EURO NCAP

www.euroncap.com

EUROPEAN NEW CAR
ASSESSMENT PROGRAMME

Technical Bulletin

Data format and
Injury Criteria Calculation

Version 2.0

March 2017
TB 021

Title	Data format and Injury Criteria Calculation
Version	2.0
Document Number	TB021
Author	R Schram
Date	February 2017
Related Documents	All test protocols
Application Date	2017

Preface

Euro NCAP contracts a number of different test laboratories in Europe to perform the official Euro NCAP tests. This Technical Bulletin describes how the test data should be acquired and supplied to Euro NCAP to ensure consistency throughout all laboratories.

Table of Contents **Page No.**

1 TEST DATA

A complete Euro NCAP assessment consists of many tests. To ensure consistency in the general folder structure, this chapter details the required folder structure.
For each (sub)test where measurements are performed on dummies, vehicles or other test equipment, all test data needs to be provided in ISO-MME 1.6 format and needs to be fully compliant with the ISO/TS 13499 standard. It should be noted that some filenames are also prescribed in this document.

1.1 General folder structure

The following structure is to be used for all test series where the name of the main folder containing all tests consists of:

- The year of test
- OEM abbreviation
- Euro NCAP internal number
- Make and Model

Where Euro NCAP tests contain a number of sub-tests, the next paragraph details the folder structure, names of the sub-system test folders and where applicable the filenames.

On the highest level, the folder structure is as follows with on the right an example using the Volvo XC90 that is assumed to be tested in 2016 with a Euro NCAP internal number of 999.

MAIN FOLDER NAME	**16-VOL-999-Volvo XC90**
<Frontal ODB test number>	16-VOL-999-OD1
<Frontal FW test number>	16-VOL-999-FW1
<Side MDB test number>	16-VOL-999-MD1
<Side Pole test number>	16-VOL-999-PO1
Whiplash tests folder	16-VOL-999-WHL
AEB City test folder	16-VOL-999-AEBC
Child Occupant Protection folder	16-VOL-999-COP
Pedestrian tests folder	16-VOL-999-PP
AEB Pedestrian test folder	16-VOL-999-AEBP
SBR test number	16-VOL-999-SBR
SAS tests folder	16-VOL-999-SAS
AEB Inter-Urban tests folder	16-VOL-999-AEBI
LSS tests folder	16-VOL-999-LSS
Euro NCAP Spreadsheet	16-VOL-999-Volvo XC90

1.1.1 *Whiplash sub-test folders*

The Whiplash test folder contains 4 sub-test folders. Three contain the dynamic data from the three dynamic pulses tested; Low, Medium and High. In addition, the rear whiplash data is contained in a separate folder. The static measurement file and whiplash test report will be filed in the main Whiplash folder.

- **MAIN FOLDER NAME**
- …
- Whiplash tests folder
  - <Whiplash Low test number>
  - <Whiplash Medium test number>
  - <Whiplash High test number>
  - <Whiplash Rear test number>
  - Static measurement file
  - Whiplash test report
- …

- **16-VOL-999-Volvo XC90**
- …
- 16-VOL-999-WHL
  - 16-VOL-999-WH1
  - 16-VOL-999-WL1
  - 16-VOL-999-WM1
  - 16-VOL-999-WHR
  - 16-VOL-999-WHLStatic
  - 16-VOL-999-WHL
- …

1.1.2 *AEB City sub-test folders*

The number of sub-test folders in the AEB City test folder is depending on the AEB City performance of the vehicle under test. For each speed tested there will be a separate sub-test folder. The AEB City test report will be filed in the main AEB City folder.

The test numbers for each subtest consists of the AEB City scenario CCRs followed by the test speed.

- **MAIN FOLDER NAME**
- …
- AEB City tests folder
  - <AEB City CCRs 10km/h>
  - <AEB City CCRs 15km/h>
  - …
  - <AEB City CCRs 50km/h>
  - AEB City test report
- …

- **16-VOL-999-Volvo XC90**
- …
- 16-VOL-999-AEBC
  - CCRs-AEB-10
  - CCRs-AEB-15
  - …
  - CCRs-AEB-50
  - 16-VOL-999-AEBC
- …

1.1.3 *COP sub-test folders*

The COP test folder contains 3 sub-test folders. They contain pictures and documents from both vehicle based assessment and the CRS installation checks as well as the vehicle manual (COP section) and CRS vehicle lists. The COP test report will be filed in the main COP folder.

- **MAIN FOLDER NAME**
- …
- COP tests folder
  - CRS installation
  - Vehicle based assessment
  - Manual & CRS vehicle lists
  - COP test report
- …

- **16-VOL-999-Volvo XC90**
- …
- 16-VOL-999-COP
  - CRS installation
  - Vehicle based assessment
  - Manual & CRS vehicle lists
  - 16-VOL-999-COP
- …

1.1.4 *Pedestrian sub-test folders*

The Pedestrian test folder contains 6 sub-test folders. The document, movie, photo, report and static folders containing general files from all tests. The folder test data contains a folder for every tested point. For each of these pedestrian tests there will be a separate sub-test folder (e.g. A10-5 folder), which needs to contain the channel and picture folders and the MME-file.

The test numbers for each subtest consists of the Euro NCAP test number followed by the GRID point label.

The test report in the main report folder should contain all plots of all tests combined in one file called (16-VOL-999-PP).

- **MAIN FOLDER NAME**
- …
- Pedestrian tests folder
  - Document
  - Movie
  - Photo
  - Report
    - Pedestrian test report
  - Static
  - Test data
    - <Adult Headform test number>
    - <Child Headform test number>
    - …
    - <Legform test number>
    - …
    - <Lower legform test number>
      - Channel
      - Photo
      - MME-file
- …

- **16-VOL-999-Volvo XC90**
- …
- 16-VOL-999-PP
  - Document
  - Movie
  - Photo
  - Report
    - 16-VOL-999-PP
  - Static
  - Test data
    - 16-VOL-999-PP-A10-5
    - 16-VOL-999-PP-C3+1
    - …
    - 16-VOL-999-PP-U+2
    - …
    - 16-VOL-999-PP-L-4
      - Channel
      - Photo
      - 16-VOL-999-PP-L-4.mme
- …

1.1.5 *AEB Pedestrian sub-test folders*

The number of sub-test folders in the AEB Pedestrian test folder is depending on the AEB Pedestrian performance of the vehicle under test. For each speed tested in each scenario there will be a separate sub-test folder. The AEB Pedestrian test report will be filed in the main AEB Pedestrian folder.

The test numbers for each subtest consists of the AEB Pedestrian scenario (CVFA, CVNA-25, CVNA-75, CVNC) followed by the test speed. Where a certain test speed is repeated three times as per AEB Pedestrian test protocol, add the repetition number.

- **MAIN FOLDER NAME**
- …
- AEB Pedestrian tests folder
  - <AEB-P CVNA75 3km/h test number>
  - <AEB-P CVNA75 10km/h test number>
  - <AEB-P CVNA75 15km/h test number>
  - <AEB-P CVFA 20km/h test number>
  - …
  - <AEB-P CVNA25 20km/h test number>
  - <AEB-P CVNA25 20km/h test number>
  - <AEB-P CVNA25 20km/h test number>
  - …
  - <AEB-P CVNA75 20km/h test number>
  - …
  - <AEB-P CVNC 20km/h test number>
  - …
  - AEB Pedestrian test report
- …

- **16-VOL-999-Volvo XC90**
- …
- 16-VOL-999-AEBP
  - CVNA75-3
  - CVNA75-10
  - CVNA75-15
  - CVFA-20
  - …
  - CVNA25-20-1
  - CVNA25-20-2
  - CVNA25-20-3
  - …
  - CVNA75-20
  - …
  - CVNC-20
  - …
  - 16-VOL-999-AEBP Test Report
- …

1.1.6 *Speed Assist Systems sub-test folders*

The Speed Assist Systems test folder contains 3 sub-test folders for the three speed limitation function tests. The Speed Assist Systems test report will be filed in the main Speed Assist Systems folder.

MAIN FOLDER NAME	**16-VOL-999-Volvo XC90**
…	…
Speed Assist Systems tests folder	16-VOL-999-SAS
<Speed limitation 50km/h test number>	SAS-50
<Speed limitation 80km/h test number>	SAS-80
<Speed limitation 120km/h test number>	SAS-120
Speed Assist Systems test report	16-VOL-999-SAS Test Report
…	…

1.1.7 *AEB Inter-Urban sub-test folders*

The number of sub-test folders in the AEB Inter-Urban test folder is depending on the AEB Inter-Urban performance of the vehicle under test. For each speed tested in each scenario there will be a separate sub-test folder. The AEB Inter-Urban test report will be filed in the main AEB Inter-Urban folder.

The test numbers for each subtest consists the AEB Inter-Urban scenario (CCRs, CCRm, CCRb), than the system used in the test (AEB, FCW) followed by the test speed. In case of the CCRb scenario the distance and brake EVT brake level.

MAIN FOLDER NAME	**16-VOL-999-Volvo XC90**
…	…
AEB Inter-Urban tests folder	16-VOL-999-AEBP
<AEB-IU CCRs FCW 30km/h test number>	CCRs-FCW-30
<AEB-IU CCRm AEB 30km/h test number>	CCRm-AEB-30
…	…
<AEB-IU CCRm FCW 30km/h test number>	CCRm-FCW-30
…	…
<AEB-IU CCRb AEB 12-2 test number>	CCRb-AEB-12-2
…	…
<AEB-IU CCRb AEB 40-6 test number>	CCRb-AEB-40-6
<AEB-IU CCRb FCW 12-2 test number>	CCRb-FCW-12-2
…	…
<AEB-IU CCRb FCW 40-6 test number>	CCRb-FCW-40-6
AEB Inter-Urban test report	16-VOL-999-AEBI Test Report
…	…

1.1.8 *Lane Support Systems sub-test folders*

The number of sub-test folders in the Lane Support Systems test folder is depending on the LKA performance of the vehicle under test. For each speed tested in each scenario there will be a separate sub-test folder. The Lane Support Systems test report will be filed in the main Lane Support Systems folder.

The test numbers for each subtest consists of the Lane Support Systems scenario (LDW-SL, LDW-DL, LKA-SL), the lateral velocity and finally followed by the letter indicating left or right.

- **MAIN FOLDER NAME**
- …
- Lane Support Systems tests folder
  - <LSS LDW-SL 0.3 left test number>
  - …
  - <LSS LDW-SL 0.5 right test number>
  - <LSS LDW-DL 0.3 left test number>
  - …
  - <LSS LDW-DL 0.5 right test number>
  - <LSS LKA-SL 0.1 left test number>
  - …
  - <LSS LKA-SL 0.5 right test number>
  - <LSS LKA-SL 0.6 left test number>
  - …
  - <LSS LKA-SL 1.0 right test number>
  - LSS test report
- …

- **16-VOL-999-Volvo XC90**
- …
- 16-VOL-999-LSS
  - LDW-SL-03L
  - …
  - LDW-SL-05R
  - LDW-DL-03L
  - …
  - LDW-DL-05R
  - LKA-SL-01L
  - …
  - LKA-SL-05R
  - LKA-SL-06L
  - …
  - LKA-SL-10R
  - 16-VOL-999-LSS Test Report
- …

1.2 ISO MME folder structure

The ISO MME folder structure is to be applied to all applicable tests and the files contained in these folders follow the ISO/TS 13499 standard. The main directory contains six folders and two files. The following folders and files (comment files when needed) need to be provided for every test performed, where the test number is the one as specified in the previous section.

For each file and folder (where necessary) the required contents is specified in detail in the paragraphs below.

- **TEST NUMBER**
  - Channel
  - Document
  - Movie
  - Photo
  - Report
  - Static
  - <test number>.mme
  - <test number>.txt

1.2.1 *Channel folder*

The channel folder contains all channels from the vehicle, impactors and dummies used in the test as defined in section 2.

- **TEST NUMBER**
  - Channel
    - <test number>.xxx
    - <test number>.chn
  - …

1.2.2 *Document folder*

The document folder contains the calibration documents and temperature log files for the test dummies used in the test.

- **TEST NUMBER**
  - …
  - Document
    - <name of document file 1>
    - <name of document file d>
  - …

1.2.3 *Movie folder*

The movie folder contains the inspection quality films, using the exact names as specified in the Euro NCAP Film and Photo protocol.

- **TEST NUMBER**
  - …
  - Movie
    - <name of movie file 1>
    - <name of movie file m>
  - …

1.2.4 *Photo folder*

The photo folder contains the inspection quality photos in two folders “Before” and “After”, where the name of the photo file consists of the test number followed by a number as specified in the Euro NCAP Film and Photo protocol.

- **TEST NUMBER**
  - …
  - Photo
    - Before
    - <name of photo file 1>
    - <name of photo file p>
    - After
    - <name of photo file 1>
    - <name of photo file p>
  - …

1.2.5 *Report folder*

The report folder contains the test report and the data plots.

- **TEST NUMBER**
  - …
  - Report
    - <name of test report>
    - <name of data plots>
  - …

1.2.6 *Static folder*

The static folder contains the static measurements file where applicable containing the data as described in the different test protocols.

- **TEST NUMBER**
  - …
  - Static
    - <name of static measurement file>
  - …

1.2.7 *MME-file*

The mme-file contains the information of the test where the type of test and subtype of test shall be selected from the table below.

- **TEST NUMBER**
  - …
  - <test number>.mme

The mme-file shall contain the following header:

```
Data format edition number   1.6
....
Customer name                Euro NCAP
Customer test ref number     <test number>
Title                        Euro NCAP <year of test>
Type of the test             <see table>
Subtype of the test          <see table>
Regulation                   <test protocol version>
Name of test object 1        <make and model>
Class of test object 1       <Euro NCAP vehicle class>
Ref. number of test object 1 <VIN number>
...
```

Euro NCAP test	**Type of Test**	**Subtype of test**
Frontal ODB	Frontal Impact	ODB
Frontal FW	Frontal Impact	FW
Side MDB	Side Impact	AE-MDB
Side Pole	Side Impact	Pole 75 degree
Whiplash	Rear Sled Test	Whiplash-LowPulse Whiplash-MediumPulse Whiplash-High
Pedestrian	Pedestrian	Adult Headform Child Headform Upper Legform Lower Legform
AEB City	AEB	CCRs
AEB Pedestrian	AEB	CVFA CVNA-25 CVNA-75 CVNC
AEB Inter-Urban	AEB	CCRs CCRm CCRb
Lane Support Systems	LSS	LDW LKA

2 CHANNEL NAMES AND FILTERS

For each dummy, impactors and test objects used in the different Euro NCAP tests the following channel names shall be used. All channels shall be supplied unfiltered/prefiltered. The appropriate filters for calculation of injury criteria and plotting of these channels will be performed by the analysis software used.

2.1 Hybrid III 50% Male

Location	Parameter	ISO code	CFC	Injury Calculation
Head	Accelerations, A_x A_y A_z	??HEAD0000H3AC[X,Y,Z]P	1000	Peak Resultant acceleration HIC_{15} Resultant 3ms cumulative exceedence
Neck	Forces, F_x F_y F_z	??NECKUP00H3FO[X,Y,Z]P	1000	Tension continuous exceedence Shear (F_x) continuous exceedence Peak Extension (M_y)
	Moments, M_x M_y M_z	??NECKUP00H3MO[X,Y,Z]P	600	
Chest	Accelerations, A_x A_y A_z	??CHST0000H3AC[X,Y,Z]P	180	Peak resultant acceleration Resultant 3 ms cumulative exceedence Peak deflection Viscous Criterion
	Deflection, D_{chest}	??CHST0003H3DSXP	180	
Pelvis	Accelerations, A_x A_y A_z	??PELV0000H3AC[X,Y,Z]P	600	
Lumbar Spine	Forces, F_x F_z	??LUSP0000H3FO[X,Z]P	600	
	Moments, M_y	??LUSP0000H3MOYP	600	
Femurs (L & R)	Forces, F_z	??FEMR[LE,RI]00H3FOZP	600	Compressive Axial Force ($-F_z$) continuous exceedence
Knees (L & R)	Displacements, D_{knee}	??KNSL[LE,RI]00H3DSXP	180	Peak displacement (-D)
Upper Tibia (L & R)	Forces, F_x F_z	??TIBI[LE,RI]UPH3FO[X,Z]P	600	Peak Tibia Compression ($-F_z$) Tibia Index
	Moments, M_x M_y	??TIBI[LE,RI]UPH3MO[X,Y]P	600	
Lower Tibia (L & R)	Forces, F_x F_z (F_y)	??TIBI[LE,RI]LOH3FO[X,Y,Z]P	600	Peak Tibia Compression ($-F_z$) Tibia Index
	Moments, M_x M_y	??TIBI[LE,RI]LOH3MO[X,Y]P	600	

2.2 Hybrid III 5% Female

Location	Parameter	ISO code	CFC	Injury Calculation
Head	Accelerations, A_x A_y A_z	??HEAD0000HFAC[X,Y,Z]P	1000	Peak Resultant acceleration HIC_{15} Resultant 3ms cumulative exceedence
Neck	Forces, F_x F_y F_z	??NECKUP00HFFO[X,Y,Z]P	1000	Tension continuous exceedence Shear (F_x) continuous exceedence Peak Extension (M_y)
	Moments, M_x M_y M_z	??NECKUP00HFMO[X,Y,Z]P	600	
Chest	Accelerations, A_x A_y A_z	??CHST0000HFAC[X,Y,Z]P	180	Peak resultant acceleration Resultant 3 ms cumulative exceedence Peak deflection Viscous Criterion
	Deflection, D_{chest}	??CHST0003HFDSXP	180	
Pelvis	Accelerations, A_x A_y A_z	??PELV0000HFAC[X,Y,Z]P	600	
Iliac (L & R)	Forces, F_x	??ILAC[LE,RI]00HFFOXP	600	
	Moments, M_y	??ILAC[LE,RI]00HFMOYP	600	
Lumbar Spine	Forces, F_x F_z	??LUSP0000HFFO[X,Z]P	600	
	Moments, M_y	??LUSP0000HFMOYP	600	
Femurs (L & R)	Forces, F_z	??FEMR[LE,RI]00HFFOZP	600	Compressive Axial Force ($-F_z$) Continuous exceedence
Knees (L & R)	Displacements, D_{knee}	??KNSL[LE,RI]00HFDSXP	180	Peak displacement (-D)
Upper Tibia (L & R)	Forces, F_x F_z	??TIBI[LE,RI]UPHFFO[X,Z]P	600	Peak Tibia Compression ($-F_z$) Tibia Index
	Moments, M_x M_y	??TIBI[LE,RI]UPHFMO[X,Y,Z]P	600	
Lower Tibia (L & R)	Forces, F_x F_z (F_y)	??TIBI[LE,RI]LOHFFO[X,Y,Z]P	600	Peak Tibia Compression ($-F_z$) Tibia Index
	Moments, M_x M_y	??TIBI[LE,RI]LOHFMO[X,Y,Z]P	600	

2.3 WorldSID 50% Male

Location	Parameter		CFC	Injury Calculation
Head	Accelerations, A_x A_y A_z	??HEAD0000WSAC[X,Y,Z]P	1000	HIC_{15} Peak acceleration 3ms exceedence (cumulative)
Neck	Forces, F_x F_y F_z	??NECKUP00WSFO[X,Y,Z]P	1000	
	Moments, M_x M_y M_z	??NECKUP00WSMO[X,Y,Z]P	600	
Shoulder	Forces, Fx, Fy, Fz	??SHLD[LE,RI]00WSFO[X,Y,Z]P	600	Peak lateral force
	Absolute Length, R	??SHRI[LE,RI]00WSDC0P	180	Peak lateral displacement Viscous criterion
	Rotation, α	??SHRI[LE,RI]00WSANZP	180	
Thorax	Absolute Length, R	??TRRI[LE,RI][01,02,03]WSDC0P	180	Peak lateral displacement Viscous criterion
	Rotation, α	??TRRI[LE,RI][01,02,03]WSANZP	180	
Abdomen	Absolute Length, R	??ABRI[LE,RI][01,02]WSDC0P	180	Peak lateral displacement Viscous criterion
	Rotation, α	??ABRI[LE,RI][01,02]WSANZP	180	
T12	Accelerations, A_x A_y A_z	??THSP1200WSAC[X,Y,Z]P	180	
Pelvis	Accelerations, A_x A_y A_z	??PELV0000WSAC[X,Y,Z]P	600	Pubic Symphysis Force
	Forces, F_y	??PUBC0000WSFOYP	600	
Femoral Neck	Forces, F_x F_y F_z	??FEAC[LE,RI]00WSFO[X,Y,Z]P	600	

2.4 BioRID-II

Location	Parameter		CFC	Injury Calculation
Head	Accelerations, A_x A_y A_z	??HEAD0000BRAC[X,Y,Z]P	60	NIC
	Velocity, V_x	??HEAD0000BRVEXV		Head rebound velocity
	Contact	??HERE000000EV00		Head contact time
Cervical Spine	Accelerations, A_x A_z	??CESP0400BRAC[X,Z]P	60	
Neck Upper	Forces, F_x F_y F_z	??NECKUP00BRFO[X,Y,Z]P	1000	Nkm Neck shear (+Fx) Neck tension (+Fz)
	Moments, M_x M_y M_z	??NECKUP00BRMO[X,Y,Z]P	600	Nkm
Neck Lower	Forces, F_x F_y F_z	??NECKLO00BRFO[X,Y,Z]P	1000	
	Moments, M_x M_y M_z	??NECKLO00BRMO[X,Y,Z]P	600	
Thoracic Spine T1 (L & R)	Accelerations, A_x A_z	??THSP01[LE,RI]BRAC[X,Z]P	60	T1- X-acceleration NIC
Thoracic Spine T8	Accelerations, A_x A_z	??THSP0800BRAC[X,Z]P	60	
Lumbar Spine	Accelerations, A_x A_z	??LUSP0100BRAC[X,Z]P	60	
Pelvis	Accelerations, A_x A_y A_z	??PELV0000BRAC[X,Y,Z]P	60	

2.5 Q6

Location	Parameter	ISO code	CFC	Injury Calculation
Head	Accelerations, A_x A_y A_z	??HEAD0000Q6AC[X,Y,Z]P	1000	HIC_{15} Resultant 3ms exceedance (cumulative)
Neck Upper	Forces, F_x F_y F_z	??NECKUP00Q6FO[X,Y,Z]P	1000	Peak Tensile Force F_z Resultant Force (side)
	Moments, M_x M_y M_z	??NECKUP00Q6MO[X,Y,Z]P	600	
Thorax	Accelerations, A_x A_y A_z	??THSP0000Q6AC[X,Y,Z]P	180	Resultant 3ms exceedance (cumulative)
	Displacement, D	??CHST0000Q6DSXP	180	

2.6 Q10

Location	Parameter	ISO code	CFC	Injury Calculation
Head	Accelerations, A_x A_y A_z	??HEAD0000QAAC[X,Y,Z]P	1000	HIC_{15} Resultant 3ms exceedance (cumulative)
Neck Upper	Forces, F_x F_y F_z	??NECKUP00QAFO[X,Y,Z]P	1000	Peak Tensile Force F_z Resultant Force (side)
	Moments, M_x M_y M_z	??NECKUP00QAMO[X,Y,Z]P	600	
Shoulder (side only)	Forces, F_x F_y F_z	??SHLD[LE,RI]00QAFO[X,Y,Z]P	1000	
T1 (side only)	Accelerations, A_y	??THSP01[LE,RI]QAACYP	1000	
Chest (T4)	Accelerations, A_x A_y A_z	??THSP0400QAAC[X,Y,Z]P	180	Resultant 3ms exceedance (cumulative)
Chest (frontal only)	Absolute Length, R	??CHST[LO,UP]00QADC0P	180	
	Rotation, α	??CHST[LO,UP]00QAANZP	180	
Chest (side only)	Absolute Length, R	??CHST[LE,RI][LO,UP]QADC0P	180	
	Rotation, α	??CHST[LE,RI][LO,UP]QAANZP	180	
Lumbar Spine	Forces, F_x F_y F_z	??LUSP0000QAFO[X,Y,Z]P	1000	
	Moments, M_x M_y M_z	??LUSP0000QAMO[X,Y,Z]P	600	
Pelvis-Sacrum	Accelerations, A_x A_y A_z	??PELV0000QAAC[X,Y,Z]P	180	
Pelvis-Pubis (side only)	Forces, F_y	??PUBC0000QAFOYP	1000	

2.7 Adult Headform

Location	Parameter	ISO code	CFC	Injury Calculation
Head	Accelerations, A_x A_y A_z	D0HEAD0000PJAC[X,Y,Z]P	1000	HIC_{15}

2.8 Small Adult / Child Headform

Location	Parameter	ISO code	CFC	Injury Calculation
Head	Accelerations, A_x A_y A_z	D0HEAD0000PSAC[X,Y,Z]P	1000	HIC_{15}

2.9 Upper Legform

Location	Parameter	ISO code	CFC	Injury Calculation
Femur	Forces, F_x	D0FEMR[UP,LO]00PUFOXP	180	Sum of Forces
	Moments, M_y	D0FEMR[UP,MI,LO]00PUMOYP	180	Bending Moment

2.10 Lower Legform (Flex-PLI)

Location	Parameter	ISO code	CFC	Injury Calculation
Femur	Moments, M_x	D0FEMR[UP,MI,LO]00PFMOXP	180	
Knee	Accelerations, A_y	D0KNEE0000PFACYP	180	
	Displacement, D_{ACL}	D0KNEEAC00PFDS0P	180	ACL/PCL
	Displacement, D_{LCL}	D0KNEELC00PFDS0P	180	
	Displacement, D_{MCL}	D0KNEEMC00PFDS0P	180	MCL
	Displacement, D_{PCL}	D0KNEEPC00PFDS0P	180	ACL/PCL
Tibia	Moments, M_x	D0TIBI[UP,LO]00PFMOXP D0TIBIMI[UP,LO]PFMOXP	180	Tibia Bending Moment

2.11 Vehicle for Passive Safety tests

Location	**Parameter**	**ISO code**	**CFC**	**Injury Calculation**
B-Post	Accelerations, A_x A_y	[14,16]BPILLO0000AC[X,Y]P	60	
Seatbelt	Force, $F_{seatbelt}$	??SEBE0003B3FO0P	60	Seat belt force modifier

2.12 Trolley

Location	**Parameter**	**ISO code**	**CFC**	**Injury Calculation**
CoG	Accelerations, A_x	M0MBARCG0000ACXP	60	

2.13 Sled

Location	**Parameter**	**ISO code**	**CFC**	**Injury Calculation**
Sled	Accelerations, A_x	S0SLED000000ACXP	60	

2.14 Vehicle for Active Safety tests

Location	**Parameter**	**ISO code**	**CFC**	**Assessment Calculation**
Time (AEB)	Time-to-Collision	10TTTC000000TI00		
	AEB activation time	10TAEB000000EV00		
	FCW activation time	10TFCW000000EV00		
	Impact time	10TIMPFR0000EV00		
Time (LSS)	LKA activation time	10TLKA000000EV00		
	LDW activation time	10TLDW000000EV00		
	Line crossing time	10TLCRFR[LE,RI]00EV00		
Vehicle Front	Position $X_{VUT,}$ Y_{VUT}	10VEHC000000DS[X,Y]P		
	Speed $V_{VUT,x,}$ $V_{VUT,y}$	10VEHC000000VE[X,Y]P		
	Acceleration A_{VUT}	10VEHC000000ACXP		
	Yaw velocity $\boldsymbol{\Psi}_{VUT}$	10VEHC000000AVZP		
Vehicle front wheel (outer edge)	Position $X_{VUT,wheel,}$ $Y_{VUT,wheel}$	1[1,3]WHEL000000DS[X,Y]P		
Steering wheel	Steering wheel velocity	10STWL000000AV1P		
Accelerator pedal	Pedal position	10PEAC000000DS0P		
Brake pedal	Pedal position	10PEBR000000DS0P		
	Pedal Force	10PEBR000000FO0P		

2.15 Euro NCAP Vehicle Target

Location	**Parameter**	**ISO code**	**CFC**	**Assessment Calculation**
EVT	Position X_{EVT}, Y_{EVT}	20VEHC000000DS[X,Y]P		
	Speed $V_{EVT,x}$, $V_{EVT,y}$	20VEHC000000VE[X,Y]P		
	Acceleration A_x	20VEHC000000ACXP		
	Yaw velocity $\boldsymbol{\Psi}_{EVT}$	20VEHC000000AVZP		

2.16 Euro NCAP Pedestrian Target

Location	Parameter	ISO code	CFC	Assessment Calculation
EPT adult & child	Position Y_{EPT}	20PED[A,C]000000DCYP		
	Speed $V_{EPT,y}$	20PED[A,C]000000VEYP		

3 INJURY CRITERIA CALCULATION

This chapter describes the calculation for each injury criteria used within Euro NCAP, including the filters that are applied to each channel used in these calculations. The analysis software used by the Euro NCAP labs will follow these calculations in detail.

For all of the calculations and for all of the dummies used, only the loading phase of the crash is considered. The loading phase for all dummies in the frontal tests will end at the point in time where the Filtered Head Acceleration A_x crosses 0 after the minimum acceleration peak value.

3.1 Head criteria

3.1.1 Head Resultant Acceleration

The Head Resultant Acceleration is calculated with the following formula:

$$A_R = \sqrt{{A_x}^2 + {A_y}^2 + {A_z}^2}$$

with:

A_x	Filtered Head Acceleration A_x	??HEAD0000??ACXA
A_y	Filtered Head Acceleration A_y	??HEAD0000??ACYA
A_z	Filtered Head Acceleration A_z	??HEAD0000??ACZA

3.1.2 HIC_{15}

The HIC_{15} value is calculated with the following formula:

$$HIC_{15} = (t_2 - t_1)\left(\frac{1}{(t_2 - t_1)}\int_{t_1}^{t_2} A_R\,dt\right)^{2.5}$$

with:

A_R Head Resultant Acceleration

3.1.3 Head Restraint Contact Time

The Head Restraint Contact Time is calculated with the following formula:

$$T_{HRC} = T_{HRC,end} - T_{HRC,start}$$

with:

$T_{HRC,start}$	Time of first contact of head and HR after T=0	??HERE000000EV00
$T_{HRC,end}$	Time where contact is lost	??HERE000000EV00

Gaps up to 1ms are ignored if proven to be the result of poor electrical contact.

3.1.4 T1 x-acceleration

The T1 x-acceleration value is calculated with the following formula:

$$T1 = \frac{T1_{left} + T1_{right}}{2}$$

with:

$T1_{left}$	Filtered left T1 acceleration	??THSP01LEBRACXD
$T1_{right}$	Filtered right T1 acceleration	??THSP01RIBRACXD

3.2 Neck criteria

3.2.1 Neck extension bending moment

The Neck extension bending moment is calculated with the following formula:

$$M_{OCy} = M_y - F_x \cdot d$$

with:

M_y	Filtered Bending Moment	??NECKUP00??MOYB
F_x	Filtered Shear Force	??NECKUP00??FOXB
d	0.01778m for HIII-50M and HIII-05F	

3.2.2 NIC

The NIC value is calculated with the following formula:

$$NIC = 0.2 \cdot A_{rel} + {v_{rel}}^2$$

with:

$$A_{rel} = T1 - A_{x,head}$$

$$v_{rel} = \int A_{rel}$$

T1	Average T1 acceleration	
$A_{x,head}$	Filtered Head Acceleration A_x	??HEAD0000BRACXD

3.2.3 Nkm

The Nkm value is calculated with the following formula:

$$Nkm(t) = N_{ep}(t) + N_{ea}(t) + N_{fp}(t) + N_{fa}(t)$$

with:

$$N_{ep}(t) = \frac{M_{ye}(t)}{-47.5} + \frac{F_{xp}(t)}{-845}$$
$$N_{ea}(t) = \frac{M_{ye}(t)}{-47.5} + \frac{F_{xa}(t)}{845}$$
$$N_{fp}(t) = \frac{M_{yf}(t)}{88.1} + \frac{F_{xp}(t)}{-845}$$
$$N_{fa}(t) = \frac{M_{yf}(t)}{88.1} + \frac{F_{xa}(t)}{845}$$

$$M_{OCy}(t) = M_y(t) - D \cdot F_x(t)$$

$F_x(t)$	Filtered Upper Neck Shear Force F_x	??NECKUP00BRFOXB
$M_y(t)$	Filtered Upper Neck Moment M_y	??NECKUP00BRMOYB
D	0.01778m	

$F_{xp}(t)$	negative portion of $F_x(t)$
$F_{xa}(t)$	positive portion of $F_x(t)$
$M_{ye}(t)$	negative portion of $M_{OCy}(t)$
$M_{yf}(t)$	positive portion of $M_{OCy}(t)$

3.3 Shoulder criteria

3.3.1 Lateral Shoulder Force

The Lateral Shoulder Force is calculated with the following formula:

$$Fy_{shoulder} = \max(F_y(t))$$

with:

F_y	Filtered Shoulder Force F_y	??SHLD[LE,RI]00WSFOYB

3.3.2 Lateral Shoulder Rib Displacement

The Lateral Shoulder Rib Displacement is calculated with the following formula:

$$Dy_{shoulder} = \max\left(D_y(t) - D_y(0)\right)$$

with:

$D_y(t) = R(t) \cdot \sin(\Phi_{IRT}(t))$

R(t)	Filtered Shoulder IR-TRACC length	??SHRI[LE,RI]00WSDC0C
$\Phi_{IRT}(t)$	Filtered Shoulder IR-TRACC rotation	??SHRI[LE,RI]00WSANZC
$D_y(0)$	Lateral Shoulder Rib Displacement @ t=0	

3.4 Chest criteria

3.4.1 Chest Deflection

The Chest Deflection value is calculated with the following formula:

$$D_{chest} = \max(D_{chest}(t))$$

with:

$D_{chest}(t)$	Filtered Chest Deflection D_{chest}	??CHST0003??DSXC

3.4.2 Seatbelt force modifier

The Seatbelt force modifier is calculated with the following formula:

$$MA_{seatbelt} = \max(MA_{seatbelt}(t))$$

with:

$$MA_{seatbelt}(t) = \frac{1}{2n+1} \sum_{j=t-n}^{j=t+n} F_{seatbelt}(j)$$

$F_{seatbelt}$	Filtered Seatbelt Force	??SEBE0003B3FO0D
n	number of samples equivalent to 10ms	

3.4.3 Lateral Thoracic Rib Displacement

The Lateral Thoracic Rib Displacement is calculated with the following formula:

$$Dy_{thorax} = \max\left(D_y(t) - D_y(0)\right)$$

with:

$D_y(t) = R(t) \cdot \sin(\Phi(t))$

R(t)	Filtered Thoracic IR-TRACC length	??TRRI[LE,RI]01WSDC0C
Φ (t)	Filtered Thoracic IR-TRACC rotation	??TRRI[LE,RI]01WSANZC
$D_y(0)$	Lateral Thoracic Rib Displacement @ t=0	

3.4.4 Viscous Criterion

The VC is calculated with the following formula:

$$VC = sf \cdot V(t) \times C(t)$$

With:

sf 1.3 for HIII-50M, 1.3 for HIII-05F and 1.0 for WorldSID

$$V(t) = \frac{8(D_{chest}(t+1) - D_{chest}(t-1)) - (D_{chest}(t+2) - D_{chest}(t-2))}{12\Delta t}$$

$$C(t) = \frac{D_{chest}(t)}{D_{constant}}$$

$D_{chest}(t)$	Filtered Chest Deflection D_{chest} for WorldSID use calculated Lateral Thoracic Rib Displacement Dy_{thorax}	??CHST0003??DSXC
Δt	Time step	
$D_{constant}$	0.229 for HIII-50M, 0.187 for HIII-05F and 0.170 for WorldSID	

3.5 Abdomen criteria

3.5.1 T12 Resultant Acceleration

The T12 Resultant Acceleration is calculated with the following formula:

$$A_R = \sqrt{{A_x}^2 + {A_y}^2 + {A_z}^2}$$

with:

A_x	Filtered T12 Acceleration A_x	??THSP1200WSACXC
A_y	Filtered T12 Acceleration A_y	??THSP1200WSACYC
A_z	Filtered T12 Acceleration A_z	??THSP1200WSACZC

3.5.2 Lateral Abdominal Rib Displacement

The Lateral Abdominal Rib Displacement is calculated with the following formula:

$$Dy_{abdomen} = \max\left(D_y(t) - D_y(0)\right)$$

with:

$$D_y(t) = R(t) \cdot \sin(\Phi(t))$$

R(t)	Filtered Abdominal IR-TRACC length	??ABRI[LE,RI]01WSDC0C
Φ(t)	Filtered Abdominal IR-TRACC rotation	??ABRI[LE,RI]01WSANZC
$D_y(0)$	Lateral Abdominal Rib Displacement @ t=0	

3.5.3 Viscous Criterion

The VC is calculated with the following formula:

$$VC = sf \cdot V(t) \times C(t)$$

With:

sf 1.0 for WorldSID

$$V(t) = \frac{8(D_{y,abdomen}(t+1) - D_{y,abdomen}(t-1)) - (D_{y,abdomen}(t+2) - D_{y,abdomen}(t-2))}{12\Delta t}$$

$$C(t) = \frac{D_{y,abdomen}(t)}{D_{constant}}$$

$Dy_{abdomen}(t)$	Calculated Lateral Abdominal Rib Displacement
Δt	Time step
$D_{constant}$	0.170 for WorldSID

3.6 Lower extremities criteria

3.6.1 Iliac Force Drop

The Iliac Force Drop value is calculated with the following formula:

$$IFD = \max(IFD(t))$$

With:

$$IFD(t) = F_{iliac}(t + 0.001) - F_{iliac}(t)$$

F_{iliac} (t)	Filtered Iliac Force F_{iliac}	??ILAC[LE,RI]00??FOXB

3.6.2 Knee Displacement

The Knee Displacement value is calculated with the following formula:

$$D_{knee} = |\min(D_{knee}(t))|$$

With:

$D_{knee}(t)$	Filtered Knee Displacement D_{knee}	??KNSL[LE,RI]00??DSXC

3.6.3 Femur Force

The Femur Force value is calculated with the following formula:

$$F_{femur} = \text{abs}(\min\left(F_{femur}(t)\right))$$

With:

$F_{femur}(t)$	Filtered Femur Force F_{femur}	??FEMR[LE,RI]00??FOZB

3.6.4 Tibia Index

The Tibia Index is calculated with the following formula:

$$TI(t) = \left|\frac{M_R(t)}{(M_R)_C}\right| + \left|\frac{F_z(t)}{(F_z)_C}\right|$$

with:

$$M_R(t) = \sqrt{M_x(t)^2 + M_y(t)^2}$$

M_x	Filtered Bending Moment M_x	??TIBI[LE,RI][UP,LO]??MOXB
F_z	Filtered Force F_z	??TIBI[LE,RI][UP,LO]??FOZB
$(M_R)_C$	225Nm for HIII-50M and 115Nm for HIII-05F	
$(F_z)_C$	35.9kN for HIII-50M and 22.9N for HIII-05F	

4 ASSESSMENT CRITERIA CALCULATION

This chapter describes the calculation for assessment criteria used within Euro NCAP active safety tests, including the filters that are applied to each channel used in these calculations. The analysis software used by the Euro NCAP labs will follow these calculations in detail.

4.1 Autonomous Emergency Braking

4.1.1 Relative impact speed

The (relative) impact speed is calculated with the following formula:

$$v_{rel,impact} = v_{VUT}(t_{impact}) - v_{EVT}(t_{impact})$$

with:

$V_{VUT,x}$	Speed of VUT	10VEHC000000VEXP
$V_{EVT,x}$	Speed of EVT	20VEHC000000VEXP
t_{impact}	Time of impact	10TIMPFR0000EV00

4.1.2 Speed reduction

The speed reduction is calculated with the following formula:

$$v_{ireduction} = v_{VUT}(t_0) - v_{VUT}(t_{impact})$$

with:

$V_{VUT,x}$	Speed of VUT	10VEHC000000VEXP
t_0	Time of start of test	
t_{impact}	Time of impact	10TIMPFR0000EV00

4.1.3 FCW Time-to-Collision

The Time-to-Collision of FCW is calculated with the following formula:

$$TTC_{FCW} = TTC(t_{FCW})$$

with:

TTC	Time-to-Collision	10TTTC000000TI00
t_{FCW}	Time of FCW initiation	10TFCW000000EV00

4.2 Lane Support Systems

4.2.1 Distance to Line Crossing for LKA

The Distance-to-Line Crossing for LKA is calculated with the following formula:

$$DTLC_{LKA} = \max(y_{VUT,wheel}) - y_{line}$$

with:

$y_{VUT,wheel}$	Lateral position of the outer edge of wheel	1[1,3]WHEL000000DSYP
y_{line}	Lateral position coordinate of inner edge of line	

4.2.2 Distance to Line Crossing for LDW

The Distance-to-Line Crossing for LDW is calculated with the following formula:

$$DTLC_{LDW} = y_{VUT,wheel}(t_{LDW}) - y_{line}$$

with:

$y_{VUT,wheel}$	Lateral position of the outer edge of wheel	1[1,3]WHEL000000DSYP
t_{LDW}	Time of LDW initiation	10TLDW000000EV00
y_{line}	Lateral position coordinate of inner edge of line	