impact zone, where the centre of the grid equals the midpoint of the impact zone (referring to the target centreline of the barrier). This will be a number of 90 points in total. Only points that meet vehicle structure must be marked. The marking shall be robust enough to withstand the impact.



$$X_{\text{Grid}} = X_{\text{Targetline}} - 1.050 \text{ mm}$$

76 $X=X_{Grid}+0$ Z=900	77 $X=X_{Grid}+150$ Z=900	78 $X=X_{Grid}+300$ Z=900	... ... ...	90 $X=X_{Grid}+2.100$ Z=900
...
16 $X=X_{Grid}+0$ Z=300	17 $X=X_{Grid}+150$ Z=300	18 $X=X_{Grid}+300$ Z=300	... ... ...	30 $X=X_{Grid}+2.100$ Z=300
1 $X=X_{Grid}+0$ Z=150	2 $X=X_{Grid}+150$ Z=150	3 $X=X_{Grid}+300$ Z=150	... ... ...	15 $X=X_{Grid}+2.100$ Z=150

5.2.4 Measure all marked points on the vehicle surface. Points that don't exist (see red points in picture above) must be added manually to complete the grid. These points have to include the calculated X- and Z-position; Y shall be set to "0".

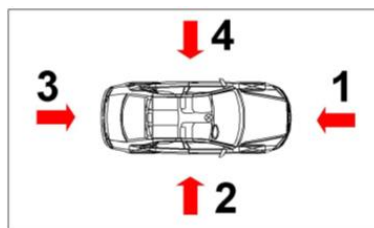
5.3 After Test

5.3.1 Measure all marked points on the vehicle surface. Points that don't exist have to be added manually to complete the grid. These points have to include the calculated X- and Z-position; Y shall be set to "0".

5.3.2 Most points will vary in X and Z Test, compared to the pre-test measurement. This can be ignored.

5.3.3 Calculate ΔY ($Y_{undeformed} - Y_{deformed}$) for each grid point.

5.3.4 Finally, the coordinates of the grid points with the related ΔY values should be exported to the assessment file (.csv-format).



VDI2 position of impact zone	Column coordinates (grid position)
Row coordinates (grid position)	Impact values for equivalent position

Content of CSV-file:

```
4;XGrid+0;XGrid+150;XGrid+300;XGrid+450;.....; XGrid+2100;
150;13;62;88;52;.....;128;
300;44;64;96;131;.....;78;
450;38;67;120;138;.....;124;
...;...;...;...;...;.....;...;
900;111;97;131;147;.....;117;
```

6. Side Oblique Pole Impact

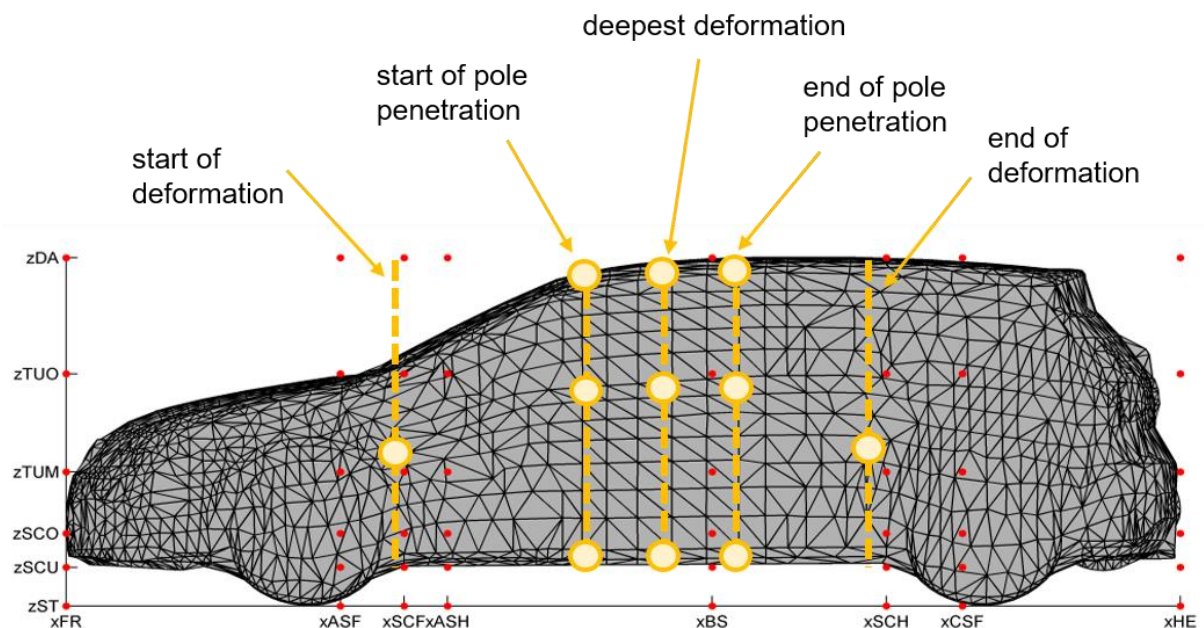
6.1 Before Test

6.1.1 Pre-crash measurement not required

6.2 After Test

6.2.1 Measure the beginning and the end of the deformation in x-direction, here the height is negligible.

6.2.2 Measure the deepest deformation, the start and the end of the penetration through the pole in x-direction at the following three heights: sill, transition door window, roof frame.



You can carry out these measurements manually using a ruler.

6.2.3 Place two rulers on a flat floor so that the zeros of the two rulers meet at the front left corner of the vehicle. The ruler at the front should be perpendicular to the front of the vehicle. The ruler on the vehicle side of the pole should be in course with both wheel contact points.

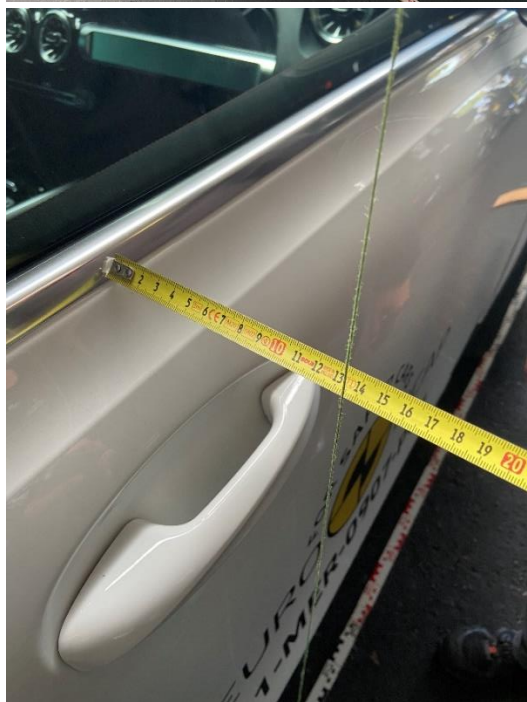




- 6.2.4 Measure the distance from the front of the vehicle to the beginning of the deformation in x-direction. The deformation usually begins between the fender and the driver's door.
- 6.2.5 Measure the end of the deformation in the same way. The end of the deformation is usually indicated by a dent in the roof frame.



- 6.2.6 Define the vehicle shape of the undeformed side using a plumb. Therefore, measure the distance from the plumb line (on top of the ruler's outer edge) to the outer body skin (striking point) at the heights described in 6.6.2. Note the values for further calculations in the EES assessment file (MS Excel template).

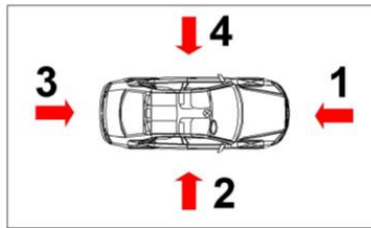


- 6.2.7 Measure the deepest deformation caused by the pole at the common three heights in y and x direction (same procedure as in 6.2.6). Also, the beginning and the end (bend points) of the penetration of the pole into the vehicle structure shall be measured.



6.2.8 Finally, the measured values should be exported to the assessment file (.csv-format).

height					
	1510	2310	2350	2500	3050
	1750	0	330	360	300
	1260	0	320	340	290
	150	0	300	310	270
		start	deformation		end



VDI2 position of
impact zone

Column coordinates
(grid position)

Row coordinates
(grid position)

Impact values for
equivalent position

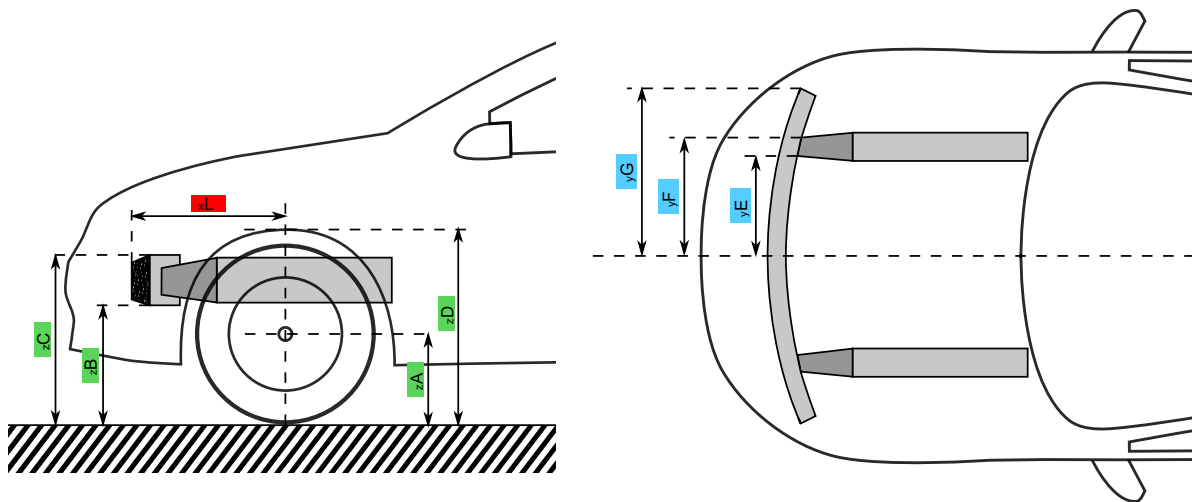
Content of CSV-file:

4;1510;2310;2350;2500;3050;
1750;0;330;360;300;0;
1260;0;320;340;290;0;
150;0;300;310;270;0;

7. Pedestrian Protection

7.1 Measurement of chassis beams

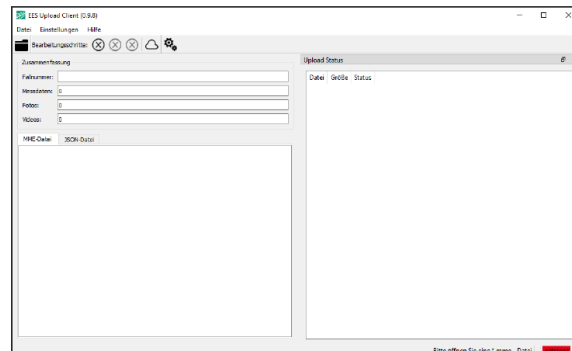
- 7.1.1 The following measurement shall be performed to evaluate the structure of the EES model, i.e. the position of the chassis beam is needed. Therefore, measure the distances illustrated in the figure below. Please note, that this measurement can only be done for conventional and hybrid electric vehicles (no BEV).



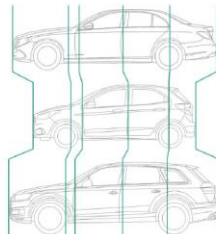
8. EES Upload Client

- 8.1 Please follow the quick start instructions which were delivered together with the EES Upload Client by Fraunhofer.
- 8.2 Dimensions from Manufacturers' Request (length, width, height of vehicle) are needed to fulfil all requirements of the Upload Client.
- 8.3 This is a platform to send out the data to the Server of Fraunhofer. The test data (vehicle channels), deformation pictures, 3D measurements and a grid definition need to be uploaded. Upload should take about 5 minutes.

- developed program: "EES Upload Client"
- upload in 3 steps:
 - (1) open a "*.mme"-file
 - (2) create the reference grid of the crashed car
 - (3) load the deformation data (*.csv")
- upload contains channels, relevant pictures and some videos (for future verification)



- step 2:
- defines reference grid for the tested car
- enables us, to scale every car to the voxel model:



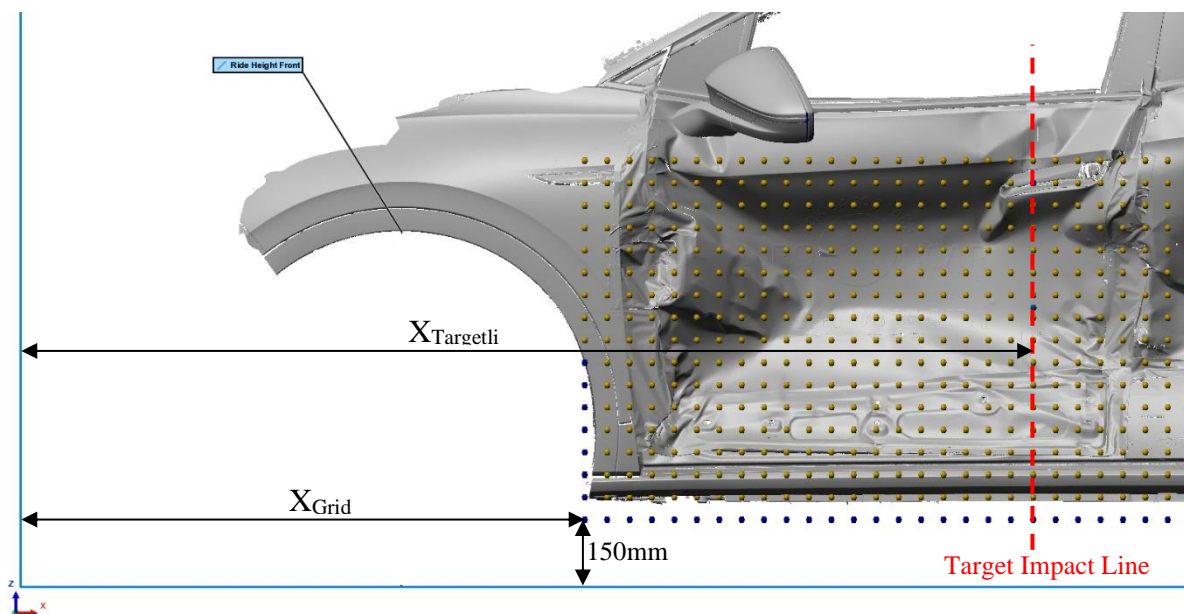
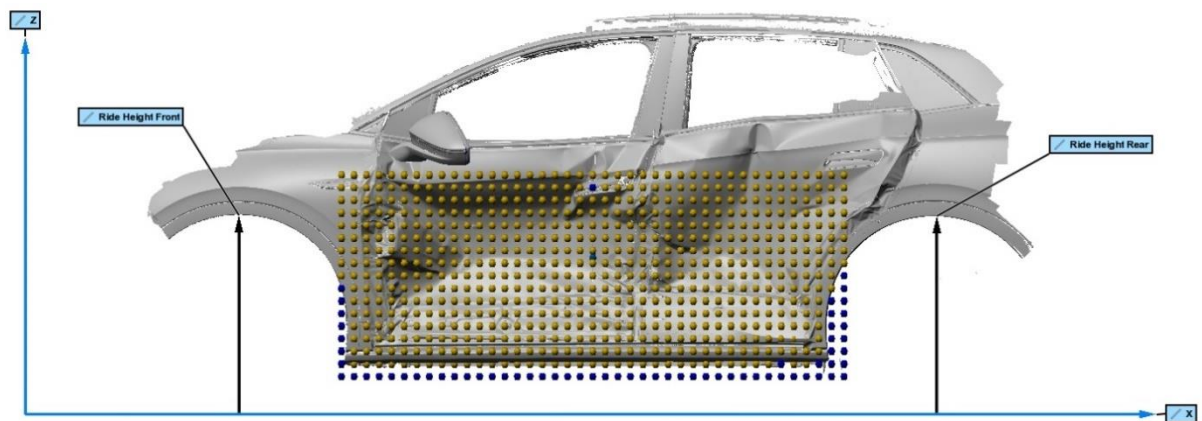
Appendix I

Examples of special cases of deformation, e. g. broken cross member, lost front tyre, cutting of longitudinal beam after removing barrier etc. will be added to this document when they become available.

Please provide any examples to the Euro NCAP Secretariat and ADAC with photographs.

Appendix II

- 1 Advanced MDB side impact measurement procedure
 - 1.1 Cover gaps on the impact side with masking tape to avoid holes in the following scan process
 - 1.2 Scan the impact side of the vehicle.
 - 1.3 Create a grid of points (2000x800mm) with an equal distance of 50mm on the impact zone, where the centre of the grid equals the mid-point of the impact zone (referring to the hit point of the barrier). This will be a number of 697 points in total.



$$X_{Grid} = X_{Targetline} - 1.000 \text{ mm}$$

657 X=X _{Grid} +0 Y=0 Z=950	658 X=X _{Grid} +50 Y=0 Z=950	659 X=X _{Grid} +100 Y=0 Z=950	... ... ...	697 X=X _{Grid} +2.000 Y=0 Z=950
...
83 X=X _{Grid} +0 Y=0 Z=250	84 X=X _{Grid} +50 Y=0 Z=250	85 X=X _{Grid} +100 Y=0 Z=250	... ... ...	123 X=X _{Grid} +2.000 Y=0 Z=250
42 X=X _{Grid} +0 Y=0 Z=200	43 X=X _{Grid} +50 Y=0 Z=200	44 X=X _{Grid} +100 Y=0 Z=200	... ... ...	82 X=X _{Grid} +2.000 Y=0 Z=200
1 X=X _{Grid} +0 Y=0 Z=150	2 X=X _{Grid} +50 Y=0 Z=150	3 X=X _{Grid} +100 Y=0 Z=150	... ... ...	41 X=X _{Grid} +2.000 Y=0 Z=150

- 1.4 The grid points shall be projected on the mesh of the scanned vehicle surface along the Y axis. Do this for the scan of the undeformed vehicle as well as for the scan of the deformed vehicle.
- 1.5 It may be that some points do not hit the mesh (e.g. because of holes in the mesh). This can be ignored if the points are outside the vehicle structure. Points on the vehicle structure should be placed as close as possible to the desired position by considering the Y value of the neighbouring grid points or the surrounding mesh surface.
- 1.6 Calculate ΔY ($Y_{\text{undeformed}} - Y_{\text{deformed}}$) for each grid point.
- 1.7 Finally, the coordinates of the grid points with the related ΔY values should be exported to the assessment file (.csv-format).