SAFETY COMPANION 2020

carhs
Empowering Engineers

Knowledge for Tomorrow's Automotive Engineering

EMPOWERING ENGINEERS FOR 25 YEARS

SEMINARS	CONFERENCES	KNOWLEDGE
Active & Passive Safety Dummy & Crash Test Engineering & Simulation	News & Updates Knowledge Exchange & Networking for Experts	Tables & Graphs Summarizing all important Rules & Regulations in Vehicle Safety

SafetyWissen Navigator

Seminar Guide

Here you find the courses you need to get your job done!

Frontal Impact

Side Impact

Restraint Systems

Pedestrian Protection

Rear Impact

Dummies + Crash Test

Legend

- Seminar/**Event** that focusses on this topic
- Seminar/**Event** that deals with this topic (among others)

Haven't found what you need?
Get in touch with us! ☎ +49-6023-964060

Dummy & Crash Test

Active Safety

Engineering & Simulation

Do not take vehicle safety for granted

SAFETY COMPANION 2020

Safety**Wissen** on 85 pages

More than 150 seminars & events

Never before have automobiles been safer than today. 60 years of research and development have given our cars a remarkable degree of passive safety.

What does that mean? It means that inside a modern car, in the event of an accident corresponding to the majority of accidents, we are safe from serious injuries. The engineering challenge is to convert the kinetic energy of even the most severe accident situations in such a way that the human being is not exposed to loads beyond his or her biomechanical limits.
Have we done enough? The clear answer is: No. There are still far too many deaths and serious injuries on the roads of Germany, Europe and the whole world.

What is necessary? Unfortunately, there is not the one approach that could prevent the tragedy of 1.3 million deaths worldwide. In the meantime, the voices that gave autonomous cars this role have also fallen silent.

Rather, many approaches are needed, that are also strongly focusing on regional conditions and adapt to ever changing boundary conditions.

The integration of active and passive safety has the potential to master future challenges such as an ageing population and alternative seating positions in highly automated vehicles with solutions.

However, it will still need requirements on the part of legislation and consumer protection organizations. These are particularly necessary in the developing markets in Asia, Africa and South America in order to implement the existing know-how of the developed countries as quickly as possible.

We support you in the implementation through our attractive training programs consisting of seminars, hands-on conferences and events. We cover the entire range of vehicle safety: from passive safety to accident prevention and safety in automated and autonomous driving.

In addition to the offers in the SafetyCompanion, we are also available to you for individual training, e. g. at your premises. Take advantage of our experience and the expertise of our trainers to achieve your training goals.

Now is the best time for your company and your employees to use the current changes in the automotive industry as an opportunity to develop new skills. We are happy to support you.

For the whole team of carhs.training

Rainer Hoffmann
President & CEO

Ralf Reuter
Executive Vice President

Seminars at carhs.training - Your Benefits

Free parking for seminar attendees

In the carhs TrainingCenter in Alzenau, there are enough free parking spaces for our course participants. So you don't have to plan any time for searching for a parking space and can start your course in a relaxed way.

Free use of the charging station

You can use our charging station for electric vehicles free of charge during your course attendance at the carhs TrainingCenter in Alzenau. Two 11 kW type-2 charging stations are available are at your disposal.

Seminar materials on paper & as PDF file

You will receive the seminar documents from us both as a ring binder for taking notes during the course and as a PDF file for storage on your computer. You can also bring your computer with you to the course and work directly in the PDF file.

Fair cancellation policy

We know that sometimes something interferes. Therefore you can cancel your seminar registration free of charge until 4 weeks before the course and until 2 weeks before the course only a lump sum of 100 Euro will be charged. You can send a substitute participant at any time. So you can register early for your seminar of choice without any risk and benefit from the → early bird rates.

Early bird rates reduce your costs

Early registrations give us and the course participants planning security. We return the favour with a significantly lower early booking price for both seminars and conferences.

All-round catering during the seminar

You don't have to bring anything: During the seminar you will be provided with snacks, fresh fruit and drinks in the breaks and we invite you to lunch with all course participants and trainers - this is the opportunity to network.

Small group sizes for maximum learning success

Our courses take place in small group sizes to ensure optimal interaction with the trainers and between students.

And WiFi?

Of course, WiFi is also available free of charge at the carhs TrainingCenter in Alzenau. However, we recommend that you not be distracted while attending the seminar. But that is of course your choice.

In-house Seminars

Seminars at your site - efficient, flexible and customized

Are you looking for an individual and customized training for your employees?
Most of the seminars from our training program can also be booked as in-house seminars in English or German language. Whether on your company site or at another venue of your choice, the scale of our in-house seminars is tailored to your needs.

Your advantages

- You retain full cost control. We offer attractive fixed prices for our in-house seminars, depending on the number of participants and the related service.
- Even for a small number of participants you can save a lot of money compared to the individual booking of seminars. Additionally, there are no costs for travel and time of your employees.
- We respect your target dates as far as possible – also upon short notice in „urgent cases“.
- You benefit from our professional organization and the top-quality seminar manuals.
- Our lecturers answer your individual questions.
- Even if you are interested in very specific questions – we are looking for a qualified lecturer and develop the seminar.

Many of our customers have integrated our in-house seminars into their company's training program.

Take advantage of this offer, too! We will be pleased to prepare you an individual offer.

References

ACTS, AUDI, Autoform, AZOS, Bentley Motors, Bertrandt, BMW, Bosch, Brose, CATARC, Continental, CSI, Daimler, Dalphimetal, Delphi, Dura Automotive, EDAG, Faurecia, Ford, F.S. Fehrer Automotive, Global NCAP, Grammer, HAITEC, Honda, IAV, IABG, IDIADA, IEE, JCI, IVM, Key Safety Systems, LEAR, Magna, Mahindra & Mahindra, MBtech, MESSRING, MGA, Opel, Open Air Systems, PATAC, P+Z, SAIC, SMP, SMSC, SEAT, Siemens, TAKATA, TASS, Tata, TECOSIM, TRW, TTTech, Valeo, VIF, Visteon, Volkswagen, ZF

Attractive prices

With reference to our regular seminar fees we offer attractive discounts on our in-house seminars:

1 Day Seminar	
Discount	for the
30 %	5th - 8th Participant
60 %	9th - 12th Participant
70 %	13th - 16th Participant
75 %	17th - 20th Participant
80 %	from the 21st Participant

2 Day Seminar	
Discount	for the
50 %	5th - 8th Participant
70 %	9th - 12th Participant
75 %	13th - 16th Participant
80 %	17th - 20th Participant
85 %	from the 21st Participant

Your contacts at carhs.training

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AUTOMOTIVE Safety Summit Shanghai 2020

Safety Technologies for the intelligent, autonomous and electrified Automobile of the Future.

The »Automotive Safety Summit Shanghai« is attracting more than 500 automotive safety experts from China and beyond to discuss the latest requirements and innovations in active and passive safety. Accompanied by a comprehensive trade show with the worldwide vendors in development technologies and services, the summit is the leading event for everyone involved in automotive safety. The 2020 event will focus on automotive safety in the context of current Megatrends: NEV, ADAS and AD.

Join »Automotive Safety Summit Shanghai« on July 16 – 17, 2020 at the Kerry Hotel in Pudong, Shanghai, China.

Keynotes from international experts, presentations on requirements and innovations, the latest developments in testing and simulation for active and passive systems will make this event a true highlight for every decision maker and engineer in the fields of active and passive safety. With the rapid rise of New Energy Vehicles (EV, PHEV and FCV), new challenges are surfacing for the safety community. The »Automotive Safety Summit Shanghai« is setting a focal point on Safety of New Energy Vehicles, discussing requirements, technologies and validation aspects for safety of NEVs.

The event will have dedicated sessions on the following topics:

- Safety of new energy vehicles
- Global legal and consumer requirements
- Pedestrian safety
- Autonomous emergency braking
- Safety testing and simulation
- Safety in autonomous driving

Who should attend?

»Automotive Safety Summit Shanghai« is addressing decision makers and engineers at all stages of the development phase, managers during the conceptual phase who need to understand upcoming global requirements, design engineers, testing and simulation specialists.

FACTS

DATE	16.-17. July 2020
HOMEPAGE	www.carhs.de/safetysummit
VENUE	Shanghai, China
LANGUAGE	English / Chinese with simultaneous translation

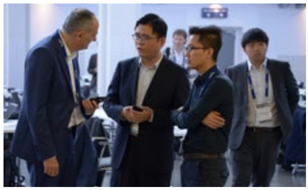
SAFETYWEEK
THE FUTURE OF AUTOMOTIVE SAFETY

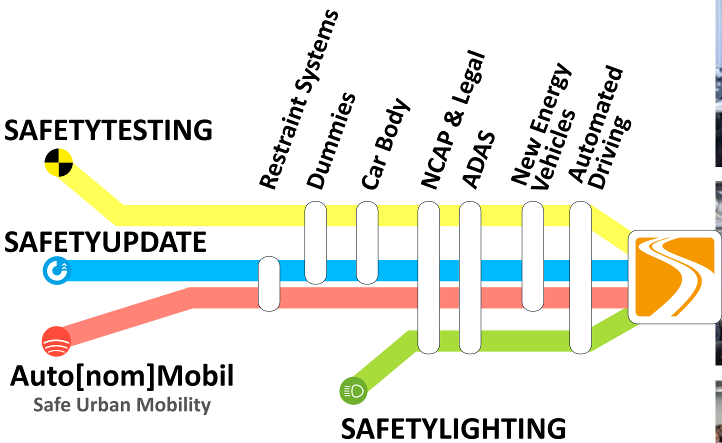
Supporting automotive development engineers to further improve automotive safety, that is the essence of SafetyWeek.

In a unique combination of knowledge congress, events and exhibition, SafetyWeek offers participants and visitors the opportunity, to bring their expertise up-to-date and to learn about the latest developments and technologies in product development and product verification.

In 2020 SafetyWeek will feature numerous highlights:

- The knowledge congress **SafetyUpDate*+active*** with the most current updates on requirements and solutions in active and passive safety. ➲ page 15
- The **SafetyLighting** with all news regarding the safety ratings and regulations for automotive headlights. ➲ page 141
- The **SafetyTesting*+active*** with the innovations from the Leaders in Testing and Simulation of components and systems in active and passive safety. ➲ page 114
- **Auto[nom]Mobil**, the expert forum on safe urban mobility ➲ page 141
- The accompanying exhibition **SafetyExpo**, the meeting point for suppliers and decision makers in automotive safety.





Who should attend?

SafetyWeek is the meeting point for everyone involved in vehicle safety. This includes developers as well as test and simulation engineers from OEMs and suppliers, manufacturers of test systems, representatives of governments and consumer protection organizations and researchers from universities and research institutes.

FACTS

DATE	28.-30. July 2020
HOMEPAGE	www.carhs.de/safetyweek
VENUE	VCC Vogel Convention Center, Würzburg
LANGUAGE	German with translation into English
PRICE	from 890 EUR (single day)

SAFETYUPDATE +active

The concept is familiar: To keep software up-to-date you regularly make an update. The same is true for automotive safety engineering: To keep yourself up-to-date you have to attend the SafetyUpDate on a regular basis. Here you get a comprehensive overview of all relevant news in automotive safety.

Active + Passive Safety = SafetyUpDate*+active*

The SafetyUpDate reflects the close integration of active and passive safety and combines both topics in one event. General topics such as the NCAP consumer tests are dealt with in plenary presentations, whereas specific topics such as testing are presented in parallel session on active respectively passive safety.

Conference Topics include:

- Regulations for active and passive safety
- NCAP consumer protection tests
- Development tools: Test & simulation
- Development strategies & solutions
- Biomechanics & accident research

From Experts for Experts

The speakers are leading experts from government agencies, consumer protection organizations, industry and universities. We consider it important that the UpDate presentations are product-neutral and practical.

Meeting Point: Expert Dialog

In addition to the presentations the SafetyUpDate encourages the communication among experts. After the presentations the speakers are available for discussions at the MeetingPoint.

Who should attend?

The SafetyUpDate is aimed at automotive developers, who are interested in active or passive vehicle safety and want to bring their knowledge up-to-date. In addition to the knowledge update, SafetyUpDate offers excellent opportunities to build and maintain contacts in the safety community.

FACTS

DATE	29.-30. July 2020	15.-16. September 2020
HOMEPAGE	www.carhs.de/update	www.carhs.de/gsu
VENUE	VCC Vogel Convention Center, Würzburg	Technische Universität Graz
LANGUAGE	German with translation into English	German with translation into English
PRICE	1.490,- EUR till 30.06.2020, thereafter 1.750,- EUR	1.490,- EUR till 18.08.2020, thereafter 1.750,- EUR

Introduction to Passive Safety of Vehicles

Course Description

Ever increasing requirements regarding vehicle safety have led to rapid developments, with major innovations in the field of Active and Passive Safety. Especially legal requirements in the USA (FMVSS 208, 214), the consumer information tests U.S. NCAP, Euro NCAP and IIHS, as well as pedestrian protection should be mentioned here. So far an end of this development is not in sight. The seminar provides an introduction to Passive Safety of Vehicles. Passive Safety is about initiatives and legal provisions for the limitation of injuries following an accident. All important topics are covered in the seminar, from accident statistics and injury-biomechanics, which are decisive parts of accident research, to the crash-rules and regulations that are derived from the latter, and also to consumer information-tests with protection criteria and test procedures, and eventually to crash tests, where the compliance with the compulsory limits is tested and proven in test procedures. Specific attention is given to dummies, with which the potential loads on a person in an accident can be measured. Finally the basic principles of occupant protection are explained, and the components of occupant protection systems, respectively restraint-systems in motor vehicles such as airbags, belt-system, steering wheel, seat, interior, stiff passenger compartment and others, as well as their increasingly complex interaction, also in terms of new systems, will be discussed.

Course Objectives

It is the primary objective of this seminar to communicate an understanding for the entire field of Passive Safety with all its facets and correlations, but also for its limits and trends. In the seminar you are going to learn about and understand the most important topics and can then judge their importance for your work. With the extensive, up-to-date documentation you obtain a valuable and unique reference book for your daily work.

Who should attend?

The seminar addresses everybody who wants to obtain an up-to-date overview of this wide area. It is suited for novices in the field of Passive Safety of Vehicles such as university graduates, career changers, project assistants, internal service providers, but also for highly qualified technicians from the crash-test lab.

Course Contents

- Introduction to vehicle safety
  - Overview active and passive safety
  - Crash physics
- Accident research
  - General accident research
  - Classifications & statistics
- Biomechanics
  - Human anatomy
  - Injury mechanisms, injury criteria
- Dummy technology
  - Dummy family
- Crash testing
  - Crash test systems and components
  - Test methods
- Crash rules and regulations
  - Institutions
  - Rules and regulations
  - NCAP tests
  - Insurance tests (IIHS, RCAR, C-IASI, ...)
- Protection principles, occupant protection systems
  - Protection principles of passive safety
  - Occupant protection systems
  - Passenger compartment, interior with steering wheel and steering column, seat
  - OOP, pre crash, post crash, sensor system, vehicle body
  - Optimization of restraint systems, adaptive systems
  - Integrated safety

Instructor

Rainer Hoffmann (carhs.training gmbh) has been involved in automotive safety throughout his career. After graduating from Wayne State University, he joined Porsche as a research associate in passive safety. Mr. Hoffmann advanced safety simulation during his subsequent tenure at ESI Group where he introduced new techniques like airbag simulation, numerical airbag folding and FE dummy modeling. As the head of the simulation department of PARS (now Continental Safety Engineering), Mr. Hoffmann led the R&D efforts for some of the first series production side airbag developments. In 1994 Mr. Hoffmann founded EASi Engineering GmbH, which in 2006 was renamed to carhs GmbH. He has authored numerous technical papers and has been granted German and international patents in the automotive safety field.

Dates

DATE	COURSE ID	VENUE	DURATION	PRICE	LANGUAGE
19.-20.02.2020	17/3540	Alzenau	2 Days	1.340,- EUR till 22.01.2020, thereafter 1.590,- EUR	German
27.-28.05.2020	17/3541	Alzenau	2 Days	1.340,- EUR till 29.04.2020, thereafter 1.590,- EUR	English
17.-18.06.2020	17/3542	Landsberg am Lech	2 Days	1.340,- EUR till 20.05.2020, thereafter 1.590,- EUR	German
01.-02.09.2020	17/3543	Tappenbeck	2 Days	1.340,- EUR till 04.08.2020, thereafter 1.590,- EUR	German
18.-19.11.2020	17/3544	Alzenau	2 Days	1.340,- EUR till 21.10.2020, thereafter 1.590,- EUR	German

Safety of Commercial Vehicles

Course Description

Freight transport has increased by more than 50 % within 15 years. An end of this trend is not foreseeable. Forecasts predict that a further increase of up to 80 % over the next 10 years will occur. Accompanied by this, vehicle safety in commercial vehicles has been increasingly coming into focus for several years and initial successes have already been achieved. For example, the number of accident victims of heavy commercial vehicle accidents has fallen by around 35 % since the turn of the millennium. Current adjustments in UN Regulations and European legislation on active and passive commercial vehicle safety also go hand in hand with development requirements that go far beyond the previous level. An important step towards improving active safety is, for example, the adoption of UN regulations UN R130 and UN R131, which have introduced the introduction of Advanced Emergency Braking Systems (AEBS) and Lane Departure Warning (LDW) since 1 November 2015 for all heavy commercial vehicles. Both systems have great potential for avoiding frontal collisions, accidents with oncoming traffic and rollover accidents or at least for reducing the consequences of accidents. Activities are currently underway to further tighten the UN R131 and to introduce a regulation on Blind Spot Information Systems (Turning assistance). However, the design of direct and indirect fields of vision (e.g. also via cameras), the cab structure, load securing and underride protection systems are still of major importance with regard to commercial vehicle safety. In this context, among other things, the regulation UN R29 on the crash behavior of the cab structure and the UN R58.03 on the rear underrun protection are of central importance.

Course Objectives

In this seminar you will get an overview of the requirements and regulations of different vehicle classes and types in the commercial vehicle sector. There is a consideration of today's legal requirements in the areas of passive and in particular active vehicle safety. Based on the requirement profile, the current state-of-the-art as well as current trends are shown.

Who should attend?

The seminar is focused on specialists and experts from the passenger car and commercial vehicle sector, engineers and technicians from calculation and testing, project engineers and managers, who want to get an overview of the requirements and technological solutions for the development of safety-relevant systems for commercial vehicles and the resulting conclusions to provide compatibility with other road users.

Course Contents

- Requirements for commercial vehicle development
  - Vehicle classes and types for commercial vehicles
  - Design of heavy commercial vehicles
  - Drivers in the development of commercial vehicles
- Measures for passive safety
  - Overview of regulations and test methods for passive commercial vehicle safety
  - Effects of the regulations on vehicle design
  - Technological feasibility
  - Protection potential and limits of passive safety measures
- Measures for active safety
  - Overview of regulations and test methods for active commercial vehicle safety
  - Effects of the regulations on vehicle design
  - Technological feasibility
  - Protection potential and limits of active safety measures
- Development strategies
  - Energy management
  - Structural design for passive safety
  - Compatibility considerations
  - Solution approaches for conflicting objectives
  - Simulation of driving sequences in active safety

Instructor

Prof. Dr. Harald Bachem (Ostfalia University of Applied Sciences) has been in charge of teaching and research in vehicle safety at the Ostfalia University of Applied Sciences since 2011. Prior to joining the university he held various management positions in industry where he was in charge of development and testing of vehicle safety functions. His last management position was head of cab body development at MAN Truck & Bus AG. Prof. Bachem is chairman of the Wolfsburg Institute for Research, Development and Technology Transfer e. V.

Date

DATE	COURSE ID	VENUE	DURATION	PRICE	LANGUAGE
20.10.2020	158/3534	Alzenau	1 Day	790,- EUR till 22.09.2020, thereafter 940,- EUR	English (UK flag)

International Safety and Crash-Test Regulations: Current Status and Future Developments

Course Description

Since the 1960's, the regulation of vehicle safety performance has had a major impact on vehicle and system design. As automotive manufacturing has evolved into an integrated global system, understanding and anticipating legal requirements has become an immense challenge. Regulators collaborate and diverge in how they address road-safety policy goals. Regulatory changes in a single market can translate into global customer requirements. And these requirements are continuously evolving. In a compact program, this two-day seminar provides a worldwide update on the passive safety landscape, covering local, national, regional, and international policy and rulemaking developments. The first segment of the seminar focuses on regulatory institutions and processes. By understanding the regulatory environment, including the trend towards an integrated global regulatory system, businesses can better prepare for changes that impact competitiveness and customer satisfaction. The second segment applies this knowledge to current and future regulatory requirements. The seminar covers crashworthiness (frontal, side, rear impact, etc.) as well as pedestrian protection and new technologies.

Course Objectives

This course informs participants of recent developments and discussions within the global regulatory community concerning passive safety. The seminar explores differences in regulatory systems and philosophies, in compliance and enforcement, and in the forces behind the regulation of vehicle safety. The course provides participants with a broad understanding current regulatory directions and guidance on how to follow, and even influence, future requirements.

Who should attend?

This seminar should be of interest to anyone involved with meeting and anticipating legal requirements for vehicle safety performance across international markets. The course provides a compact review of changes in passive safety requirements and current priorities across the international regulatory community. Moreover, the course provides knowledge critical to understanding differences in the way regulators establish and enforce these legal requirements.

Course Contents

- History of safety regulation and development of legal regimes (e.g., self-certification, type approval, product liability, in-use surveillance)
- Regulatory agencies and rulemaking processes (e.g., UN, European Union, U.S. NHTSA, etc.)
- Regulatory drivers and priorities
- Types and purposes of regulations (UN Regulations, GTR, FMVSS, EU Regulations and Directives, etc.)
- Developments in crashworthiness and occupant protection requirements (frontal impact, side impact, pole-side impact, full width barrier, offset deformable barrier, mobile barrier, etc.)
- Vulnerable road user (VRU) protection (e.g., pedestrian safety, cyclist safety)
- Safety of new propulsion technologies (electric vehicles, hydrogen fuel-cells, minimum vehicle noise levels)
- Passive safety implications of new safety technologies (e.g., emergency call systems, collision avoidance, VRU detection, automated driving)

Instructors

John Creamer (GlobalAutoRegs.com) is the founder of GlobalAutoRegs.com and a partner in The Potomac Alliance, a Washington-based international regulatory affairs consultancy. In his client advisory role, Mr. Creamer is regularly involved with meetings of the UN World Forum for the Harmonization of Vehicle Regulations (WP.29). Previously, he has held positions with the US International Trade Commission and the Motor & Equipment Manufacturers Association (representing the US automotive supplier industry), as the representative of the US auto parts industry in Japan, and with TRW Inc. (a leading global automotive safety systems supplier).

Dr. Thomas Kinsky (Humanetics Europe GmbH) completed his studies in automotive engineering at the TU Dresden in 1991 and received his doctorate at the TU Graz in 2015. From 1991 to 1995 he worked as an officially certified expert at TÜV Rheinland and then took over the management of the vehicle construction department at a small medium-sized company. From 1999 to 2018 he was employed at Opel Automobile GmbH in the area of vehicle regulations. Most recently, as a senior expert, he was responsible for the development of legislation on passive vehicle safety and represented Opel in discussions with authorities and associations. He has been Director Business Development at Humanetics Europe GmbH since 2018. In this role he is Humanetics' representative for all topics regarding dummy development as well as for the requirements of passive and active safety.

Dates

DATE	COURSE ID	VENUE	DURATION	PRICE	LANGUAGE
09.-10.03.2020	16/3564	Alzenau	2 Days	1.340,- EUR till 10.02.2020, thereafter 1.590,- EUR	German
03.-04.06.2020	16/3528	Alzenau	2 Days	1.340,- EUR till 06.05.2020, thereafter 1.590,- EUR	English
10.-11.11.2020	16/3565	Alzenau	2 Days	1.340,- EUR till 13.10.2020, thereafter 1.590,- EUR	German

Crash-Regulations: Europe, United Nations, USA, China and India

Instrument Panel
UN R21, 32, 33
US FMVSS 201
IN IS 15223

Side Windows
UN R43, GTR 6
US FMVSS 205, 226

Interior
UN R12, 21, 43, GTR 6
US FMVSS 201, 203, 204, 205
CN GB 11552-2009
IN IS 15223, AIS 096

Roof
US FMVSS 216, 216a
CN GB 26134-2010

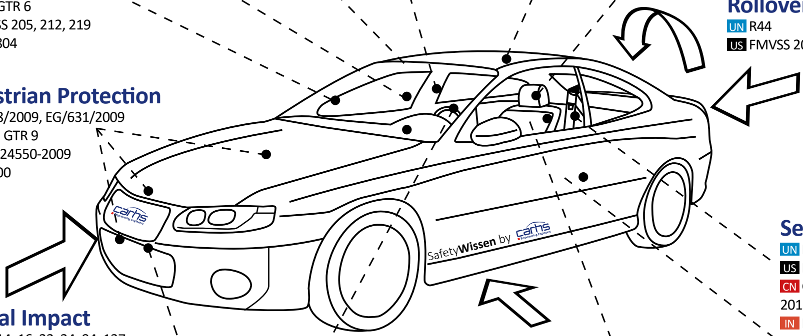
Headrests
UN R17, 25, GTR 7
US FMVSS 202a
CN GB 11550-2009, GB 15083-2006
IN IS 15546

Windscreeen
UN R43, GTR 6
US FMVSS 205, 212, 219
IN IS 15804

Rollover
UN R44
US FMVSS 201, 216, 216a, 301

Rear Impact
UN R17, 25, 32, 34, 42, 58
US FMVSS 202a, 207, 301, 581
CN GB 11550-2009, GB 18296-2001 20072-2006
IN AIS 101

Pedestrian Protection
EU EG/78/2009, EG/631/2009
UN R127, GTR 9
CN GB/T 24550-2009
IN AIS 100



Seat Belts
UN R14, 16, 17
US FMVSS 208, 209, 210
CN GB 14166-2013, GB 14167-2013, 15083-2006
IN IS 15139, 15140

Frontal Impact
UN R12, 14, 16, 33, 34, 94, 137
US FMVSS 203, 204, 208, 209, 210, 301
CN GB 11551-2014 , 11557-2011 , 14166-2013, 14167-2013 GB/T 20913-2007
IN IS 15139, 15140, AIS 096, 098

Bumper
UN R42
US FMVSS 581
CN GB 17354-1998
IN IS 15901

Steering Wheel
UN R12
US FMVSS 203, 204
CN GB 11557-2011
IN IS 11939, AIS 096

Side Impact
UN R95, 135, GTR 14
US FMVSS 214
CN GB 20071-2006, GB/T 37337-2019
IN AIS 099

Seats
UN R16, 17, 21, 44, 129, 145
US FMVSS 201, 202a, 207, 213, 225
CN GB 11550-2009, 14166-2013, 15083-2006, 27887-2011
IN IS 15546, 15139, 15532, AIS 072

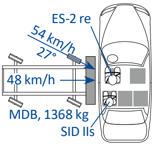
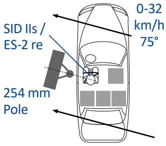
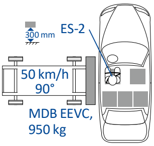
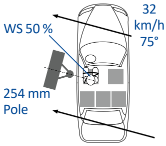
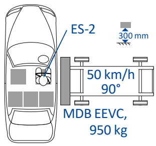
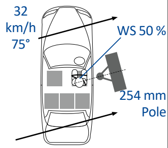
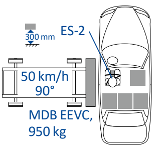
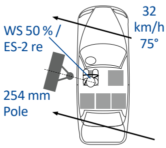
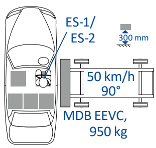
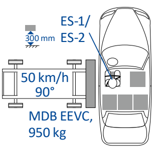
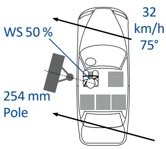
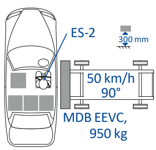
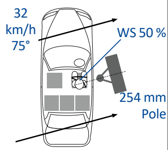
Doors
UN R11, GTR 1
US FMVSS 206
CN GB 15743-1995, 15086-2013
IN IS 14225

Rules and Regulations on Occupant Protection

	Full Width Frontal		Offset Frontal	
USA	FMVSS 208	0° 56 km/h, H III 50 % / H III 50 %; 0° / ± 5° 56 km/h, H III 5 % / H III 5 %; 0° / ± 5° 32-40 km/h, H III 5 % / H III 5 %; 0° / ± 30° 32-40 km/h, H III 50 % / H III 50 %	FMVSS 208	ODB 40 %, 200 mm, 0° 40 km/h, H III 5 % / H III 5 %
Europe	UN R137[1]	0° 50 km/h, H III 50 % / H III 5 %	UN R94	ODB 40 %, 200 mm, 0° 56 km/h, H III 50 % / H III 50 %
Japan	Art. 18	0° 50 km/h, H III 50 % / H III 5 %	Art 18	ODB 40 %, 200 mm, 0° 56 km/h, H III 50 % / H III 50 %
China	GB 11551-2014	0° 50 km/h, H III 50 % / H III 50 %	GB/T 20913-2007	ODB 40 %, 200 mm, 0° 56 km/h, H III 50 % / H III 50 %
India			AIS-098	ODB 40 %, 200 mm, 0° 56 km/h, H III 50 % / H III 50 %
South Korea	KMVSS 102-3	0° 48,3 / 50[2], H III 50 % / H III 50 %, 5 %[2]		
Australia	ADR 69/00	0° 48 km/h, H III 50 % / H III 50 %	ADR 73/00	ODB 40 %, 200 mm, 0° 56 km/h, H III 50 % / H III 50 %

[1] Mandatory as part of the EU type approval for new types from July 6, 2022, for new registrations from July 7, 2024.
[2] From September 2020

Ground clearance of the lower edge of the deformable barrier

Side Barrier	Side Pole	Pedestrian	Rear	Head Impact	Rollover
FMVSS 214 	FMVSS 214 		FMVSS 202a FMVSS 301	FMVSS 201	Roof Crush: FMVSS 216a Ejection Mitigation: FMVSS 226
UN R95 	UN R135[1] 	R (EC) 78/2009 R (EC) 631/2009 UN R127	UN R34	UN R21	
Art. 18 	Art. 18 	Article 18	Article 22-4	Article 20	
GB 20071-2006 	GB/T 37337-2019 	GB/T 24550-2009	GB 20072-2006	GB11552-2009	Roof Crush: GB26134-2010
AIS-099 		AIS-100	AIS-101	IS15223	
KMVSS 102 	KMVSS 102-4[2] 	KMVSS 102-2		KMVSS 88	
ADR 72/00 	ADR 85/00 			ADR 21	

[1] Mandatory as part of the EU type approval for new types from July 6, 2022, for new registrations from July 7, 2024.
[2] From September 2020

Crash Safety of Hybrid and Electric Vehicles

Course Description

During recent years, electric vehicles have achieved an ever-increasing importance for the automotive market. A compliance of future restrictions for CO2 emissions will not be possible without electrified power trains. All mayor OEM offer an increasing variety of hybrid vehicles (HEV), plug-in hybrid vehicles (PHEV) and pure electric vehicles (BEV). Also a first offer of fuel cell electric vehicles (FCEV) is in the market. In 2018 nearly 2 million electrified vehicles (BEV and PHEV) were sold worldwide. For 2020 more than 5 million will be expected. The breakthrough of the automotive electrification is evident. Nevertheless, several challenges for vehicle safety arise with new these technologies. Electric shock risks on high-voltages systems, fire hazards in case of lithium-ion batteries and risks of rupture in case of gas tanks are the most important issues here. For every mode of drive, specific drive components and their particular safety requirements are described. In addition to common rules and standards, specific needs based on real-life accidents are being discussed. For all relevant vehicle components the respective safety requirements, safety concepts and exemplary safety initiatives will be discussed. The state of the art concerning test standards, verification methods and possibilities for virtual safety will be shown. Future trends will be presented with the help of current research projects and results. Practical experience of rescuing, recovering and towing of electric vehicles complete the spectrum of accident safety.

Course Objectives

Participants will get an overview about automotive safety of electric vehicles and will learn the special challenges and solutions which come along. Participants will be able to apply test methods and safeguarding concepts and to pursue development strategies in a target-oriented way.

Who should attend?

The seminar addresses development and research engineers as well technicians in the fields of testing and engineering with electric vehicles. Due to its current relevance the course suits young professionals as well as experienced engineers who want to deepen their knowledge in this field.

Course Contents

- Overview alternative drive systems: hybrid, electric vehicles, fuel cell, gas vehicles
- Challenges for vehicle safety
- Legal requirements and standards, safety requirements for real-world accidents
- Safety of high voltage systems
- Battery safety
- Gas tank safety
- Fuel cell safety
- Structural safety
- Safety concepts
- Rescuing, recovering and towing of electric vehicles

Instructor

Rainer Justen (Mercedes-Benz AG) has 30 years of experience in the field of vehicle safety. After his studies in mechanical engineering with a focus on automotive engineering he started his career in the automotive development at Daimler AG in 1987. Several career milestones in the fields of vehicle safety, project management, safety concepts and active safety / driver assistance systems made him an expert on all relevant topics of automotive safety. Since 2008 he is working in the field of safety for alternative drive systems. Rainer Justen is author of numerous publications and papers on this topic. In 2015 Rainer Justen received the SAE Automotive Safety Award for his work on the Safety of Li-Ion Batteries in Electric Vehicles from the American Society of Automotive Engineers (SAE).

Dates

DATE	COURSE ID	VENUE	DURATION	PRICE	LANGUAGE
26.-27.03.2020	173/3593	Alzenau	2 Days	1.340,- EUR till 27.02.2020, thereafter 1.590,- EUR	
02.-03.07.2020	173/3594	Alzenau	2 Days	1.340,- EUR till 04.06.2020, thereafter 1.590,- EUR	
05.-06.11.2020	173/3595	Alzenau	2 Days	1.340,- EUR till 08.10.2020, thereafter 1.590,- EUR	

FMVSS 305: Safety Requirements for Electric Vehicles

Scope:

Cars, busses, trucks with a GVWR of 4536 kg or less that use electrical components with working voltages higher than 60 volts direct current (VDC) or 30 volts alternating current (VAC), and whose speed attainable is more than 40 km/h.

Post-crash Requirements:

Under the test conditions described below (impact test and subsequent static rollover)

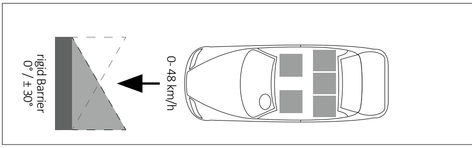
- max. 5 litres of electrolyte may spill from the batteries,
- there shall be no evidence of electrolyte leakage into the passenger compartments,
- all components of the electric energy storage / conversion system must be anchored to the vehicle,
- no battery system component that is located outside the passenger compartment shall enter the passenger compartment,
- each HV source in the vehicle must meet one of the 3 following **electrical safety requirements**
  - (1) **electrical isolation** must be greater than or equal to:
    - 500 ohms/V for an AC HV source,
    - 100 ohms/V for an AC HV source if it is conductively connected to a DC HV source, but only if the AC HV source meets the physical barrier protection requirements specified in the first 3 sub-items of (3)
    - 100 ohms/V for all DC HV sources,
  - (2) the **voltage level** of the HV source (Vb, V1, V2) must be ≤ 30 VAC for AC components or 60 VDC for DC components.
  - (3) **physical barrier protection** against electric shock shall be demonstrated by meeting the following conditions:
    - the HV source meets protection degree IPXXB
    - resistance between exposed conductive parts of the electrical protection barrier (EPB) of the HV source and the electrical chassis is < 0.1 ohms
    - resistance between an exposed conductive part of the EPB of the HV source and any other simultaneously reachable exposed conductive parts of EPBs within 2.5 meters of it must be < 0.2 ohms
    - voltage between exposed conductive parts of the EPB of the HV source and the electrical chassis is ≤ 30 VAC or 60 VDC
    - voltage between an exposed conductive part of the EPB of the HV source and any other simultaneously reachable exposed conductive parts of EPBs within 2.5 meters of it must be ≤ 30 VAC or 60 VDC

Docket No. NHTSA-2019-0009

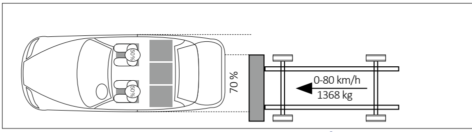
TP-305-01

Test Conditions:

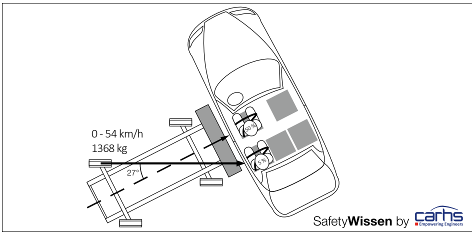
Frontal impact against a rigid barrier at 48 km/h



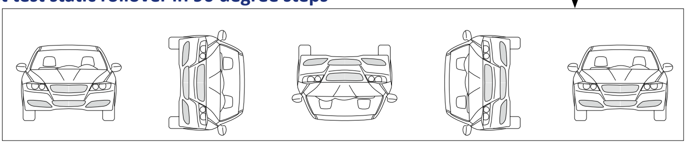
Rear moving barrier impact at 80 km/h (FMVSS 301)



Side moving deformable barrier impact at 54 km/h (FMVSS 214)



Post-impact test static rollover in 90 degree steps

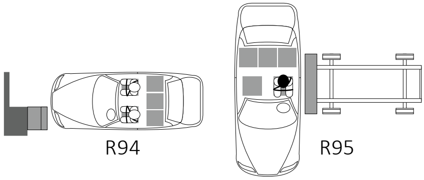


UNECE: Safety Requirements for Electric Vehicles

Extension of UN R94 / R95:

UN R94, 03 Series, Supplement 1

UN R95, 03 Series, Supplement 7

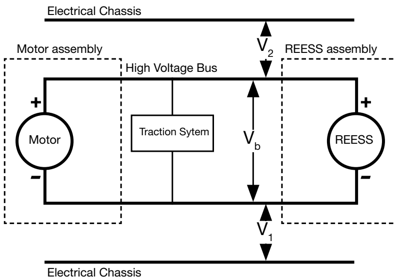


After crash tests according to UN R94 and R95 vehicles with a high voltage electrical powertrain (> 60 V DC or > 30 V AC) must meet the following requirements:

1. Protection against Electrical Shock

at least one of the four criteria specified below shall be met:

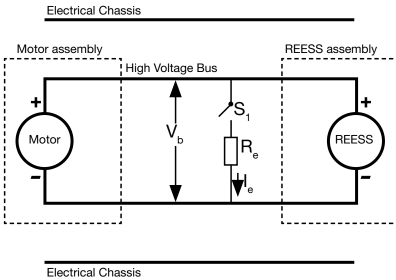
- Absence of high voltage:
  The voltages V_b, V_1 and V_2 shall be
  ≤ 30 V AC or ≤ 60 V DC :



- Low electrical energy:
  The total energy (TE) on the high voltage buses shall < 2.0 J.
  Prior to the impact a switch S_1 and a known discharge resistor R_e is connected in parallel to the relevant capacitance .
  Not earlier than 5 s and not later than 60 s after impact S_1 shall be closed while the voltage V_b and the current I_e are recorded.
  From this TE is caluclated as follows:

$$TE = \int_{tc}^{th} V_b \times I_e dt$$

with tc = time of closing S_1
th = time when voltage drops below 60 V DC



- Physical protection:
  For protection against direct contact with high voltage live parts, the protection IPXXB shall be provided.
- Isolation resistance:
  - If the AC HV buses and the DC high voltage buses are galvanically isolated from each other, isolation resistance between the HV bus and the electrical chassis shall be ≥ 100 Ω/V of the working voltage for DC buses, and ≥ 500 Ω/V of the working voltage for AC buses.
  - If the AC HV buses and the DC HV buses are galvanically connected isolation resistance between the HV bus and the electrical chassis shall be ≥ 500 Ω/V of the working voltage. (if the protection IPXXB is satisfied for all AC HV buses or the AC voltage is ≤ 30 V after the vehicle impact, the isolation resistance shall be R_i ≥ 100 Ohm/V)

2. Electrolyte Spillage

- In the period from the impact until 30 minutes after no electrolyte from the REESS (Rechargeable Electrical Energy Storage System) shall spill into the passenger compartment and no more than 7 % of electrolyte shall spill from the REESS.

3. REESS Retention

REESS located inside the passenger compartment shall remain in the location in which they are installed and REESS components shall remain inside REESS boundaries. No part of any REESS that is located outside the passenger compartment for electric safety assessment shall enter the passenger compartment during or after the impact test.

UN R100:

M and N class vehicles with a maximum speed > 25 km/h must also comply with UN R100 02 series.

UN R100, 02 Series, Supplement 4

Vehicle Safety under Self-Certification: Principles, Obligations, Enforcement and Remedies

Course Description

When looking at regulatory requirements across different markets, it's common to think in terms of technical specifications, checking for differences in test procedures and performance criteria. However, failure to consider how the regulations are used can be a fatal mistake because safety authorities differ in how they apply and enforce their requirements. This seminar looks at the self-certification compliance and enforcement system which focuses heavily on monitoring the performance of vehicles in use. Compliance with the legal standards is only one part of a much larger, more complex system requiring the assurance of safety throughout the lifetime of every vehicle on the road. Manufacturers must have systems in place to detect possible safety concerns regardless of whether they relate to compliance with specific standards and must communicate continuously with safety authorities or run the risk of damaging recalls that can place the company in peril.

Course Objectives

This seminar provides a review of self-certification compliance and enforcement mechanisms toward helping manufacturers avoid expensive recalls, costly penalties, and lost reputation.

Who should attend?

The seminar is aimed at employees from the development departments of automobile manufacturers and suppliers who develop vehicles for the U.S. market as well as all employees in the areas of product strategy, sales and warranty and defect management for the U.S. market.

Course Contents

- Background and origins of self-certification
- Players and processes in U.S. rulemaking
- Principles of U.S. safety compliance and enforcement
- Role of product liability laws
- Role of Federal Motor Vehicle Safety Standards (FMVSS)
- NHTSA and FMVSS compliance
- NHTSA and safety monitoring
- Non-regulatory methods to ensure safety
- Safety defects and motor vehicle recalls
- Manufacturer roles and responsibilities
- Outlook for U.S. safety policies

Images: NHTSA

Instructor

John Creamer (GlobalAutoRegs.com) is the founder of GlobalAutoRegs.com and a partner in The Potomac Alliance, a Washington-based international regulatory affairs consultancy. In his client advisory role, Mr. Creamer is regularly involved with meetings of the UN World Forum for the Harmonization of Vehicle Regulations (WP.29). Previously, he has held positions with the US International Trade Commission and the Motor & Equipment Manufacturers Association (representing the US automotive supplier industry), as the representative of the US auto parts industry in Japan, and with TRW Inc. (a leading global automotive safety systems supplier).

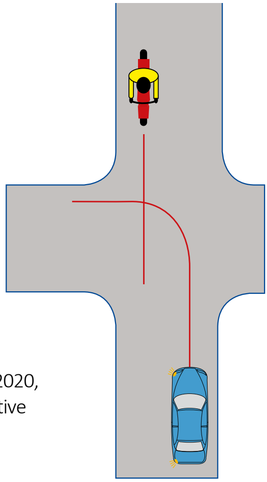
Date

DATE	COURSE ID	VENUE	DURATION	PRICE	LANGUAGE
13.-14.10.2020	183/3529	Alzenau	2 Days	1.340,- EUR till 15.09.2020, thereafter 1.590,- EUR	English (UK flag)

Euro NCAP UpDate 2020

Get ready for Euro NCAP‘s latest rating revision!

Image: Thatcham Research



The Road Map 2025 systematically expands and updates all areas of the Euro NCAP rating. After a series of new and changed assessment procedures had already been implemented in 2020, many innovations are scheduled for 2022. At the Euro NCAP UpDate, experts from the respective working groups provide detailed information on the current status of these new procedures:

- Find out the current state of discussion on the upcoming protocols.
- Take advantage of the discussion with the experts active in the Euro NCAP working groups.

Contents

- Roadmap 2025
  - AEB/LSS Car-to-Powered Two Wheelers
  - New Car-to-Car AEB scenarios (Junction & Crossing, Head-on)
  - Automatic Emergency Steering AES
  - New test method for pedestrian and cyclist impact (new leg impactor aPLI and extended head impact zone)
  - Rescue, Extrication & Safety
  - Child Presence Detection
  - Driver Monitoring
  - Virtual Testing
  - Scenario based assessment
- #TestingAutomation
  - Assessment of automated driving functions
- Field reports on the current test procedures

Who should attend?

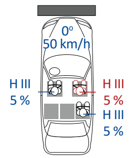
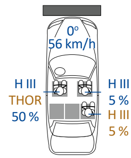
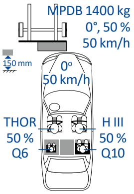
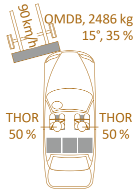
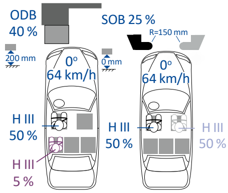
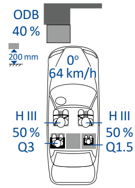
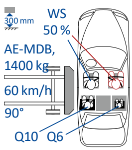
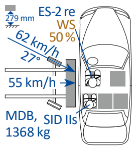
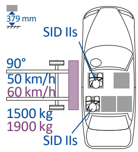
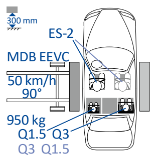
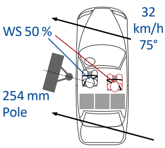
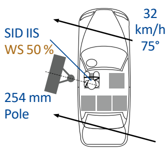
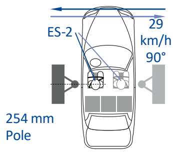
The Euro NCAP UpDate is suited for everybody who wants to be prepared for Euro NCAP's upcoming requirements.

FACTS

DATE	15.-16. December 2020
HOMEPAGE	www.carhs.de/euroncap
VENUE	Frankfurt am Main
LANGUAGE	(UK flag)
PRICE	1.490,- EUR till 17.11.2020, thereafter 1.750,- EUR

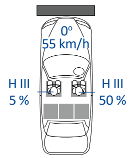
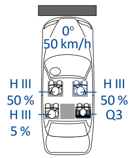
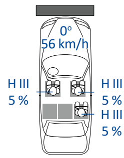
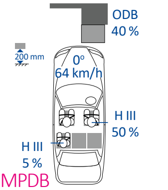
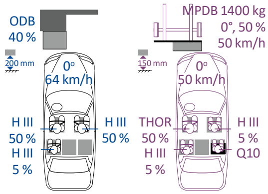
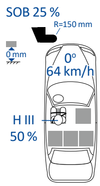
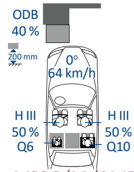
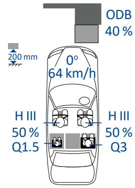
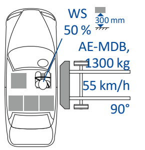
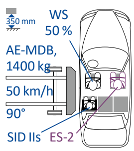
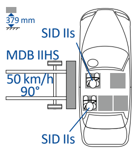
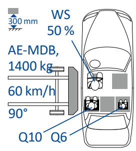
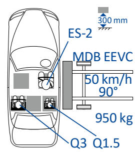
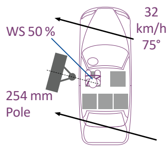
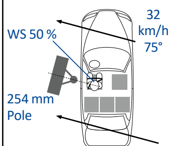
NCAP-Tests in Europe, America and Australia

Items written in italics are not part of the overall rating **2020 2021 2022 2023 date of implementation unknown**

	Euro NCAP / ANCAP	U.S. NCAP	IIHS	Latin NCAP
Full Width			Get familiar with all NCAP tests in just 2 days with our seminar: **NCAP - New Car Assessment Programs: Tests, Assessment Methods, Ratings** learn more on ➲ page 30	
ODB / SOB				
MDB	 ■ Far Side Occupant Protection			
Pole	 ■ Far Side Occupant Protection			
Rollover		■ SSF	■ Roof Crush	
Pedestrian	■ Flex PLI, aPLI ■ Upper Legform ■ Headforms ■ AEB/AES VRU Ped., Cyclist, PTW ■ AEB Reverse Pedestrian	■ Flex PLI ■ Upper Legform ■ Headforms ■ AEB Pedestrian ■ Rear Automatic Braking	■ AEB Pedestrian	■ Flex PLI ■ Upper Legform ■ Headforms ■ AEB VRU
Child Safety	■ Frontal MPDB ■ Side MDB ■ CRS - Installation ■ Veh. Based Assessment, COPD		■ *LATCH (Lower Anchors and Tethers for Children)* ■ *Booster Seat Rating*	■ Frontal ODB ■ Side MDB ■ CRS - Installation ■ Veh. Based Assessment
Whiplash	■ Static Front / Rear ■ Dynamic (2 Pulses)		■ Static ■ Dynamic (1 Pulse)	■ Static ■ Dynamic (1 Pulse) ■ AEB City
Other	■ SBR, SAS, AEB, LSS, AEB, Occupant Status, AES, Rescue, *AD*	■ *FCW, LDW, AEB, DBS,* BSD, Headlights	■ AEB, FCW, SBR ■ Headlights ■ *Low Speed Bumper*	■ SBR, ESC, SAS, BSD, LSS, AEB, eCall, Rescue Sheet, Rear Impact: UN R32
	➲ page 32	➲ page 48	➲ page 52	➲ page 57

NCAP-Tests in Asia

Items written in italics are not part of the overall rating 2020 2021 2022 2023

	JNCAP	C-NCAP	C-IASI	KNCAP	ASEAN NCAP
Full Width					
ODB / SOB	 ■ MPDB			 ■ MPDB/SO/OMDB	
MDB		 except EV/HEV		 ■ Far Side Occ. Prot.	
Pole		 EV/HEV only			
Rollover		■ Curtain Airbag	■ Roof Crush	■ SSF	
Pedestrian	■ Flex PLI ■ Headforms ■ *AEB Pedestrian*	■ Flex PLI, aPLI ■ Headforms ■ AEB Pedestrian	■ Flex PLI ■ Upper Legfom ■ Headforms ■ AEB Pedestrian ■ ABE Cyclist	■ Flex PLI, aPLI ■ Upper Legform ■ Headforms ■ AEB Pedestrian ■ AEB Cyclist	■ Flex PLI ■ Headforms
Child Safety	■ *CRS Rating*	■ Q3 in Full Width Frontal ■ Q10 in MPDB ■ CRS - Installation ■ *CRS Rating*		■ Frontal ODB ■ Side MDB	■ Frontal ODB ■ Side MDB ■ CRS - Installation ■ Veh. Based Assmt. ■ CPD
Whiplash	■ Dynamic (1 Pulse)	■ Dynamic (1 Pulse) ■ Rear Seats Dynamic	■ Static ■ Dynamic (1 Pulse)	■ Static ■ Dynamic (1 Pulse) ■ Rear Seats Static	
Other	■ SBR, *AEB, LSS, Rear View, Headlights, eCall, Pedal Misapplication*	■ ESC, SBR, AEB, FCW, LDW, BSD, SLIF, SAS, LKA, eCall, V2X, Headlights	■ AEB, FCW ■ Low Speed Bumper	■ SBR, FCW, LDW, SLD, AEB, BSD, LKA, RCTA, ISA, Airbag, AES, Headlights	■ BST, Rear View, AHB, HPT, Safety Assist Technologies

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NCAP - New Car Assessment Programs: Tests, Assessment Methods, Ratings

Course Description

In 1979 the first New Car Assessment Program (NCAP) was established by NHTSA in the United States. The goal was to motivate competing car manufacturers to enhance the safety level of their cars beyond the minimum safety standards defined by regulations. The same approach has been followed globally by other organizations (e. g. by Euro NCAP, IIHS, ANCAP, JNCAP, KNCAP, C-NCAP, ...). Euro NCAP which has been established in 1997 has taken a leading role and has significantly influenced other countries and regions. The NCAP programs in many cases are highly dynamic, especially in comparison with rulemaking activities. In order to reach the goal to continuously improve the safety level of cars, the requirements need to be permanently adapted to the state of technology. Developers in the automotive industry need to know about upcoming changes at an early stage in order to be able to design or equip their vehicles accordingly. In this seminar attendees get an overview of the organizations in charge of the NCAP programs and become familiar with the various test and assessment methods.

NEW

The seminar is conducted several times a year with changing focuses:

- **Focus passive safety:** Here the focus is on test and assessment methods for passive safety. Frontal and side impact, whiplash, child protection and pedestrian protection are discussed in detail. Tests for active safety are only mentioned in as far as they are relevant for the overall rating.
- **Focus active safety:** Here the focus is on active safety systems such as AEB or lane assistance. The tests and assessments for these systems are explained in detail. Tests for passive safety are only mentioned in as far as they are relevant for the overall rating.

In both focusses the current overall rating methods are described and explained. In addition to that an outlook is given on the roadmaps and future developments of the NCAP programs.

Who should attend?

The seminar addresses design, simulation, testing and project engineers as well as managers who want to get a current overview on the global range of NCAP programs with an outlook on upcoming topics and trends from an insider. Depending on the focus of their work attendees should chose the appropriate focus of the seminar.

Course Contents

- New Car Assessment Programs - overview
- U.S. NCAP
- IIHS
- Euro NCAP
- ANCAP
- JNCAP
- KNCAP
- C-NCAP
- C-IASI
- Latin NCAP
- ASEAN NCAP
- Bharat NCAP
- Global NCAP

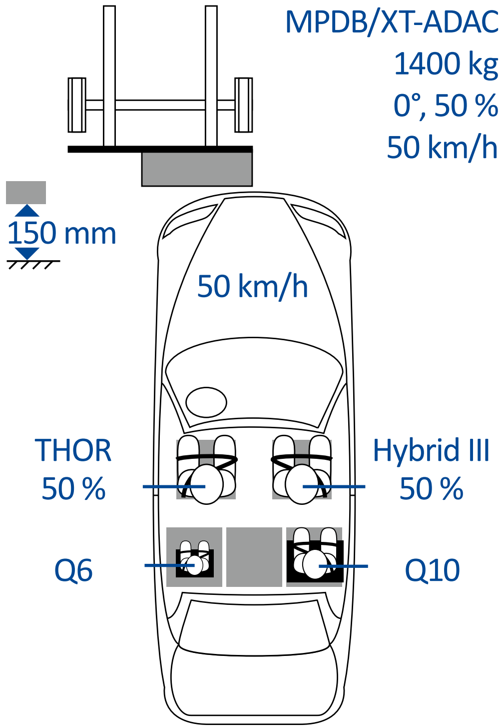
Instructor

Direktor and Professor Andre Seeck (German Federal Highway Research Institute) is head of the division "Vehicle Technology" with the German Federal Highway Research Institute (BASt). In this position he is responsible for the preparation of European Safety Regulations. Furthermore he represents the German Federal Ministry of Transport and Digital Infrastructure in the Board of Directors of Euro NCAP and he is the chairman of the strategy group on automated driving and of the rating system. These positions enable him to gain deep insight into current and future developments in vehicle safety. In 2017 NHTSA awarded him the U. S. Government Special Award of Appreciation.

Dates

DATE	COURSE ID	VENUE	DURATION	PRICE	LANGUAGE
05.-06.03.2020	164/3468	Alzenau	2 Days	1.340,- EUR till 06.02.2020, thereafter 1.590,- EUR	
17.-18.06.2020	164/3579	Alzenau	2 Days	1.340,- EUR till 20.05.2020, thereafter 1.590,- EUR	
30.11.-01.12.2020	164/3580	Alzenau	2 Days	1.340,- EUR till 02.11.2020, thereafter 1.590,- EUR	

Euro NCAP / ANCAP: MPDB Frontal Impact



Assessment Procedure:

1. Calculation of **points for each measured criterion** (➲ p. 34) ①:
   Where a value falls between the **higher** ② and **lower** ③ **performance limit**, the score is calculated by linear interpolation. The maximum score is 4 points. Exceeding the **capping limit** ④ leads to loss of all points related to that tests.
2. Calculation of **points for each body region** ⑤:
   The lowest scoring criterion is used to determine the performance of each region.
   There are four body regions:
   - Head and neck
   - Chest and abdomen
   - Pelvis, femur and knee
   - Lower leg and foot
3. The **Modifiers** ⑥ are deducted from the body region score.
4. Calculation of **point for the test**:
   For each body region the lowest score of driver ⑦ or passenger ⑧ is used to determine the score. The maximum score for the test is 16 points.
5. When a **door opens** in the test, a minus one-point modifier for each opening door will be applied to the score for that test.
6. The **Compatibility assessment** (➲ page 36) comprises:
   - Homgenity of barrier deformation ⑨
   - Barrier bottoming out ⑩
   - Occupant Load Criterion OLC ⑪

   It is applied as a modifier ⑫ to the total test score. The dedcution is limited to 8 points. In 2020 and 2021 the deduction is halved and limited to 4 points.
7. For the overall rating (➲ page 46) the score of the MPDB test is scaled by a factor of 0.5, i. e. a maximum of 8 points is available.

Protocols

Testing	**MPDB Testing Protocol Version 1.1.1**
Assessment	**Assessment Protocol AOP Version 9.1.2**
Dummy	**Technical Bulletin 026 Version 1.0**
Barrier	**Technical Bulletin 022 Version 1.2**
Compatibility	**Technical Bulletin 027 Version 1.1.1**

Euro NCAP / ANCAP: MPDB Frontal Impact

Dummy	⑤ Region	① Criteria	② 4 Points	③ 0 Points	④ Capping	⑥ Modifiers
Frontal Impact against MPDB with 50 % Overlap @ 50/50 km/h						
Driver: THOR 50 % SBL-B ⑦	Head[1]	HIC$_{15}$	< 500	> 700	> 700	Unstable airbag/steering wheel contact (-1 pt) Hazardous airbag deployment (-1 pt) Incorrect airbag deployment (-1 pt) Steering column displ. (-1 pt)
		a$_{3ms}$ (g)	< 72	> 80	> 80	
		SUFEHM/BrIC	Monitoring			
	Neck	M$_{y,extension}$ (Nm)	< 42	> 57	> 57	
		F$_{z,tension}$ (kN)	< 2.7	> 3.3	> 3.3	
		F$_{x,shear}$ (kN)	< 1.9	> 3.1	> 3.1	
	Chest	Deflection R$_{max}$ (mm)	< 35	> 60	> 60	A-pillar displacement (-2 pt) Compartment deformed (-1 pt) Steering wheel contact (-1 pt) Incorrect airbag deployment (-1 pt) Shoulder belt load > 6 kN (-2 pt)
	Abdomen	Deflection (mm)	-	> 88	-	
	Pelvis	Acetabulum$_{Compression}$ (kN)	< 3.28	> 4.1	-	Incorrect airbag deployment (-1 pt) Submarining[2] (-4 pt) Variable contact (-1 pt) Concentrated loading (-1 pt)
	Femur	Axial Force (kN)	< 3.8	> 9.07 > 7.56 @ 10 ms	-	
	Knee	Displacement (mm)	< 6	> 15	-	
	Tibia	Tibia Index	< 0.4	> 1.3	-	Z–displacement of worst pedal (-1 pt) Footwell rupture (-1 pt) Pedal blocking (-1 pt)
		Axial Force (kN)	< 2	> 8	-	
	Foot	x–Displacement pedal (mm)	< 100	> 200	-	
Passenger: Hybrid III 50 % ⑧	Head[1]	HIC$_{15}$	< 500	> 700	> 700	Unstable airbag contact (-1 pt) Hazardous airbag deployment (-1 pt) Incorrect airbag deployment (-1 pt)
		a$_{3ms}$ (g)	< 72	> 80	> 80	
	Neck	M$_{y,extension}$ (Nm)	< 42	> 57	> 57	
		F$_{z,tension}$ (kN)	< 2.7 @ 0 ms < 2.3 @ 35 ms < 1.1 @ 60 ms	> 3.3 @ 0 ms > 2.9 @ 35 ms > 1.1 @ 60 ms	> 3.3 @ 0 ms > 2.9 @ 35 ms > 1.1 @ 60 ms	
		F$_{x,shear}$ (kN)	< 1.9 @ 0 ms < 1.2 @ 25-35 ms < 1.1 @ 45 ms	> 3.1 @ 0 ms > 1.5 @ 25-35 ms > 1.1 @ 45 ms	> 3.1 @ 0 ms > 1.5 @ 25-35 ms > 1.1 @ 45 ms	
	Chest	Deflection (mm)	< 22	> 42	> 42	Incorrect airbag deploymt. (-1 pt) Shoulder belt load > 6 kN (-2 pt)
		VC (m/s)	< 0.5	> 1.0	> 1.0	
	Femur	Axial Force(kN)	< 3.8	> 9.07 > 7.56 @ 10 ms	-	Variable contact (-1 pt) Concentrated loading (-1 pt) Incorrect airbag deployment (-1 pt)
	Knee	Displacement (mm)	< 6	> 15	-	
	Tibia	Tibia Index	< 0.4	> 1.3	-	
		Axial Force(kN)	< 2	> 8	-	

For each door that opens during the test a -1 point modifier will be applied to the score of the test.

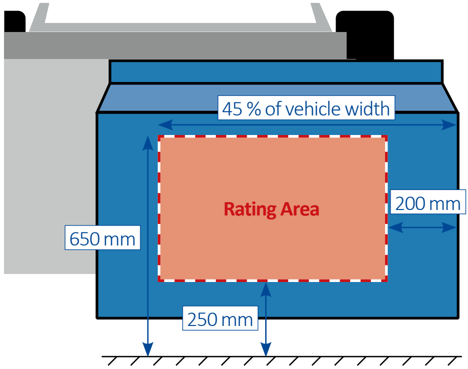
[1] If there is no hard contact (i. e. ares, peak < 80 g and no other evidence of hard contact) a score of 4 points is awarded.

[2] When any of the two iliac forces drops within 1 ms and when the submarining is confirmed on the high speed film.

Euro NCAP / ANCAP: MPDB Frontal Impact Compatibility Assessment

Homogenity Assessment based on the Standard Deviation of the post-test Barrier Deformation within the Rating Area of the PDB Front Face (9)

- Scanning the deformed PDB front and generating a mesh with a maximum element size of 10 mm from the resulting point cloud.
- Creation of a point grid centered on the undeformed PDB front with uniform spacings of 20 mm (1400 grid points).
- Projection of the grid points on the mesh and calculation of the intrusion at each of the points in the rating area.
- Calculation of the standard deviation s [mm] of the intrusion (i. e. the deviation from the mean intrusion within which 68.2 % of the intrusion values fall).
- Calculation of the homogenity factor ***h*** [%]:
  - for s < 50 mm: h = 0
  - for 50 mm ≤ s ≤ 150 mm: h = (s - 50 mm) / 100 mm
  - for s > 150 mm: h = 100 %



Bottoming out of the PDB (10)

A 2 point modifier ***M_{BO}*** is applied if a barrier face penetration depth of 630 mm in an area that is larger than 40 mm x 40 mm occurs.

Calculation of the Occupant Load Criterion OLC (11)

- Determine velocity course of the MPDB by integrating the measured X-acceleration (a_X) on the centre of gravity of the MPDB (filtered with CFC 180):

$$v_v(t) = \int a_x(t)\,dt + v_0$$

with v_0 = initial velocity of the MPDB.

- OLC, t_1 and t_2 can be calculated with solving the following equation system:

$$\int_{t=0}^{t=t_1} v_0\,dt - \int_{t=0}^{t=t_1} v_v(t)\,dt = 0.065$$

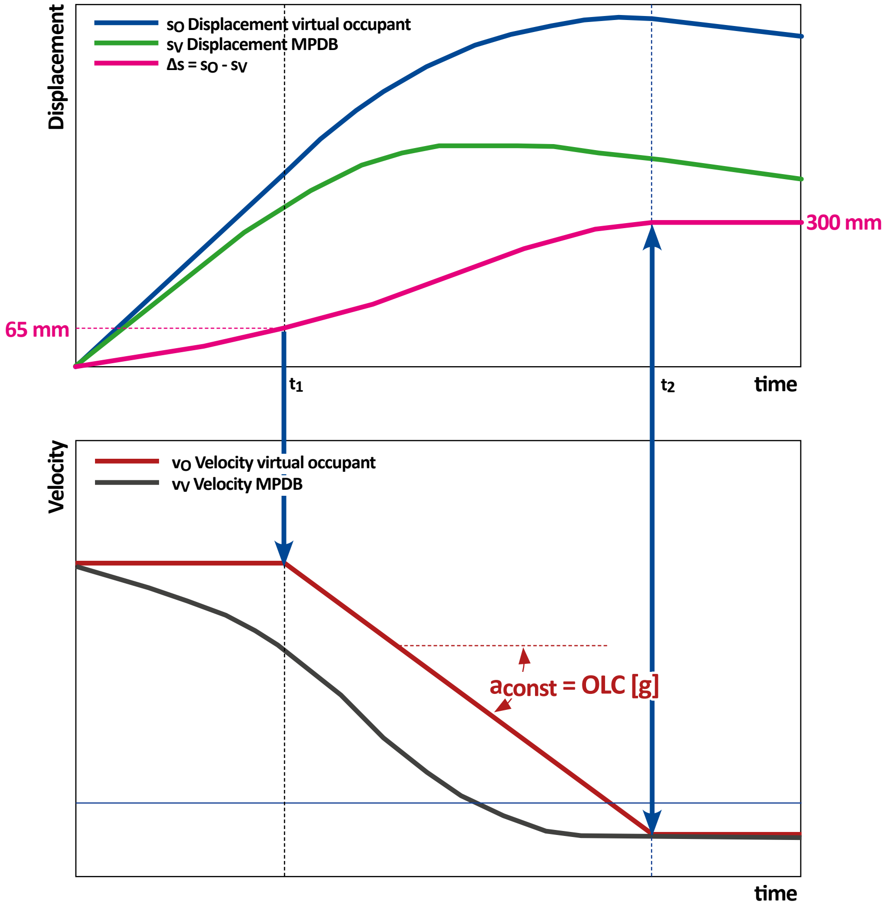
$$\int_{t=t_1}^{t=t_2} \big(v_0 - OLC\cdot(t-t_1)\big)\,dt - \int_{t=t_1}^{t=t_2} v_v(t)\,dt = 0.235$$

$$v_0 - OLC\cdot(t_2 - t_1) = v_v(t_2)$$

with t_1 = end of the free-flight-phase of a virtual dummy on the barrier along a displacement of 65 mm

t_2 = end of the restraining-phase of a virtual dummy on the barrier along a displacement of 235 mm after the free-flight-phase (i. e. a total displacement of 300 mm)

- For compatibility assessment **OLC** shall be converted from SI units into g.



Calculation of the Compatibility Modifier ⑫

- for $OLC < 25$ g:
  $M_{Compat} = -2 \cdot h - M_{BO}$
- for $25\text{ g} \leq OLC \leq 40$ g:
  $M_{Compat} = -2 \cdot OLC/15 + 10/3 - h \cdot ((4 \cdot OLC/10 - 8) - (2 \cdot OLC/15 - 10/3)) - M_{BO}$
  M_{Compat} is limited to -8 points
- for $OLC > 40$ g:
  $M_{Compat} = -2 - 6 \cdot h - M_{BO}$
  M_{Compat} is limited to -8 points
- in 2020 - 2022 M_{Compat} is multiplied with 0.5 (i. e. M_{Compat} is limited to -4 points)
- M_{Compat} is deducted from the total score (max. 16 points) of the MPDB frontal crash

Euro NCAP MPDB Frontal Crash Workshop

with Praxis Session

Course Description

In 2020 Euro NCAP introduced the MPDB (Moving Progressive Deformable Barrier) frontal crash. With this new crash test, Euro NCAP wants to assess not only the self-protection of vehicles, but also partner protection, i. e. compatibility. The new test procedure poses a number of challenges: the test with 2 moving objects (vehicle + barrier car) is much more demanding than a test against the crash block. In addition there is the use of the new THOR dummy. Due to the new compatibility evaluation, the test evaluation also goes beyond the previous scope. For example, the energy input into the barrier and the deformation pattern must be evaluated. The MPDB Workshop shows the new test procedure from test preparation (trolley, barrier and dummy seating). The workshop will be held at the ADAC Technical Centre in Landsberg, where the new test procedure was developed to a large extent, and will ensure the greatest possible practical relevance.

Course Objectives

Course participants will become familiar with the practical preparation, execution and evaluation of the MPDB crash. ADAC experts will answer questions about the new Euro NCAP test procedure.

Who should attend?

The workshop is aimed at all those who design vehicles for this load case or test vehicles to that effect.

Course Contents

- Overview of the MPDB Test
  - Roadmap / schedule
  - Development of the test and assessment procedure
  - Current status of the working group
  - Integration into the overall rating (scores, modifiers)
- Trolley and barrier
  - Specifications
  - Test preparation
- THOR dummy
  - Dummy specifications (build level)
  - Experiences from the round robin test
  - Praxis: Seating procedure
  - Injury criteria, limit values, modifiers
  - Explanation of head injury assessment with SUFEHM
- Compatibility rating
  - Compatibility modifier components
  - Determining the OLC
  - Praxis: Evaluation of barrier deformation (barrier scan)

Image: ADAC

Instructor

Volker Sandner (ADAC Technik Zentrum Landsberg) has been head of the Vehicle Safety Department of ADAC, which includes active safety, passive safety and accident research, since 2010. Before that, from 1999-2007 he was in charge of the construction of ADAC's crash test lab as a team manager. From 2007-2010 he lead the Passive Safety Department of ADAC. At Euro NCAP he is a member of the Board of Directors and chairman of the frontal impact working group. In addition to that he is member of the side impact working group, the techincal working group and the ratings group of Euro NCAP. He is also lecturer for vehicle safety at the University of Applied Sciences in Munich.

Dates

DATE	COURSE ID	VENUE	DURATION	PRICE	LANGUAGE
30.-31.03.2020	182/3625	Landsberg am Lech	2 Days	1.340,- EUR till 02.03.2020, thereafter 1.590,- EUR	German
18.-19.11.2020	182/3626	Landsberg am Lech	2 Days	1.340,- EUR till 21.10.2020, thereafter 1.590,- EUR	English

Euro NCAP / ANCAP Protection Criteria in Frontal Impact

Assessment Protocol Version 9.1.2

Dummy	Region	Criteria	4 Points	0 Points	Capping	Modifiers
Frontal-Impact against Rigid Wall with 100 % overlap @ 50 km/h						
Hybrid III 5 %	Head[1]	HIC_{15}	< 500	> 700	> 700	Unstable airbag/steering wheel contact (-1 pt) Hazardous airbag deployment (-1 pt) Incorrect airbag deployment (-1 pt) Steering column displacement (-1 pt) Rear seat: head forward excursion (-4 pt)
		a_{3ms} (g)	< 72	> 80	> 80	
	Neck[2]	$M_{y,extension}$ (Nm)	< 36	> 49	> 57[4]	
		$F_{z,tension}$ (kN)	< 1.7	> 2.62	> 2.9[4]	
		$F_{x,shear}$ (kN)	< 1.2	> 1.95	> 2.7[4]	
	Chest	Deflection (mm)	< 18	> 42[5]	> 42[5]	Steering wheel contact (-1 pt) Incorrect airbag deployment (-1 pt) Shoulder belt load > 6 kN (-2 pt)
		VC (m/s)	< 0.5	> 1.0	> 1.0	
	Femur	Axial Force (kN)	< 2.6	> 6.2	-	Submarining[3] (-4 pt)

[1] If there is no hard contact (i. e. ares, peak < 80 g and no other evidence of hard contact) a score of 4 points is awarded. For the rear passenger in the rigid wall impact the score is based on a_{3ms} only, if there is no hard contact.

[2] For the rear passenger, the neck score is the sum of all three criteria, with the following maximum score per criterion: Shear 1 point, Tension 1 point, Extension 2 points

[3] When any of the two iliac forces drops within 1 ms and when the submarining is confirmed on the high speed film.

[4] Driver only

[5] from 2023: 34 mm

Knee Mapping Workshop: The Euro NCAP Test Procedure

Course Description

Euro NCAP plays a leading role among the tests assessing the passive safety of vehicles in Europe. Its influence now also extends to other countries. Recently the knee impact test procedure within the Euro NCAP frontal impact test was modified, the goal being a less subjective assessment. A hard contact or a sharp edge in the knee area implies the danger for a car manufacturer to be punished with a so-called knee modifier (reduction in points). The knee modifier is the most frequent penalty within the Euro NCAP and impairs some vehicles' otherwise 5-star ratings. The allocation of a knee modifier often is a controversial decision. If a knee modifier has been allocated by the Euro NCAP inspector the car manufacturer has the possibility of proving - by means of a complex sled test procedure - that the modifier was not justified. After a short introduction the main focus of the workshop is on the current Euro NCAP assessment procedure for frontal impact in the knee area (knee mapping). The current requirements will be explained in detail, in particular the knee modifiers 'Variable Contact' and 'Concentrated Loading', the areas of inspection and the threshold values. Positive / negative examples will facilitate the participants' understanding of the requirements and the assessment procedure. Participants will learn how to avoid a modifier. The sled test procedure will also be explained and discussed in detail. In the afternoon a demo vehicle, which can be provided by participants, will be analyzed. Volker Sandner, a trained Euro NCAP inspector, can give valuable hints here. A perspective regarding the future development of the test procedure will be given at the end of the seminar.

Who should attend?

The seminar addresses specialists from the field of crash, engineers and technicians from numerical simulation and testing, project engineers and managers who want to have a first-hand, up-to-date information and hints on how to avoid knee modifiers in Euro NCAP.

Course Contents

- Overview of Euro NCAP crash tests
- Euro NCAP requirements in the knee area
- Knee modifier, knee mapping test procedure
- Sled test procedure for knee impact
- Discussion of the assessment procedure and possibilities of interpretation
- Workshop with analysis of test vehicles, which can be provided by participants
- Future development of the test procedure

The workshop was very informative and relevant. The final analysis of a test vehicle was very helpful.“

Ray Longbottom
SAIC Motor UK Technical Centre Ltd., UK

Instructor

Volker Sandner (ADAC Technik Zentrum Landsberg) has been head of the Vehicle Safety Department of ADAC, which includes active safety, passive safety and accident research, since 2010. Before that, from 1999-2007 he was in charge of the construction of ADAC's crash test lab as a team manager. From 2007-2010 he lead the Passive Safety Department of ADAC. At Euro NCAP he is a member of the Board of Directors and chairman of the frontal impact working group. In addition to that he is member of the side impact working group, the techincal working group and the ratings group of Euro NCAP. He is also lecturer for vehicle safety at the University of Applied Sciences in Munich.

Date

DATE	COURSE ID	VENUE	DURATION	PRICE	LANGUAGE
15.09.2020	57/3624	Landsberg am Lech	1 Day	790,- EUR till 18.08.2020, thereafter 940,- EUR	German

Euro NCAP / ANCAP Protection Criteria in Side Impact

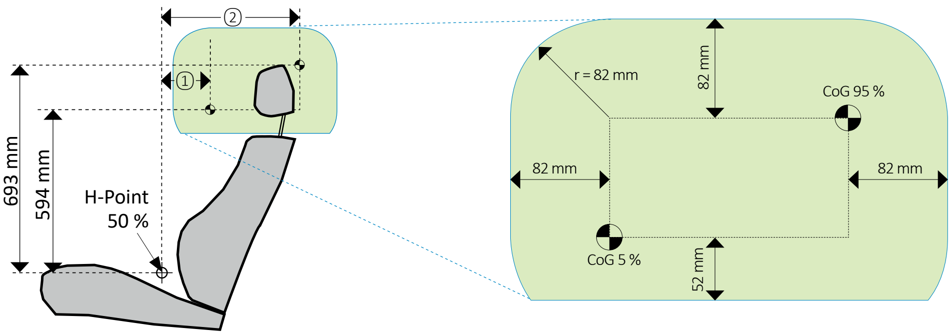
Assessment Protocol Version 9.1.2

Dummy	Region	Criteria	4 Points	0 Points	Capping	Modifiers
Barrier Side Impact (AE-MDB) @ 60 km/h & Pole Side Impact @ 32 km/h						
World SID 50 %	Head[1]	HIC_{15}	< 500	> 700	> 700	incorrect airbag deployment (-1 point) door opening (-1 point/door) lateral shoulder force > 3.0 kN (deduction of all chest points) VC > 1.0 m/s (deduction of all chest/abdomen points) head protection device assessment (-4 points)
		a_{3ms} (g)	< 72	> 80	> 80	
	Chest	Deflection (mm)	< 28	> 50	> 50 (MDB) > 55 (Pole)	
	Abdomen	Deflection (mm)	< 47	> 65	> 65	
	Pelvis	Pubic Symphysis Peak Force (kN)	< 1.7	> 2.8	> 2.8	

[1] Pole: no sliding scale, only capping if HIC_{15} > 700 or $a_{res,\ peak}$ > 80 g or direct head contact with the pole.

Modifier Side Head Protection Device

Inside the ‚Head Protection Device Assessment Zone' (green) the head protection system's coverage is assessed. If the coverage is insufficient a 4 point modifier is applied the overall pole impact score. Areas outside the Daylight Opening (FMVSS 201) are excluded from assessment. Seams are not penalized if the un-inflated area is no wider than 15 mm. Any other un-inflated areas that are no larger than 50 mm in diameter (or equivalent area) are not penalized.



The head protection device (HPD) evaluation zone (green) is defined as a rounded rectangle around the head CoG box (defined by the head CoGs of the 5 % female and 95 % male occupants) at a distance of 82 mm from the upper and fore/aft edges and 52 mm below the bottom edge. The x-position of the CoG is defined relative to the H-Point of the 50 % male:

Front seats:
1 = H-Point(x) + 126 mm - seat travel (5th %ile- 50th %ile)
2 = H-Point(x) + 147 mm + seat travel (50th %ile- 95th %ile)

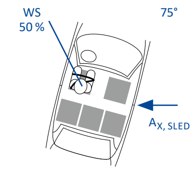
Rear seats:
1 = H-Point(x) + 126 mm - remaining seat travel
2 = H-Point(x) + 147 mm + remaining seat travel

Euro NCAP / ANCAP Far Side Occupant Protection in Side Impacts

Test & Assessment Protocol Version 2.0.1

Test Procedure

- 2 sled tests on acceleration based sled rig
- Pulses:
  - Test 1: $A_{X,\ SLED} = A_{Y,\ VEHICLE}$ (AE-MDB @ 60 km/h) x 1.035
  - Test 2: $A_{X,\ SLED} = A_{Y,\ VEHICLE}$ (Pole @ 32 km/h) x 1.035
- BIW mounted with centerline angled 75° towards direction of travel
- Spacers (EPP60) fitted in gaps between the struck side and the passenger seat and the passenger seat and center console
- WorldSID 50 % on driver seat



Assessment

- Prerequisites:
  - Structural stability of doors, hinges, roof rail and sill in MDB and pole crash. No opening of doors on struck side in MDB and pole crash.
  - Total score from MDB and pole crash ≥ 10 points out of 12.
  - No failure of restraint systems for side impact protection in MDB and pole crash.

- Dummy Criteria:

Dummy	Region	Criteria	Max. Points	0 Points	Capping
Far Side Occupant Protection Sled Test					
World SID 50 %	Head	HIC_{15} (with direct contact only)	< 500	> 700	> 700
		a_{3ms} (g)	< 72	> 80	> 80
	Neck	Upper Neck Tension F_Z (kN)	< 3.74	> 3.74	-
		Upper Neck Lateral Flexion M_XOC (Nm)	< 162	> 248	-
		Upper Neck Extension neg. M_YOC (Nm)	< 50	> 50	-
		Lower Neck Tension F_Z (kN)	< 3.74	> 3.74	-
		Lower Neck Lateral Flexion M_X (Nm)	< 162	> 248	-
		Lower Neck Extension neg. M_Y (Nm)*	-	> [100]*	-
	Chest & Abdomen	Chest Lateral Compression (mm)	< 28	> 50	> 50
		Abdomen Lateral Compression (mm)	< 47	> 65	> 65

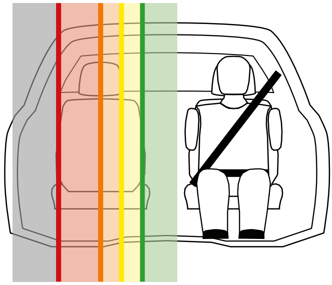
* Monitoring for 2020 - 2022

- Max Points are depending on Peak Head Excursion and Far Side Countermeasures:
  The maximum available points for each body region depends on the amount of head excursion and the availability of a far side countermeasure.

Region	Zone / Countermeasure	Peak Head Excursion in Zone: Capping	Red* ≤ 125 mm	Red* > 125 mm	Orange	Yellow	Green
Head	with	0	0	2	3	4	4
	without	0	0		1	2	4
Neck	with	0	4	4	3	4	4
	without	0	1		1	2	4
Chest & Abd.	with	0	0	0	3	4	4
	without	0	0		1	2	4
Max Dummy Score	**with**	**0**	**4**	**6**	**9**	**12**	**12**
	without	**0**	**1**		**3**	**6**	**12**

* score is depending on wether the red excursion line is > 125 mm outboard of the orange excursion line or not

- Excursion Lines:
  - Red Line: Maximum post test intrusion of the interior door panel from AE-MDB (60 km/h) and 75° pole impacts respectively.
  - Orange Line: Seat centerline of the struck side seat
  - Yellow Line: 125 mm inboard from struck side seat centerline
  - Green Line: 250 mm inboard from struck side seat centerline



- Excursion Zones:
  - Capping Zone: Outboard from the Red Line
  - Red Zone: Between Red Line and Orange Line
  - Orange Zone: Between Orange Line and Yellow Line
  - Yellow Zone: Between Yellow Line and Green Line
  - Green Zone: Inboard from Green Line

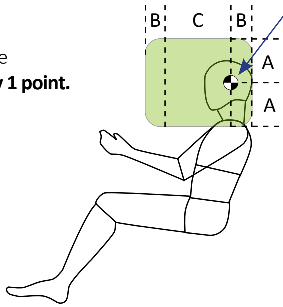
- Pelvis and Lumbar Spine Modifiers

Criteria	Perfor-mance Limit	Modifier
PSPF (kN)	> 2.8	-4 Points applied to the dummy score for each test
Lumbar F_Y (kN)	> 2.0	
Lumbar F_Z (kN)	> 3.5	
Lumbar M_X (Nm)	> 120	

- Total Score:
  The total score (max. 12 from test 1 + 12 from test 2 = 24 points) will be scaled down to a maximum of **4 points** and is part of the AOP score.

- Occupant to Occupant Protection:
  If the vehicle is equipped with a countermeasure, it must prove that the measure prevents occupant to occupant (O2O) interaction. This is verified in the full scale pole side impact (in 2020/2021 alternatively in the MDB impact). This test will be exectued with an additional WS 50 % dummy on the front passenger seat.
  Criteria for O2O head protection:
  - No exceedance of the **head lower performance criteria**
  - No evidence of **direct contact** between the far side occupants head and any part of the nearside occupant (from 2022 onwards)
  - For an assymetric countermeasure the OEM must provide evidence that it provides **protection in impacts from both sides**
  - Protection must be offered in a **protection zone**:

  If the countermeasure fails to meet these criteria, the total far side score (max. 4 points) will be **reduced by 1 point.**



CoG marking from passenger in pole test position

A = 120 mm
B = 82 mm
C = Distance between driver (mid + 20 mm) and passenger (rearmost) head CoG locations

Euro NCAP / ANCAP
Rescue, Extrication & Safety Assessment

Test & Assessment Protocol Version 1.1.1

Rescue Sheet

Rescue Sheet Requirements	Penalty for not meeting the requirements
Rescue Sheet availability	-2
Rescue Sheet should be provided in PDF format as a unique document i. e. one file per model variant	-1
Rescue Sheet should be no more than four A4 sized pages	
Commercial licenses and/or exclusive publishing rights may not infringe on the rights of Euro NCAP and its members to make Rescue Sheets available at no cost to the general public	
Rescue Sheets must be supplied in at least the following languages: English, German, French and Spanish. From 2023: Rescue Sheets must be supplied in at least one of the official languages of each EU country + UK	
Rescue sheet must meet ISO 17840 Part 1 format and should include a summary following ISO 17840 Part 3	
Rescue sheet content must be correct (checked in post-crash inspection)	

Extrication

Extrication Requirements	Penalty for not meeting the requirements
Automatic Door Locking (ADL): All side doors must be unlocked after frontal crash tests and non-struck side doors must be unlocked after side crash tests	-1
Post crash side door opening force < 750 N	
Post crash hinged side door opening angle ≥ 45°	
Post crash sliding side door opening ≥ 500 mm	
Electric retracting door handles: After all full scale crash tests, the handles of all side doors must be in the extended/ready to open position or remain in retracted position but allow to be grabbed nevertheless by the first responder without any tool	
Seat belt buckle unlatching force ≤ 60 N on seats occupied during frontal crashes	
Seat belt buckle unlatching force on seats occupied during side crashes is monitored in 2020 - 2022 and will be limited from 2023	
Max. total penalties from Rescue Sheet & Extrication	-2

Post Crash Technology

Prerequisite for scoring: no penalties for Rescue Sheet requirements

Post Crash Technology Requirements	Score for meeting the requirements
Advanced eCall system providing the likely number of occupants	0.5
Advanced eCall system providing the recent vehicle locations N1 and N2	0.5
Multi Collision Brake (MCB) verified by ■ destruction-free demonstration of braking caused by the MCB trigger signal ■ documentation showing that the MCB trigger signal is sent during a crash test	1
Max. total score	2

Euro NCAP / ANCAP Rating: 2020 - 2024

Overall Rating Protocol 9.0.1

Adult Occupant Protection	2020 - 2022	2023 - 2024
	max. points	
MPDB Frontal Impact	8	8
Full-width Frontal Impact	8	8
Side impact (MDB)	**6**	6
Side Impact (Pole)	**6**	6
Side Impact (Far Side Occupants MDB & Pole)	**4**	4
Whiplash Front Seats	**3**	3
Whiplash Rear Seats	**1**	1
Rescue	**2**	**4**
max. points (1)	38	**40**
normalised score (2)	actual points / (1)	
weighting (3)	40 %	
weighted score (4)	(2) x (3)	

Child Occupant Protection	2020 - 2022	2023 - 2024
	max. points	
Dyn. Tests Frontal	16	16
Dyn. Tests Side	8	8
CRS Installation	12	12
Vehicle Based Assessment	13	13
max. points (1)	49	49
normalised score (2)	actual points / (1)	
weighting (3)	20 %	
weighted score (4)	(2) x (3)	

VRU Protection	2020 - 2022	2023 - 2024
	max. points	
Head Impact	24	**18**
Leg Impact	6	**18**
Upper Leg Impact	6	
AEB VRU-Pe	**9**	9
AEB VRU-Cy	**9**	9
AEB Junction Assist PTW		**6**
LSS PTW		**3**
max. points (1)	**54**	**63**
normalised score (2)	actual points / (1)	
weighting (3)	20 %	
weighted score (4)	(2) x (3)	

Safety Assist	2020 - 2022	2023 - 2024
	max. points	
Occupant Status Monitoring	**3**	3
Speed Assistance Systems	3	3
Lane Support Systems	4	**3**
AEB Car-to-Car	**6**	**9**
max. points (1)	**16**	**18**
normalised score (2)	actual points / (1)	
weighting (3)	20 %	
weighted score (4)	(2) x (3)	

Balancing: minimum normalised score (2) by box for the respective star rating[1]:

	Adult 2020 - 2022	Adult 2023 - 2024		Child 2020 - 2022	Child 2023 - 2024		VRU 2020 - 2022	VRU 2023 - 2024		Safety Assist 2020 - 2022	Safety Assist 2023 - 2024
★★★★★	80 %	80 %	+	80 %	80 %	+	60 %	**70 %**	+	70 %	70 %
★★★★	70 %	70 %	+	70 %	70 %	+	50 %	**60 %**	+	60 %	60 %
★★★	60 %	60 %	+	60 %	60 %	+	40 %	**50 %**	+	50 %	50 %
★★	50 %	50 %	+	50 %	50 %	+	30 %	**40 %**	+	40 %	40 %
★	40 %	40 %	+	40 %	40 %	+	20 %	**30 %**	+	30 %	30 %

Overall score (5) = ∑(4)

The overall score is used only for ranking the results within vehicle categories.

Bold figures indicate changes with respect to the previous year

[1] A vehicle that meets all of the balance criteria for a 5-star overall rating cannot have any critical red body region (after modifiers are applied). In case of a red critical body region, the vehicle is limited to a maximum of 4-stars.

Dual Rating

VSSTR Protocol Version 7.4.1

Euro NCAP Logo Guidelines

Euro NCAP issues a base rating for standard equipment only. Fitment rates for safety assist technologies are no longer considered. Optionally manufacturers of cars that have achieved at least 3 stars can apply for a secondary rating of a model equipped with an optional safety package that meets a certain market installation rate (an average of 25 % in the first 3 years and of 55 % in the subsequent 3 years). The safety package must be actively promoted by the manufacturer. The safety package must be available, at least as an option, on all variants in the model range.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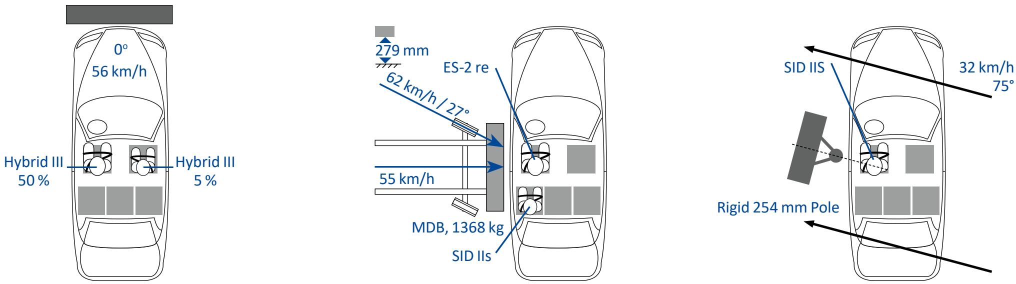
U.S. NCAP: Tests and Criteria

Docket No. NHTSA–2006–26555

Laboratory Test Procedure Oct 2015



Injury Criteria

Injury Risk Curves

SafetyWissen by carhs

Frontal-Impact against Rigid Wall with 100 % Overlap @ 56 km/h

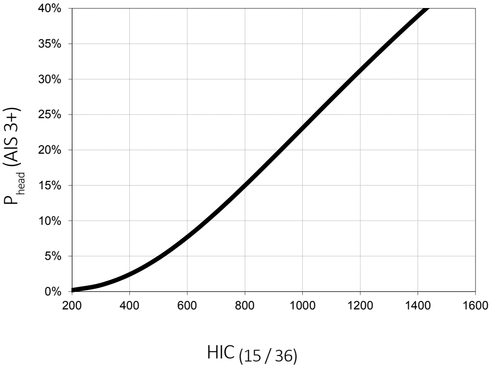
Dummy	Hybrid III 50 % (Driver)	Hybrid III 5 % (Passenger)
Head (HIC_{15})	$P_{head}(AIS\,3+) = \Phi\left(\frac{\ln(HIC15) - 7.45231}{0.73998}\right)$ *where* Φ = cumulative normal distribution	$P_{head}(AIS\,3+) = \Phi\left(\frac{\ln(HIC15) - 7.45231}{0.73998}\right)$ *where* Φ = cumulative normal distribution
Chest (Deflection in mm)	$P_{chest\_defl}(AIS\,3+) = \frac{1}{1+e^{10.5456-1.568*(ChestDefl)^{0.4612}}}$	$P_{chest\_defl}(AIS\,3+) = \frac{1}{1+e^{10.5456-1.7212*(ChestDefl)^{0.4612}}}$
Femur (Force in kN)	$P(AIS\ 2+) = \frac{1}{1+e^{5.795-0.5196\,Femur\_Force}}$	$P(AIS\ 2+) = \frac{1}{1+e^{5.7949-0.7619\,Femur\_Force}}$
Neck (N_{ij} and Tension/ Compression in kN)	$P_{neck\_Nij}(AIS\,3+) = \frac{1}{1+e^{3.2269-1.9688\,Nij}}$ $P_{neck\_Tens}(AIS3+) = \frac{1}{1+e^{10.9745-2.375\,Neck\_Tension}}$ $P_{neck\_Comp}(AIS3+) = \frac{1}{1+e^{10.9745-2.375\,Neck\_Compression}}$ $P_{neck} = \max imum(P_{neck\_Nij}, P_{neck\_Tens}, P_{neck\_Comp})$	$P_{neck\_Nij}(AIS\,3+) = \frac{1}{1+e^{3.2269-1.9688\,Nij}}$ $P_{neck\_Tens}(AIS3+) = \frac{1}{1+e^{10.958-3.770\,Neck\_Tension}}$ $P_{neck\_Comp}(AIS3+) = \frac{1}{1+e^{10.958-3.770\,Neck\_Compression}}$ $P_{neck} = \max imum(P_{neck\_Nij}, P_{neck\_Tens}, P_{neck\_Comp})$
Overall	$P_{joint} = 1 - (1-P_{head}) \times (1-P_{neck}) \times (1-P_{chest}) \times (1-P_{femur})$	

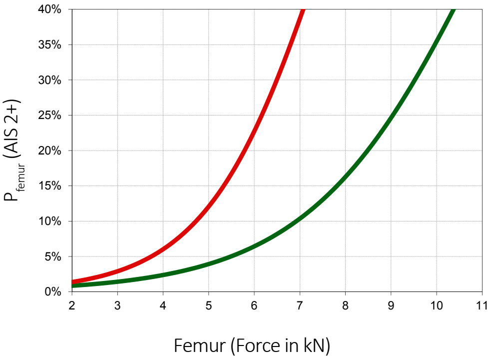
Side Impact (MDB & Pole Test)

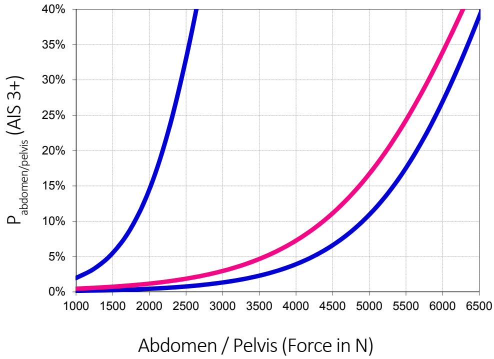
	ES-2re 50 %	SID-IIs 5 %
Head (HIC_{36})	$P_{head}(AIS3+) = \Phi\left(\frac{\ln(HIC36) - 7.45231}{0.73998}\right)$ *where* Φ = cumulative normal distribution	$P_{head}(AIS\,3+) = \Phi\left(\frac{\ln(HIC36) - 7.45231}{0.73998}\right)$ *where* Φ = cumulative normal distribution
Chest (Rib Deflection in mm)	$P_{chest}(AIS3+) = \frac{1}{1+e^{5.3895-0.0919*\max.\,rib\ deflection}}$	
Abdomen (Abdominal Force in N)	$P_{abdomen}(AIS3+) = \frac{1}{1+e^{6.04044-0.002133*F}}$ *where F = total abdominal force (N) in ES-2re*	
Pelvis (Force in N)	$P_{pelvis}(AIS3+) = \frac{1}{1+e^{7.5969-0.0011*F}}$ *where F is the pubic force in the ES-2re in Newtons*	$P_{pelvis}(AIS2+) = \frac{1}{1+e^{6.3055-0.00094*F}}$ *where F is the sum of acetabular and iliac force in the SID – IIs dummy in Newtons*
Overall	$P_{joint} = 1 - (1-P_{head}) \times (1-P_{chest}) \times (1-P_{abdomen}) \times (1-P_{pelvis})$	$P_{joint} = 1 - (1-P_{head}) \times (1-P_{pelvis})$

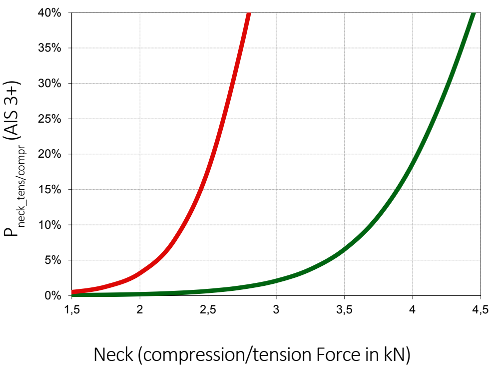
U.S. NCAP: Injury Risk Curves

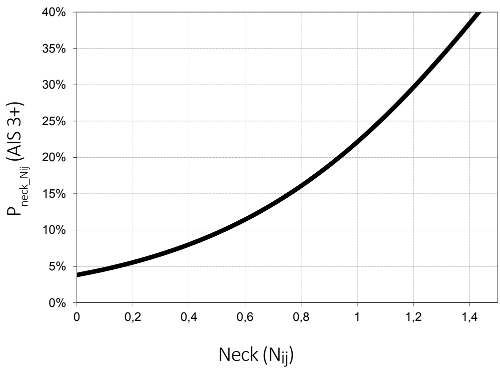
Hybrid III 50 %
Hybrid III 5 %
multiple Dummys
ES-2re 50 %
SID-IIs 5 %
SafetyWissen by carhs











U.S. NCAP: Rating Scheme

Frontal Crash Test		Side Pole Test	Side MDB Test		Rollover Test
Driver	Passenger	Front Seat	Front Seat	Rear Seat	
Injury Criteria	Injury Criteria	Injury Criteria	Injury Criteria	Injury Criteria	
Probabilty of Injury (Risk Curves) P_{joint}	Probabilty of Injury (Risk Curves) P_{joint}	Probabilty of Injury (Risk Curves) P_{joint}	Probabilty of Injury (Risk Curves) P_{joint}	Probabilty of Injury (Risk Curves) P_{joint}	Probabilty of Rollover P_{roll}
$RR^{*}=P_{joint}/base^{**}$	$RR^{*}=P_{joint}/base^{**}$	$RR^{*}=P_{joint}/base^{**}$	$RR^{*}=P_{joint}/base^{**}$	$RR^{*}=P_{joint}/base^{**}$	$RR^{*}=P_{roll}/base^{**}$
Driver Stars (50 %)	Passenger Stars (50 %)	Stars (20 %)	Stars (80 %)	Rear Seat Stars (50 %)	Overall Rollover Star Rating (3/12)
		Front Seat Stars (50 %)			
Overall Frontal Star Rating (5/12)		Overall Side Star Rating (4/12)			
Vehicle Safety Score (VSS)					

*RR = relative risk; **base = baseline risk = 15 %

Rating procedure

Using the Injury Risk Curves on ➲ page 48 and page 49, the risk of a serious injury (AIS 3+) can be calculated from the injury criteria measured in the crash test. The joint risk for an occupant can be determined using the following formulae:

Frontal Impact: $P_{joint} = 1 - (1 - P_{head}) \times (1 - P_{neck}) \times (1 - P_{chest}) \times (1 - P_{femur})$

Side Impact: $P_{joint} = 1-(1- P_{head}) \times (1- P_{chest}) \times (1- P_{abdomen}) \times (1- P_{pelvis})$

This risk is compared to a so called baseline risk which was set to 15 %. This ratio is called relative risk (RR) from which the star rating is determined using the following table:

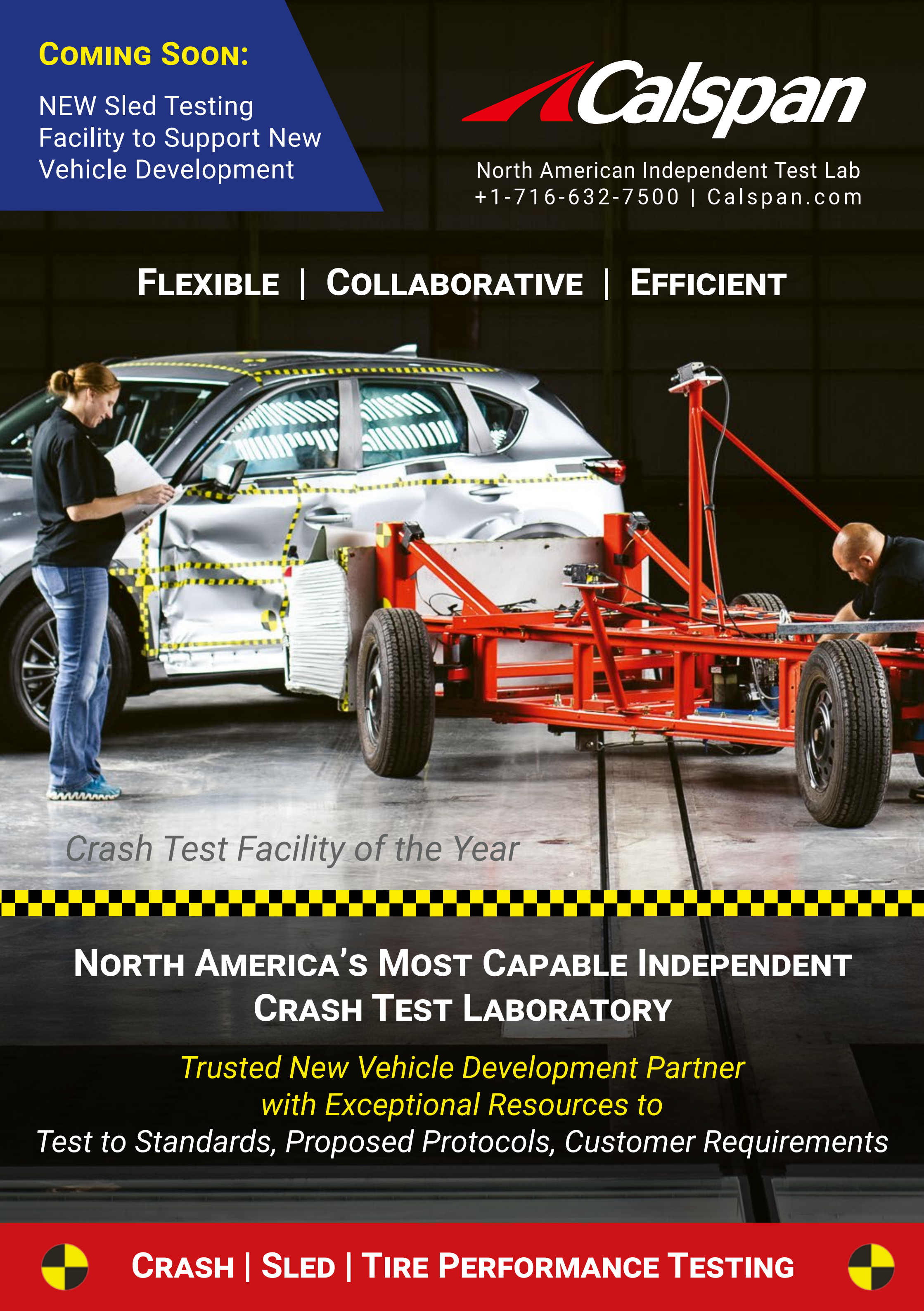
RR	0	0.67	1	1.33	2.67
Stars	★★★★★	★★★★	★★★	★★	★

The rollover star rating is determined using the following table:

RR(roll)	0	0.67	1.33	2.0	2.67
Stars	★★★★★	★★★★	★★★	★★	★

The Vehicle Safety Score (VSS) is calculated as follows: (5/12) × RR(front) + (4/12) × RR(side) + (3/12) × RR(roll). The VSS star rating is determined using the following table:

VSS	0	0.67	1	1.33	2.67
Stars	★★★★★	★★★★	★★★	★★	★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IIHS Rating

Testing Protocol Version XVIII (Jul 2017)

Rating Guidelines September 2014

Dummy	Region	Criteria	Good	Acceptable	Marginal	Poor
Frontal Impact against ODB with 40 % Overlap @ 64 km/h						
H III 50 %	Head & Neck	HIC_{15}	≤ 560	≤ 700	≤ 840	> 840
		N_{ij}	≤ 0.80	≤ 1.00	≤ 1.20	> 1.20
		$F_{z,tension}$ (kN)	≤ 2.6	≤ 3.3	≤ 4.0	> 4.0
		$F_{z,compression}$ (kN)	≤ 3.2	≤ 4.0	≤ 4.8	> 4.8
		$a_{res\ peak}$ (g)	Values > 70 result in downgrading			
	Chest	a_{3ms} (g)	≤ 60	≤ 75	≤ 90	> 90
		Deflection (mm)	≤ 50	≤ 60	≤ 75	> 75
		Deflection rate (m/s)	≤ 6.6	≤ 8.2	≤ 9.8	> 9.8
		VC (m/s)	≤ 0.8	≤ 1.0	≤ 1.2	> 1.2
	Legs & Feet	Femur Axial Force (kN) (Force duration corridors)	≤ 7.3 @ 0 ms ≤ 6.1 @ 10 ms	≤ 9.1 @ 0 ms ≤ 7.6 @ 10 ms	≤ 10.9 @ 0 ms ≤ 9.1 @ 10 ms	> 10.9 @ 0 ms > 9.1 @ 10 ms
		Knee Displacement (mm)	≤ 12	≤ 15	≤ 18	> 18
		TI (upper, lower)	≤ 0.80	≤ 1.00	≤ 1.20	> 1.20
		Tibia Axial Force (kN)	≤ 4.0	≤ 6.0	≤ 8.0	> 8.0
		Foot acceleration (g)	≤ 150	≤ 200	≤ 260	> 260

Testing Protocol Version V (Dec 2019)

Dummy	Region	Criteria	Good	Acceptable	Marginal	Poor
Seat/Head Restraints: Static Assessment (➲ page 107)						
HRMD	Head & Neck	Backset (mm)	≤ 70	≤ 90	≤ 110	> 110
		Distance from top of head (mm)	≤ 60	≤ 80	≤ 100	> 100
Seat/Head Restraints: Dynamic Assessment						
BioRID IIg	Head & Neck	Vector sum of the standardized shear (FX) and tension (FZ) values $\{F_x / 315\}^2 + \{(F_z - 234) / 1131\}^2$	$< \{0.450\}^2$	$\leq \{0.825\}^2$	$> \{0.825\}^2$	
		Time to head restraint contact (ms)	for values > 70 ms the rating is reduced by one level*			
		T1 acceleration (g)	for values > 9.5 the rating is reduced by one level*			
			* only if both exceed the given level			

The overall rating equals the static or dynamic rating, whichever is worse.
Exceptions: If the static rating is „Acceptable“ but the backset is sufficient for a „Good“ rating and the dynamic rating is „Good“ then the overall rating is also „Good“. If the static rating is „Marginal“ or „Poor“ no dynamic test is made and the overall rating is „Poor“.

IIHS Rating

Rating Guidelines Nov 2016 | Testing Protocol Version X (Jul 2017)

Dummy	Region	Criteria	Good	Acceptable	Marginal	Poor
Barrier Side Impact (IIHS MDB) @ 50 km/h						
SID-IIs 5 %	Head/ Neck	HIC_{15}	≤ 623	≤ 779	≤ 935	> 935
		$F_{z,tension}$ (kN)	≤ 2.1	≤ 2.5	≤ 2.9	> 2.9
		$F_{z,compression}$ (kN)	≤ 2.5	≤ 3.0	≤ 3.5	> 3.5
	Chest/ Torso	Shoulder deflection (mm)	Values > 60 result in downgrading			
		Ø Rib deflection (mm)	≤ 34	≤ 42	≤ 50	> 50
		Worst Rib deflection (mm)			51 - 55	> 55
		Deflection rate (m/s)	≤ 8.20	≤ 9.84	≤ 11.48	> 11.48
		VC (m/s)	≤ 1.00	≤ 1.20	≤ 1.40	> 1.40
	Pelvis/ Left Femur	Acetabulum force (kN)	≤ 4.0	≤ 4.8	≤ 5.6	> 5.6
		Ilium force (kN)	≤ 4.0	≤ 4.8	≤ 5.6	> 5.6
		Combined acetabulum and ilium force (kN)	≤ 5.1	≤ 6.1	≤ 7.1	> 7.1
		Femur A-P force (3 ms clip, kN)	≤ 2.8	≤ 3.4	≤ 3.9	> 3.9
		Femur L-M force (3 ms clip, kN)	≤ 2.8	≤ 3.4	≤ 3.9	> 3.9
		Femur A-P bending moment (3 ms clip, Nm)	≤ 254	≤ 305	≤ 356	> 356
		Femur L-M bending moment (3 ms clip, Nm)	≤ 254	≤ 305	≤ 356	> 356
Structure		Intrusion: B-pillar to driver seat centerline distance (mm)	≥ 125	≥ 50	≥ 0	< 0

Testing Protocol Version III (July 2016)

	Criteria	Good	Acceptable	Marginal	Poor
Roof Crush (➲ page 76)					
Stiffness to weight ratio (SWR)	F_{max} / m x g	≥ 4.00	≥ 3.25	≥ 2.50	< 2.5

IIHS TOP SAFETY PICK | IIHS TOP SAFETY PICK+

Year	TSP Criteria	TSP+ Criteria
2020 2021	■ Crash tests: „Good“ ■ Front Crash Prevention & AEB Pedestrian: at least „Advanced“ ■ Headlights: at least „Acceptable“[1]	■ Crash tests: „Good“ ■ Front Crash Prevention & AEB Pedestrian: at least „Advanced“ ■ Headlights: at least „Acceptable“[2]

[1] at least "Acceptable" headlights need to be available as optional equipment

[2] at least "Acceptable" headlights need to be standard equipment

IIHS Rating: Small Overlap

Testing Protocol Version VI (Jul 2017)

Rating Protocol Version V (Jul 2017)

Dummy	Region	Criteria	Good	Acceptable	Marginal	Poor
Frontal Impact against Small Overlap Barrier with 25 % Overlap @ 64 km/h						
Structure Rating: Intrusions (mm) ❶	Lower Occupant Compartment	lower hinge pillar (resultant)	≤ 150	≤ 225	≤ 300	> 300
		footrest (resultant)				
		left toepan (resultant)				
		brake pedal (resultant)				
		parking brake pedal (resultant)				
		rocker panel (lateral)	≤ 50	≤ 100	≤ 150	> 150
	Upper Occupant Compartment	steering column (longitutinal)	≤ 50	≤ 100	≤ 150	> 150
		upper hinge pillar (resultant)	≤ 75	≤ 125	≤ 175	> 175
		upper dash (resultant)				
		left instrument panel (resultant)				
H III 50 %	Head & Neck ❷	HIC_{15}	≤ 560	≤ 700	≤ 840	> 840
		N_{ij}	≤ 0.80	≤ 1.00	≤ 1.20	> 1.20
		$F_{z,tension}$ (kN)	≤ 2.6	≤ 3.3	≤ 4.0	> 4.0
		$F_{z,compression}$ (kN)	≤ 3.2	≤ 4.0	≤ 4.8	> 4.8
	Chest/ Torso ❸	a_{3ms} (g)	≤ 60	≤ 75	≤ 90	> 90
		Deflection (mm)	≤ 50	≤ 60	≤ 75	> 75
		Deflection rate (m/s)	≤ 6.6	≤ 8.2	≤ 9.8	> 9.8
		VC (m/s)	≤ 0.8	≤ 1.0	≤ 1.2	> 1.2
	Femur ❹	KTH Injury Risk (%)	≤ 5	≤ 15	≤ 25	> 25
	Leg & Foot ❺	Knee Displacement (mm)	≤ 12	≤ 15	≤ 18	> 18
		TI (upper, lower)	≤ 0.80	≤ 1.00	≤ 1.20	> 1.20
		Tibia Axial Force (kN)	≤ 4.0	≤ 6.0	≤ 8.0	> 8.0
		Foot Acceleration (g)	≤ 150	≤ 200	≤ 260	> 260


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IIHS Rating: Small Overlap

Frontal Impact against Small Overlap Barrier with 25 % Overlap @ 64 km/h

Restraints & Dummy Kinematics Rating	SafetyWissen by carhs
Rating system based on a demerit system	**Demerits**
Frontal Head Protection	
Partial frontal airbag interaction	**1**
Minimal frontal airbag interaction	**2**
Excessive lateral steering wheel movement (> 100 mm)	**1**
Two or more head contacts with structure	**1**
Late deployment or non deployment of frontal airbag	**automatic Poor**
Lateral Head Protection	
Side head protection airbag deployment with limited forward coverage	**1**
No side head protection airbag deployment	**2**
Excessive head lateral movement	**1**
Front Chest Protection	
Excessive vertical steering wheel movement (> 100 mm)	**1**
Excessive lateral steering wheel movement (> 150 mm)	**1**
Occupant containment and miscellaneous	
Excessive occupant forward excursion (> 250 mm)	**1**
Occupant burn risk	**1**
Seat instability	**1**
Seat attachment failure	**automatic Poor**
Vehicle door opening	**automatic Poor**

Restraints & Kinematics ❻	**Good**	**Acceptable**	**Marginal**	**Poor**
Sum of Demerits	≤ 1	≤ 3	≤ 5	> 5

Small Overlap Overall Rating

Rating system based on a demerit system. Demerits result from the injury, structure and restraints & kinematics ratings.

Component Rating	**Good**	**Acceptable**	**Marginal**	**Poor**
Vehicle Structure Rating ❶	0	2	6	10
Head/Neck Injury Rating ❷	0	2	10	20
Chest Injury Rating ❸	0	2	10	20
Thigh and Hip Injury Rating ❹	0	2	6	10
Leg and Foot Injury Rating ❺	0	1	2	4
Restraints / Kinematics Rating ❻	0	2	6	10
The overall rating depends on the sum of demerits:				SafetyWissen by carhs
Overall Rating	**Good**	**Acceptable**	**Marginal**	**Poor**
Sum of demerits	≤ 3	≤ 9	≤ 19	> 19

Latin NCAP Rating: 2020 - 2024

	Adult Occupant Protection		Child Occupant Protection		Pedestrian Protection		Safety Assist		
		2020 - 2024		2020 - 2024		2020 - 2024		2020 - 2022	2023 2024
		max. points		max. points		max. points		max. points	max. points
	Offset Frontal Impact	16	Dyn. Tests Frontal	16	Head Impact	24	Seat Belt Reminder	10	10
	Side Impact (MDB)	8	Dyn. Tests Side	8	Lower Leg Impact	6	Speed Assistance Systems	3	3
	Side Impact (Pole)	8	CRS Installation	12	Upper Leg Impact	6	AEB Inter-Urban[2]	9	9
	Whiplash Front Seats	3	Vehicle Based	13	AEB VRU[2]	**12**	ESC	15	15
	AEB City[2]	3					Lane Support Syst. (LDW, LKA, RED)[2]	3	3
	Rear End Impact UN R32	1					Blind Spot Detection[2]	3	3
	Rescue Sheet	1					eCall		**(2)[3]**
	max. points (1)	40	max. points (1)	49	max. points (1)	48	max. points (1)	43	**43**
	normalised score (2)	actual points / (1)	normalised score (2)	actual points / (1)	normalised score (2)	actual points[1] / (1)	normalised score (2)	actual points / (1)	actual points / (1)
	Balancing: minimum normalised score (2) by box for the respective star rating:								
2020 - 2022	★★★★★	75 %	+	80 %	+	40 %	+	75 %	
	★★★★	70 %		65 %		35 %		65 %	
	★★★	60 %		50 %		30 %		50 %	
	★★	50 %		30 %		20 %		40 %	
	★	40 %		15 %		10 %		10 %	
2023 - 2024	★★★★★	**80 %**	+	80 %	+	**50 %**	+		**80 %**
	★★★★	70 %		**70 %**		**40 %**			**70 %**
	★★★	60 %		**55 %**		30 %			**60 %**
	★★	50 %		**40 %**		**25 %**			**50 %**
	★	40 %		**20 %**		10 %			**50 %**

[1] In 2020 and 2021 the total Pedestrian Protection score is calculated as follows: (Head score + Upper Leg score + Lower Leg score) x 1.15 + AEB score x 0.55

[2] System will be assessed if it is offered in all Latin NCAP markets as option and meets the following fitment rates:

System	2020	2021	2022	2023	2024
AEB City	10 %	10 %	10 %	**30 %**	30 %
AEB VRU	10 %	10 %	10 %	**30 %**	30 %
AEB Inter-Urban	10 %	10 %	10 %	**30 %**	30 %
BSD + LDW + LKA + RED combined	25 %	25 %	**35%**	**45 %**	**55 %**

Protocol Version 1.1.2

[3] Bonus points do not increase the max. total points

Bold figures indicate changes with respect to the previous year

Latin NCAP Protection Criteria in Frontal Impact

Dummy	Region	Criteria	4 Points	0 Points	Capping	Modifiers
Frontal Impact against ODB with 40 % Overlap @ 64 km/h						
Hybrid III 50 %	Head[1,2] Neck	HIC_{15}	< 500	> 700	> 700	Unstable airbag/steering wheel contact (-1 pt) Hazardous airbag deployment (-1 pt) Incorrect airbag deployment (-1 pt) Steering column displacement (-1 pt) Passenger head contact w/ dashboard (-1 pt)
		a_{3ms} (g)	< 72	> 80	> 80	
		$M_{y,extension}$ (Nm)	< 42	> 57	> 57	
		$F_{z,tension}$ (kN)	< 2.7 @ 0 ms	> 3.3 @ 0 ms	> 3.3 @ 0 ms	
			< 2.3 @ 35 ms	> 2.9 @ 35 ms	> 2.9 @ 35 ms	
			< 1.1 @ 60 ms	> 1.1 @ 60 ms	> 1.1 @ 60 ms	
		$F_{x,shear}$ (kN)	< 1.9 @ 0 ms	> 3.1 @ 0 ms	> 3.1 @ 0 ms	
			< 1.2 @ 25-35 ms	> 1.5 @ 25-35 ms	> 1.5 @ 25-35 ms	
			< 1.1 @ 45 ms	> 1.1 @ 45 ms	> 1.1 @ 45 ms	
	Chest	Deflection (mm)	< 22	> 42	> 42	A-pillar displacement (-2 pt) Compartment integrity (-1 pt) Steering wheel contact (-1 pt) Incorrect airbag deployment (-1 pt) Shoulder belt load > 6 kN (-2 pt)
		VC (m/s)	< 0.5	> 1.0	> 1.0	
	Femur Knee	Axial Force (kN)	< 3.8	> 9.07 > 7.56 @ 10 ms	- -	Variable contact (-1 pt) Concentrated loading (-1 pt) Incorrect airbag deployment (-1 pt)
		Displacement (mm)	< 6	>15	-	
	Tibia Foot	Tibia Index	< 0.4	> 1.3	-	Z–displacement of worst pedal (-1 pt) Footwell rupture (-1 pt) Pedal blocking (-1 pt)
		Axial Force (kN)	< 2	> 8	-	
		x–Displacement pedal (mm)	< 100	> 200	-	
						door opening (-1 pt/door) fuel leakage (-1 pt)

1 If there is no hard head contact (i.e. $a_{res,\,peak}$ < 80 g and no other evidence of hard contact) a score of 4 points is awarded.

2 If no steering wheel airbag is fitted and HIC15 < 700 and a_{3ms} < 80 g, 2 headform tests according to UN R12 are carried out (hub/spoke junction and rim spoke junction). Assessment is based on the following criteria:

Dummy	Region	Criteria	2 Points	0 Points	Capping
UN R12 6.8 kg headform	Head	HIC_{15}			> 700
		a_{3ms} (g)	< 65	> 80	> 80
		$a_{res,\,peak}$ (g)	< 80	> 120	> 120

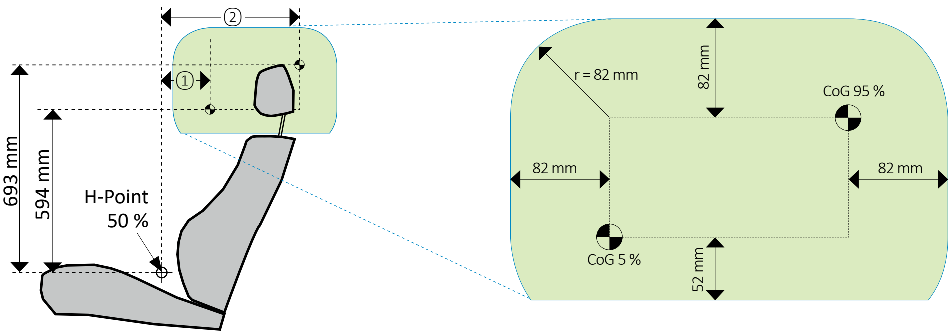
Latin NCAP Protection Criteria in Side Impact

Dummy	Region	Criteria	4 Points	0 Points	Capping	Modifiers
Barrier Side Impact @ 50 km/h & Pole Side Impact @ 29 km/h						
ES-2	Head[1]	HIC_{15}	< 500	> 700	> 700	incorrect airbag deployment (-1 pt) backplate loading F_y 1.0 ... 4.0 kN (0 ... -2 pt) T12 F_y 1.5 ... 2 kN / M_x 150 ... 200 Nm (0 ... -2pt) head protection device assessment (-2 pt front, -2 pt rear²)
		a_{3ms} (g)	< 72	> 88	> 88	
	Chest	Deflection (mm)	< 22	> 42	> 42	
		VC (m/s)	< 0.32	> 1.0	> 1.0	
	Abdomen	$Force_{compression}$ (kn)	< 1.0	> 2.5	> 2.5	
	Pelvis	Pubic Symphysis Peak Force (kN)	< 3.0	> 6.0	> 6.0	
						door opening (-1 pt/door) fuel leakage (-1 pt)

[1] Pole: no sliding scale, only capping if HIC15 > 700 or ares, peak > 80 g or direct head contact with the pole.
[2] From 2022:- 4 pt rear

Modifier Side Head Protection Device

Inside the ‚Head Protection Device Assessment Zone' (green) the head protection system's coverage is assessed for both front and rear seats. If the coverage is insufficient a -2 point modifier is applied to the overall AOP score. Areas outside the Daylight Opening (FMVSS 201) are excluded from assessment. Seams are not penalized if the un-inflated area is no wider than 15 mm. Any other un-inflated areas that are no larger than 50 mm in diameter (or equivalent area) are not penalized.



The head protection device (HPD) evaluation zone (green) is defined as a rounded rectangle around the head CoG box (defined by the head CoGs of the 5 % female and 95 % male occupants) at a distance of 82 mm from the upper and fore/aft edges and 52 mm below the bottom edge. The x-position of the CoG is defined relative to the H-Point of the 50 % male:

Front seats:

① = H-Point(x) + 126 mm - seat travel (5th %ile- 50th %ile)

② = H-Point(x) + 147 mm + seat travel (50th %ile- 95th %ile)

Rear seats:

① = H-Point(x) + 126 mm - remaining seat travel

② = H-Point(x) + 147 mm + remaining seat travel

ASEAN NCAP

Overall Assessment Protocol Version 2.0

Overall Rating 2021 - 2025

	Adult Occupant Protection		Child Occupant Protection		Safety Assist		Motorcyclist Safety		
	Offset Frontal Impact 16 Side Impact (MDB) 8 HPT 8		Frontal Impact 16 Side Impact 8 CRS Installation 12 Vehicle-based Assmt. 13 CPD 2		Seat Belt Reminder 6 ABS / ESC 6 AEB 6 Advanced SATs 3		Blind Spot (BST) 8 Rear View (ARV) 4 Auto High Beam (AHB) 2 Pedestrian Protection 2 Advanced MST (2)[1]		
max. points (1)	32		51		21		16		
normalized score (2)	actual points / (1)		actual points / (1)		actual points / (1)		actual points / (1)		Overall score (5)
weighting (3)	40 %		20 %		20 %		20 %		
weighted score (4)	(2) x (3)		(2) x (3)		(2) x (3)		(2) x (3)		∑(4)
Rating	Balancing: minimum normalized score (2) per box required for the respective star rating:								
	score	points	score	points	score	points	score	points	
★★★★★	80 %	25.60	75 %	38.25	70 %	14.70	50 %	8.00	
★★★★	70 %	22.40	60 %	30.60	50 %	10.50	40 %	6.40	
★★★	60 %	19.20	30 %	15.30	40 %	8.40	30 %	4.80	
★★	50 %	16.00	25 %	12.75	30 %	6.30	20 %	3.20	
★	40 %	12.80	15 %	7.65	20 %	4.20	10 %	1.60	

[1] Bonus points do not increase the max. total points

Adult Occupant Protection

AOP Assessment Protocol Version 2.0

Frontal Impact against ODB with 40 % Overlap @ 64 km/h

Dummy	Region	Points	Criteria	
H III 50 % front	Head, Neck	4	$HIC_{15} < 500$; $a_{3ms} < 72$ g $M_{y,extension} < 42$ Nm $F_{z,tension} < 2.7$ kN @ 0 ms / < 2.3 kN @ 35 ms / < 1.1 kN @ 60 ms $F_{x,shear} < 1.9$ kN @ 0 ms / < 1.2 kN @ 25 – 35 ms / < 1.1 kN @ 45 ms	max. 16 points
		0	$HIC_{15} > 700$; $a_{3ms} > 80$ g $M_{y,extension} > 57$ Nm $F_{z,tension} > 3.3$ kN @ 0 ms / > 2.9 kN @ 35 ms / > 1.1 kN @ 60 ms $F_{x,shear} > 3.1$ kN @ 0 ms / > 1.5 kN @ 25 – 35 ms / > 1.1 kN @ 45 ms	
	Chest	4	Deflection < 22 mm; VC < 0.5 m/s	
		0	Deflection > 42 mm; VC > 1.0 m/s	
	Femur, Knee	4	Axial $Force_{compression} < 3.8$ kN Knee Displacement < 6 mm	
		0	Axial $Force_{compression} > 9.07$ kN @ 0 ms / > 7.56 @ 10 ms Knee Displacement > 15 mm	
	Tibia Foot	4	TI < 0.4; Axial $Force_{compression} < 2$ kN Pedal rearward displacement < 100 mm	
		0	TI > 1.3; Axial $Force_{compression} > 8$ kN Pedal rearward displacement > 200 mm	

Barrier Side Impact (MDB) @ 50 km/h

Dummy	Region	Points	Criteria	
ES-2	Head	4	$HIC_{36} < 650$; $a_{3ms} < 72$ g	max. 16 points[2]
		0	$HIC_{36} > 1000$; $a_{3ms} > 88$ g	
	Chest	4	Deflection < 22 mm; VC < 0.32 m/s	
		0	Deflection > 42 mm; VC > 1.0 m/s	
	Abdomen	4	$Force_{compression} < 1.0$ kN	
		0	$Force_{compression} > 2.5$ kN	
	Pelvis	4	PSPF < 3.0 kN	
		0	PSPF > 6.0 kN	

[2] scaled down to 8 points in the overall rating

Dummy	Region	Points	Criteria	

Frontal Impact with 100 % Overlap @ 50 km/h ❶

Dummy	Region	Points	Criteria	
H III 50 % front	Head	5	$HIC_{36} < 650$; $a_{3ms} < 72$ g	max. 20 points
		0	$HIC_{36} > 1000$; $a_{3ms} > 88$ g	
	Neck	2	$M_{y,extension} < 42$ Nm $F_{z,tension} < 2.7$ kN @ 0 ms / < 2.3 kN @ 35 ms / < 1.1 kN @ 60 ms $F_{x,shear} < 1.9$ kN @ 0 ms / < 1.2 kN @ 25 – 35 ms / < 1.1 kN @ 45 ms	
		0	$M_{y,extension} > 57$ Nm $F_{z,tension} > 3.3$ kN @ 0 ms / > 2.9 kN @ 35 ms / > 1.1 kN @ 60 ms $F_{x,shear} > 3.1$ kN @ 0 ms / > 1.5 kN @ 25 – 35 ms / > 1.1 kN @ 45 ms	
	Chest	5	Deflection < 22 mm; VC < 0.5 m/s	
		0	Deflection > 50 mm; VC > 1.0 m/s	
	Femur Knee	2	Axial $Force_{compression} < 3.8$ kN; Knee Displacement < 6 mm	
		0	Axial $Force_{compression} > 9.07$ kN @ 0 ms / > 7.56 @ 10 ms; Knee Displacement > 15 mm	
	Tibia	2	TI < 0.4; Axial $Force_{compression} < 2$ kN	
		0	TI > 1.3; Axial $Force_{compression} > 8$ kN	
H III 5 % rear	Head	1.6	$HIC_{15} < 500$	
		0	$HIC_{15} > 700$	
	Neck	0.4	$F_{x,shear} < 1200$ N; $F_{z,tension} < 1700$ N; $M_{y,extension} < 36$ Nm	
		0	$F_{x,shear} > 1950$ N; $F_{z,tension} > 2620$ N; $M_{y,extension} > 49$ Nm	
	Chest	2	Deflection < 23 mm	
		0	Deflection > 48 mm	

Frontal Impact against ODB with 40 % Overlap @ 64 km/h ❷

Dummy	Region	Points	Criteria	
H III 50 % front	Head, Neck	4	$HIC_{36} < 650$; $a_{3ms} < 72$ g $M_{y,extension} < 42$ Nm $F_{z,tension} < 2.7$ kN @ 0 ms / < 2.3 kN @ 35 ms / < 1.1 kN @ 60 ms $F_{x,shear} < 1.9$ kN @ 0 ms / < 1.2 kN @ 25 – 35 ms / < 1.1 kN @ 45 ms	max. 20 points
		0	$HIC_{36} > 1000$; $a_{3ms} > 88$ g $M_{y,extension} > 57$ Nm $F_{z,tension} > 3.3$ kN @ 0 ms / > 2.9 kN @ 35 ms / > 1.1 kN @ 60 ms $F_{x,shear} > 3.1$ kN @ 0 ms / > 1.5 kN @ 25 – 35 ms / > 1.1 kN @ 45 ms	
	Chest	4	Deflection < 22 mm; VC < 0.5 m/s	
		0	Deflection > 50 mm; VC < 1.0 m/s	
	Femur Knee	4	Axial $Force_{compression} < 3.8$ kN; Knee Displacement < 6 mm	
		0	Axial $Force_{compression} > 9.07$ kN @ 0 ms / > 7.56 @ 10 ms; Knee Displacement > 15 mm	
	Tibia	4	TI < 0.4; Axial $Force_{compression} < 2$ kN	
		0	TI > 1.3; Axial $Force_{compression} > 8$ kN	
H III 5 % rear	Head, Neck	2	$HIC_{15} < 500$; $F_{x,shear} < 1200$ N; $F_{z,tension} < 1700$ N; $M_{y,extension} < 36$ Nm	
		0	$HIC_{15} > 700$; $F_{x,shear} > 1950$ N; $F_{z,tension} > 2620$ N; $M_{y,extension} > 49$ Nm	
	Chest	2	Deflection < 23 mm	
		0	Deflection > 48 mm	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C-NCAP

Dummy	Region	Points	Criteria	
Barrier Side Impact (AE-MDB) @ 50 km/h ③				
WS 50 front	Head	4	$HIC_{15} < 500$; $a_{3ms} < 72$ g	max. 20 points
		0	$HIC_{15} > 700$; $a_{3ms} > 80$g	
	Chest	4	Deflection < 28 mm	
		0	Deflection > 50 mm; VC > 1.0 m/s; Shoulder Lateral Force > 3.0 kN	
	Abdomen	4	Deflection < 47 mm	
		0	Deflection > 65 mm; VC > 1.0 m/s	
	Pelvis	4	PSPF < 1.7 kN	
		0	PSPF > 2.8 kN	
SID-IIs rear	Head	1	$HIC_{15} < 500$	
		0	$HIC_{15} > 700$	
	Chest	1	Deflection < 31 mm	
		0	Deflection > 41 mm; VC > 1.0 m/s	
	Abdomen	1	Deflection < 38 mm	
		0	Deflection > 48 mm; VC > 1.0 m/s	
	Pelvis	1	Force < 3500 N	
		0	Force > 5500 N	
Whiplash Test @ Δv = 20 km/h ④				
BioRID II	NIC	2	< 8 m²/s²	max. 5 points
		0	> 30 m²/s²	
	Upper Neck	1.5	$F_{x+} < 340$ N; $F_{z+} < 475$ N; $M_y < 12$ Nm	
		0	$F_{x+} > 730$ N; $F_{z+} > 1130$ N; $M_y > 40$ Nm	
	Lower Neck	1.5	$F_{x+} < 340$ N; $F_{z+} < 257$ N; $M_y < 12$ Nm	
		0	$F_{x+} > 730$ N; $F_{z+} > 1480$ N; $M_y > 40$ Nm	
	Max. dyn. seatback defl.	-2	> 25.5°	
	Dyn. seat displacement	-5	> 20 mm	
	HRMD interference	-2	Y/N	
Additional Points ⑤				
SBR passenger		1	Visual / audio signal with occupant detection	max. 5 pt.
		0.5	Visual / audio signal without occupant detection	
SBR 2nd row		1	Status indicator for each 2nd row seat	
Side protection		3	Side / curtain-airbag	

Overall Rating

Weighting: Occupant Protection 70 %,Pedestrian Protection + Active Safety 15 % each

Stars	Total score	Balancing: Occupant Protection ❶+❷+❸+❹+❺	Balancing: Pedestrian Protection	Balancing: Active Safety
★★★★★☆	90 %	95 %	75 %	72 %
★★★★★	82 %	85 %	65 %	55 %
★★★★	72 %	75 %	50 %	26 %
★★★	60 %	65 %	40 %	
★★	45 %	55 %	20 %	
★	< 45 %	< 55 %	< 20 %	

JNCAP

Frontal Impact against Rigid Wall with 100 % Overlap @ 55 km/h & against ODB with 40 % Overlap @ 64 km/h

Dummy	Region	Weight	Points	Criteria	
H III 50 %	Head	0.923	4	HIC_{36} < 650	max. 12 points (after weighting)
			0	HIC_{36} > 1000	
			0...-1	Modifier: steering wheel upward displacement 72...88 mm	
	Neck	0.231	4	$M_{y,extension}$ < 42 Nm $F_{z,tension}$ < 2.7 kN @ 0 ms / < 2.3 kN @ 35 ms / < 1.1 kN @ 60 ms $F_{x,shear}$ < 1.9 kN @ 0 ms / < 1.2 kN @ 25 – 35 ms / < 1.1 kN @ 45 ms	
			0	$M_{y,extension}$ > 57 Nm $F_{z,tension}$ > 3.3 kN @ 0 ms / > 2.9 kN @ 35 ms / > 1.1 kN @ 60 ms $F_{x,shear}$ > 3.1 kN @ 0 ms / > 1.5 kN @ 25 – 35 ms / > 1.1 kN @ 45 ms	
	Chest	0.923	4	Deflection < 22 mm	
			0	Deflection > 42 mm; a_{3ms} > 60 g	
			0...-1	Modifier: steering wheel rearward displacement 90...110 mm	
	Femur	0.923	2	Axial $Force_{compression}$ < 7 kN	
			0	Axial $Force_{compression}$ > 10 kN	
	Tibia	0.923	2	TI < 0.4	
			0	TI > 1.3	
			0...-1	Modifier: Pedal upward displacement 72...88 mm	
			0...-1	Modifier: Pedal rearward displacement 100...200 mm	
			-1	Modifier: Tibia Axial Force > 8.0 kN	
H III 5 %	Head	0.8	4	HIC_{15} < 500	max. 12 points (after weighting)
			0	HIC_{15} > 700	
	Neck	0.2	4	$F_{x,shear}$ < 1200 N; $F_{z,tension}$ < 1700 N; $M_{y,extension}$ < 36 Nm	
			0	$F_{x,shear}$ > 1950 N; $F_{z,tension}$ > 2620 N; $M_{y,extension}$ > 49 Nm	
	Chest	0.8	4	Deflection < 23 mm (ODB) Deflection < 18 mm (Full-width, ODB from 4/2020)	
			0	Deflection > 48 mm (ODB) Deflection > 42 mm (Full-width, ODB from 4/2020) Deflection > 34 mm (Full-width from 4/2020)	
	Abdomen	0.8	4	4 points awarded by default	
			-2	Modifier: Left belt strap rising (submarining)	
			-2	Modifier: Right belt strap rising (submarining)	
	Femur	0.4	4	Axial $Force_{compression}$ < 4.8 kN	
			0	Axial $Force_{compression}$ > 6.8 kN	

SafetyWissen by carhs

Barrier Side Impact (AE-MDB) @ 55 km/h

Dummy	Region	Weight	Points	Criteria	
WS 50 front	Head	1.0	4	HIC_{15} < 500	max. 12 pt. (after weighting)
			0	HIC_{15} > 700	
	Chest	1.0	4	Deflection < 28 mm	
			0	Deflection > 50 mm Shoulder Lateral Force > 3.0 kN	
	Abdomen	0.5	4	Deflection < 47 mm	
			0	Deflection > 65 mm	
	Pelvis	0.5	4	PSPF < 1.7 kN	
			0	PSPF > 2.8 kN	

Rating Scheme Frontal & Side Impact, Whiplash:

Level	Points
5	≥ 10.5
4	≥ 9
3	≥ 7.5
2	≥ 6
1	< 6

JNCAP

Whiplash Test

Dummy	Criteria		Weight	Points	Limits	
BioRID II	NIC		1	4	< 8 m²/s²	max. 12 points (after weighting)
				0	> 30 m²/s²	
	Upper Neck F_{x+}	score is calculated based on the worst injury criterion	2	4	< 340 N	
				0	> 730 N	
	Upper Neck F_{z+}			4	< 475 N	
				0	> 1130 N	
	Upper Neck M_y Flexion			4	< 12 Nm	
				0	> 40 Nm	
	Upper Neck M_y Extension			4	< 12 Nm	
				0	> 40 Nm	
	Lower Neck F_{x+}			4	< 340 N	
				0	> 730 N	
	Lower Neck F_{z+}			4	< 257 N	
				0	> 1480 N	
	Lower Neck M_y Flexion			4	< 12 Nm	
				0	> 40 Nm	
	Lower Neck M_y Extension			4	< 12 Nm	
				0	> 40 Nm	

Where a value falls between the upper and lower limit, the score is calculated by linear interpolation (sliding scale).

Passive Safey Rating

	max. score	weight	max. weighted score	total	total
Occupant Protection					100 ★★★★★ ≥ 82[2] ★★★★ ≥ 72.5 ★★★ ≥ 63 ★★ ≥ 53.5 ★ < 53.5
Full-width Frontal				59	
Driver	12	0.875	10.5		
Passenger	12	0.875	10.5		
Offset Frontal					
Driver	12	0.875	10.5		
Passenger (rear)	12	0.875	10.5		
Side Impact					
Driver	12	0.625	7.5		
Passenger[1]	12	0.625	7.5		
Whiplash					
Driver	12	0.083	1		
Passenger	12	0.083	1		
Pedestrian Protection (➲ page 98)					
Head Impact	4	8	32	37	
Leg Impact	4	1.25	5		
Seat Belt Reminder					
Front	50	0.04	2	4	
Rear	50	0.04	2		

SafetyWissen by carhs

[1] For the passenger the same score as for the driver is assumed.
[2] Downgrade to 4 stars, unless at least level 4 is reached for occupant protection and pedestrian protection.

KNCAP

Protocol 2019

Category	Impact Safety		Pedestrian Safety		Driving Safety		
	Full Width Frontal	16	Head Impact	24	Rollover	5	
	Offset Deformable Barrier	16	Leg Impact	6	Braking	5	
	Barrier Side Impact	16			*Basic Active Devices:*		
	Child Protection	8			FCW	1	
	Whiplash	4			LDW	1	
	Pole Side Impact (optional [1])	*2*			SLD	1	
					SBR front	1	
					SBR rear	1	
					AEB Inter-Urban	2	
					AEB City	3	
					Additional Active Devices[1]	2	
max. total points (1)	60 points		30 points		20 points		
normalized score (2)	actual points / (1)		actual points / (1)		actual points / (1)		
weighting (3)	60 %		20 %		20 %		
weighted score (4)	(2) x (3)		(2) x (3)		(2) x (3)		Overall score (5) *max. 100*

Overall classification: Minimum normalized scores (2) and total score (5) per rating class

	Impact Safety	Pedestrian Safety	Driving Safety	Overall score (5)
1st Grade	≥ 90.1 %	≥ 60.1 %	-	≥ 86.1 %
2nd Grade	≥ 83.1 %	≥ 50.1 %	-	≥ 81.1 %
3rd Grade	≥ 76.1 %	≥ 40.1 %	-	≥ 76.1 %
4th Grade	≥ 69.1 %	≥ 35.1 %	-	≥ 71.1 %
5th Grade	≤ 69.0 %	≤ 35.0 %	-	≤ 71.0 %

Star rating per category: Minimum normalized scores (2) for the respective star rating

Category	Impact Safety	Pedestrian Safety	Driving Safety
★★★★★	≥ 93.1 %	≥ 83.1 %	≥ 84.8 %
★★★★	≥ 90.1 %	≥ 63.1 %	≥ 70.5 %
★★★	≥ 87.1 %	≥ 43.1 %	≥ 55.4 %
★★	≥ 84.1 %	≥ 23.1 %	≥ 40.3 %
★	≤ 84.0 %	≤ 23.0 %	≤ 40.2 %

[1] Optional items can be assessed upon the manufacturers request. The maximum total points remains the same. ASCC (0.5); BSD (0.5); RCTA (0.5); LKA (0.5); ISA (0.5); AEB Pedstrian (1); Advanced Airbag (1) - Max. total points for Additional Active Devices = 2

KNCAP

Protocol 2019

Dummy	Region	Points	Criteria	
Frontal Impact against ODB with 40 % Overlap @ 64 km/h				
H III 50 %	Head, Neck	4	$HIC_{15} < 500$; $a_{3ms} < 72$ g; $M_{y,extension} < 42$ Nm; $F_{z,tension} < 2.7$ kN; $F_{x,shear} < 1.9$ kN	max. 16 points
		0	$HIC_{15} > 700$; $a_{3ms} > 80$ g; $M_{y,extension} > 57$ Nm; $F_{z,tension} > 3.3$ kN; $F_{x,shear} > 3.1$ kN	
	Chest	4	Deflection < 22 mm; VC < 0.5 m/s	
		0	Deflection > 42 mm; VC > 1.0 m/s	
	Femur Knee	4	Axial $Force_{compr} < 3.8$ kN; Knee displacement < 6 mm	
		0	Axial $Force_{compr} > 9.07$ kN; Knee displacement > 15 mm	
	Tibia	4	TI < 0.4; Axial $Force_{compr} < 2$ kN	
		0	TI > 1.3; Axial $Force_{compr} > 8$ kN	
Modifiers		-1	Unstable airbag/incorrect airbag deployment (from head score)	
		-1	Excessive head forward excursion (from head score)	
		-1	Steering wheel detachment from steering column (from driver score)	
		0...-1	Steering wheel upward displacement 72...88 mm (from head score)	
		0...-1	Steering wheel rearward displacement 90...110 mm (from head score)	
		-1	Steering wheel contact (from chest score)	
		-2	Shoulder belt load > 6 kN (from chest score)	
		0...-1	A-pillar rearward displacement 100...200 mm (from chest score)	
		-1	Door latch or hinge failure (from chest score)	
		-1	Incorrect airbag deployment (from femur score)	
		0...-1	Pedal upward displacement 72...88 mm (from tibia score)	
		0...-1	Pedal rearward displacement 100...200 mm (from tibia score)	
		-1/door	Door opening during impact	
		-1	Fuel leakage	

Dummy	Region	Points	Criteria	
Frontal-Impact against Rigid Wall with 100 % Overlap @ 56.3 km/h				
H III 5 %	Head[1]	4	$HIC_{15} < 500$; $a_{3ms} < 72$ g	max. 16 points[4]
		0	$HIC_{15} > 700$; $a_{3ms} > 80$ g	
	Neck[2]	4	$F_{x,shear} < 1.2$ kN; $F_{z,tension} < 1.7$ kN; $M_{y,extension} < 36$ Nm	
		0	$F_{x,shear} > 1.95$ kN, $F_{z,tension} > 2.62$ kN, $M_{y,extension} > 49$ Nm	
	Chest	4	Deflection < 22 mm; VC < 0.5 m/s	
		0	Deflection > 48 mm; VC > 1.0 m/s	
	Femur	4	Axial $Force_{compr} < 2.6$ kN	
		0	Axial $Force_{compr} > 6.2$ kN	
Modifiers		-1	Unstable airbag/incorrect airbag deployment (from head score)	
		-1	Excessive head forward excursion (from head score)	
		-1	Steering column displacement (from head score)	
		-1	Steering wheel detachment from steering column (from driver score)	
		-4	Rear seat: excessive head forward excursion (from head score)	
		-2	Rear seat: head contact with vehicle interior (from head score)	
		-1	Steering wheel contact (from chest score)	
		-2	Shoulder belt load > 6 kN (from chest score)	
		-1	Incorrect airbag deployment (from femur score)	
		-4	Submarining[3] (from femur score)	
		-1/door	Door opening during impact	
		-1	Fuel leakage	

[1] For the rear passenger in the rigid wall impact the score is based on a_{3ms} only, if there is no hard contact.
[2] For the rear passenger, the neck score is the sum of all three criteria, with the following maximum score per criterion: Shear 1 point, Tension 1 point, Extension 2 points
[3] When any of the two iliac forces drops 1 kN within 1 ms and when the submarining is confirmed on the high speed film.
[4] The total score is the weighted average of the front seat score (weight = 2) and the rear seat score (weight = 1).

KNCAP

Protocol 2019

Barrier Side Impact (AE-MDB) @ 55 km/h

WS 50 %	Head	4	$HIC_{15} < 500$; $a_{3ms} < 72$ g	max. 16 points
		0	$HIC_{15} > 700$; $a_{3ms} > 80$ g	
	Chest	4	Deflection < 28 mm;	
		0	Deflection > 50 mm; VC ≥ 1.0 m/s; Shoulder $Force_{Lateral}$ ≥ 3.0 kN	
	Abdomen	4	Deflection < 47 mm;	
		0	Deflection > 65 mm; VC ≥ 1.0 m/s	
	Pelvis	4	PSPF < 1.7 kN	
		0	PSPF > 2.8 kN	
Modifiers		-1	Incorrect airbag deployment (from head score)	
		-1/door	Door opening during impact	
		-1	Fuel leakage	

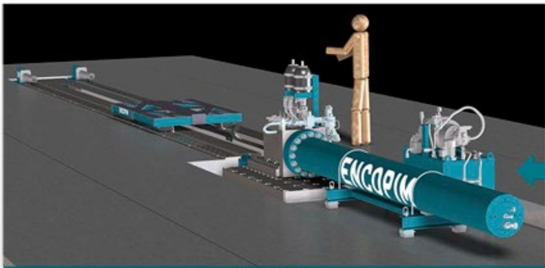
Pole Side Impact @ 32 km/h

WS 50 %	Head	2	$HIC_{15} < 500$	max. 2 pt.
		0	$HIC_{15} > 700$	
Modifiers		-1	Incorrect airbag deployment (from head score)	
		-1/door	Door opening during impact	
		-0.5	Fuel leakage	

Whiplash Test

Dynamic Assessment Front Seat		1.5 Points	0 Points		max. 10 points	max. 14 points (scaled to 4)
BioRID IIg	NIC	11.00	24.00	max. 9 points		
	Nkm	0.15	0.55			
	Rebound velocity (m/s)	3.2	4.8			
	Upper Neck $F_{x,shear}$ (N)	30	190			
	Upper Neck $F_{z,tension}$ (N)	360	750			
	T1 acceleration[1] (g)	9.30	13.10			
	T-HRC[1] (ms)	57	82			
Geometry Assessment Front Seat		1 Point	-1 Point			
HRMD	Backset (mm)	40	100	max. 1 pt		
	Height (mm)	0	80			
Geometry Assessment Rear Seat		1 Point	0 Points		max. 4 points	
Heff (mm)	in highest position	≥ 770	< 770			
	in worst case position	≥ 720	< 720			
ΔCP X	in highest position	≤ 504.5 · sin (Torso angle-2.6) + 116	> 504.5 · sin (Torso angle-2.6) + 116			
ΔCP X	in worst case position	≤ 504.5 · sin (Torso angle-2.6) + 116	> 504.5 · sin (Torso angle-2.6) + 116			
Non-Use position acc. to KMVSS or no Non-Use position		yes	no			
Modifiers						
Fixed or integrated head restraint / no height lock			-2			
Height lock failure			-2			

[1] Only the maximum score from either T1 acceleration or head restraint contact time is used in the rating.



SCAT

ALIS

DITS

Bharat New Car Assessment Program (India)

Phase I Assessment scheme

Category	Test / Requirement	Max. points available for meeting relevant legal (AIS) requirements	Max. points available for meeting BNCAP criteria	Max. total score
Adult Occupant Protection	ODB Frontal Test 40 % / 56 km/h (AIS 098 / UN R94)	4	12	24
	MDB Side Test 50 km/h (AIS 099 / UN R95)	4	4	
Child Occupant Protection	Dynamic Assessment in ODB Frontal Test	-	4	4
Pedestrian Protection	Head Impact (AIS 100)	4	-	4
Other Safety Features (OSF)	Rear Impact (AIS 101 / UN R34)	-	2	12
	Type approved ABS System		2	
	Seat Belt Reminder (SBR) Driver 1 point, Passenger 1 point		2	
	Seat Belt Reminder (SBR) all forward facing rear seats		1	
	Validated Electronic Stability Control (ESC)		1	
	Validated Electronic Brake Distribution (EBD)		1	
	Type approved Head Restraint System (for all forward facing outboard seats)		1	
	Child Lock Functionality Check		1	
	Speed Warning system		1	
Total score				44

	Overall Rating		Adult Occupant Protection	
Rating	required points (out of max. 44)	% of max	required points (out of max. 24)	% of max
★★★★★[1]	37.4	85	21	87.5
★★★★½	34.1	77.5	19	79.2
★★★★	30.8	70	17	70.8
★★★½	27.5	62.5	14.5	60.4
★★★	24.2	55	12	50
★★½	20.9	47.5	8.4	35
★★	17.6	40	4.8	20
★½	15.4	35	3.6	15
★	13.2	30	2.4	10
½	6.6	15	1.2	5

[1] To be eligible for 5 stars the frontal offset crash test must be conducted at 64 km/h.
Note: BNCAP is still in its introduction phase. Therefore modifications may still occur.

Product Liability in the Automobile Industry

Course Description

In the framework of the ongoing extension of active and passive safety systems automobiles are becoming increasingly complex.

In this context the faultlessness of systems becomes more and more important, as with growing complexity, especially in the field of autonomous vehicles, not only the number but also the severity of possible faults is increasing. Even implemented equal parts strategies can quickly lead to a large number of affected vehicles in case of defects. An indicator for this is the growing number of recalls in recent years.

Each manufacturer holds the responsibility for consequential damages caused by its products when used as intended. This responsibility is defined by law in all countries and has civil and criminal penalties.

Examples include cases of damage and recalls of large numbers of vehicles that several OEMs were obliged to do during the last few years.

Obviously a safety related recall of a mass product may have severe or even existence-threatening consequences.

Consequently, manufacturers must ensure faultlessness throughout their organization. Amongst others, questions may raise like:

- Who in the company is responsible for product safety?
- Is your entire organization set up to avoid safety-related errors or to reduce the risk?
- Is compliance with product liability ensured throughout the company?
- In the case of allegations, can targeted and comprehensive evidence be quickly provided?
- How can unwarranted claims be averted?
- What can be learned from the product liability cases, which are particularly well received by the public?

Course Objectives

The aim of this course is to convey the importance of product liability for businesses and employees as well as an understanding of preventive measures.

Who should attend?

The seminar is aimed at all decision-makers in the automotive development, production and at suppliers who want to learn about the consequences of product liability and want to get familiar with preventive measures.

Course Contents

- Fundamentals of Product Liability
- Civil and criminal responsibility of the company and personal liability of employees
- Liability for Defects
- Product liability in Europe and in the U.S.
- U.S. TREAD ACT, Reporting obligation for OEMs and suppliers
- Motor Vehicle Whistleblower Act (what to expect?)
- Importance of norms and standards (e.g. ISO26262 Functional Safety)
- Product liability and advertisement / public relations of companies
- Quality management and its relevance from a product liability point of view
- Product liability in the supply chain
- Consequences of new technologies (driver assistance systems, autonomous vehicles)
- Instructions, warnings
- Risk minimization within the organization, prevention
- Preventive product safety measures during product development
- Product observation and resulting consequences
- Documentation, conclusive evidence
- Insurance of product liability risk
- Recall decision and processing

Instructor

Hans-Georg Lohrmann was Manager of Reliability & Conformity of Production at ZF TRW Automotive GmbH. He has many years of experience in the field of safety, reliability and product liability in the automotive sector. Since September 2015 he has retired and is still active as a freelance consultant. He specializes in the area of restraint systems for vehicle occupant protection and supports his clients in the areas of reliability, safety planning and methods of verification and litigation support.

Dates

DATE	COURSE ID	VENUE	DURATION	PRICE	LANGUAGE
17.-18.02.2020	116/3589	Alzenau	2 Days	1.340,- EUR till 20.01.2020, thereafter 1.590,- EUR	German
25.-26.05.2020	116/3590	Alzenau	2 Days	1.340,- EUR till 27.04.2020, thereafter 1.590,- EUR	English
28.-29.09.2020	116/3591	Alzenau	2 Days	1.340,- EUR till 31.08.2020, thereafter 1.590,- EUR	German

Static Vehicle Safety Tests in Automotive Development

Course Description

When thinking about vehicle safety testing people first think about dynamic crash tests of the full vehicle or crash simulations performed on a sled test facility. In addition to these dynamic tests, however, numerous other tests on the car body and components such as seats, steering, instrument panel, pillars, bumpers, etc. have to be performed during the development of a car. At first sight, these experiments perhaps are less spectacular, but in practice they are also very complex. The seminar provides an introduction to static vehicle safety testing. Static vehicle safety tests serve the determination of criteria to minimize injury that may occur due to an accident. The seminar covers the entire field of static vehicle safety testing, ranging from biomechanical research to legal regulations and consumer protection related requirements. It discusses the required test equipment (impactors, test facilities) and the typical load cases of the experiments. Finally, the testing specifications, including the protection criteria are explained.

Course Objectives

After participating in the seminar "Static Vehicle Safety Tests in Automotive Development", the participants have gained an overview of the static vehicle safety tests to be performed on the car body and the components. They have acquired knowledge about the essential procedures in Europe and North America as well as their backgrounds and gained insight into equipment necessary to carry out the experiments.

Who should attend?

The seminar is aimed at specialists from crash-related car body and component development, engineers and technicians from test and analysis departments as well as project engineers and managers.

Course Contents

- Introduction
- Static roof crush according to FMVSS 216a
- Static door intrusion according to FMVSS 214
- Test procedures for exterior and interior parts FMVSS 201U, UN R21 & R42
- Testing of seats and head restraints according to FMVSS 202 and UN R17, R21 and R25
- Test procedures on seat-belts according to UN R14 and R21
- Test procedures for steering systems according to FMVSS 203, UN R12
- Test procedures for child seat anchors (ISOFIX) of FMVSS 225

Instructors

Matthias Kunkel (ACTS GmbH & Co. KG) has been with ACTS GmbH & Co. KG in the field of testing since 2000. As a test engineer, he is currently the team leader for component safety tests.

Alexander Martellucci (ACTS GmbH & Co. KG) began his professional career in physical laboratories in the pharmaceutical industry. Since 1992 he is involved in the testing of components for vehicle safety. Until 1995 he worked in the steering wheel laboratory and until 1998 he headed the airbag testing at TRW. Since 1998 he has been with ACTS GmbH & Co. KG until 2002 as head of the component laboratory, and since then as manager Technology.

Dates

DATE	COURSE ID	VENUE	DURATION	PRICE	LANGUAGE
02.03.2020	140/3567	Alzenau	1 Day	790,- EUR till 03.02.2020, thereafter 940,- EUR	
04.11.2020	140/3568	Alzenau	1 Day	790,- EUR till 07.10.2020, thereafter 940,- EUR	

Crashworthy and Lightweight Car Body Design

Course Description

In the development of a car body different - sometimes conflicting - design requirements have to be met. Depending on the intended drive unit, the fulfilling of the crash regulations considering the lightweight principles is a key task. Therefore, it is mandatory that designers have a good understanding of the crash behavior of mechanical structures. The combination of knowledge about mechanics and the ability to use modern design tools allows for an efficient development process without unnecessary design iterations.

Course Objectives

The objective of the seminar is to present new methods for crashworthy car body design. At the beginning of the course the mechanical phenomena of crash events will be discussed. Subsequently modern development methods (CAD design and crash simulation) will be treated. Thereafter modern implementations of safety design measures will be presented. Mathematical optimization of structural design - which is increasingly used in industry - will be covered at the end of the course.

Who should attend?

This 2 day course addresses designers, test and simulation engineers as well as project leaders and managers working in car body development and analysis.

Course Contents

- Mechanics of crash events
  - Accelerations during collisions
  - Structural loading during collisions
  - Examination of real crash events
  - Stability problems
  - Plasticity
- Lightweight principles for the car body design
  - Lightweight design rules
  - Car body design
  - CAE conform design
- Crash simulation
  - Finite Element modelling of a car body
  - Finite Element analysis with explicit methods
  - Possibilities and limitations
- Technical implementation of safety measures
  - Energy absorbing members
  - Car bodies
  - Electric car bodies
  - Safety systems
  - Pedestrian protection
  - Post crash
- Use of mathematical optimization procedures in real world applications
  - Approximation techniques
  - Optimization software & strategies
  - Shape and topology optimization

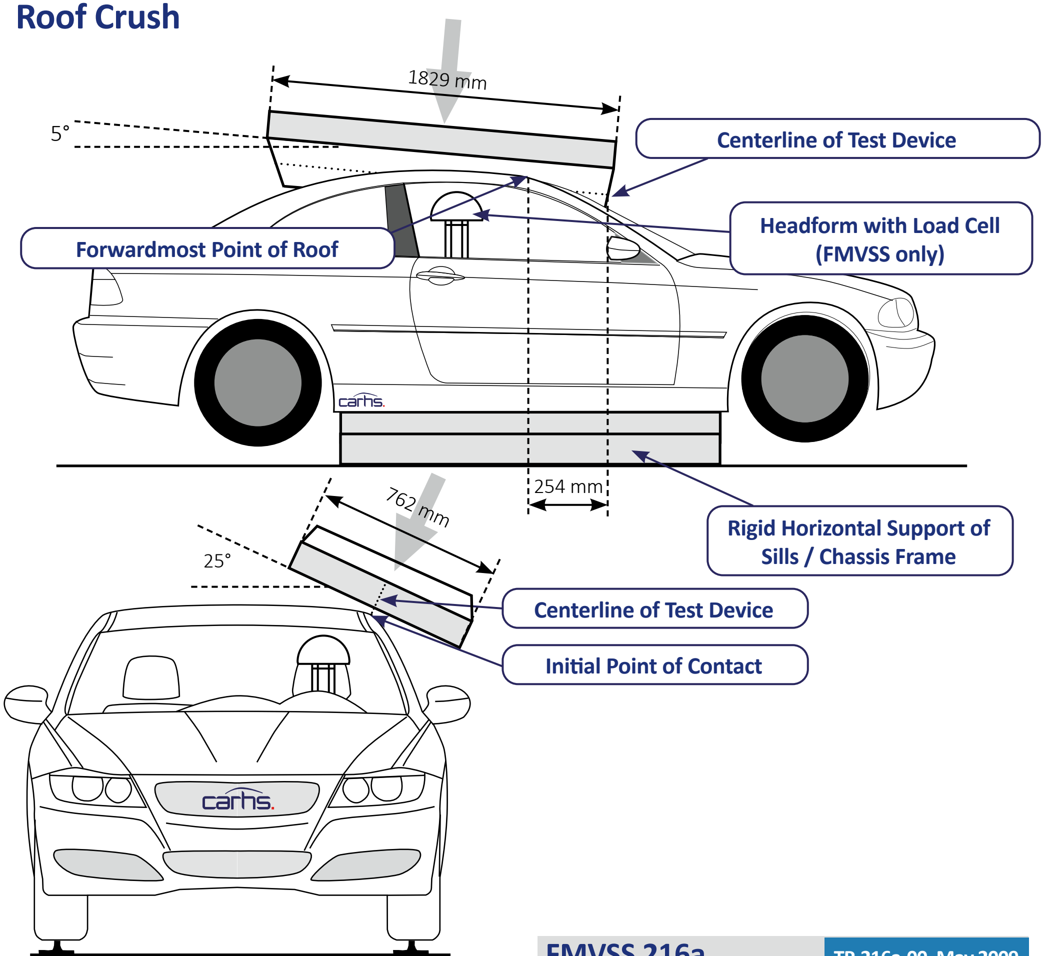
Instructor

Prof. Dr.-Ing. Axel Schumacher (University of Wuppertal) studied mechanical engineering at the universities of Duisburg and Aachen. He received his doctorate on structural optimization from the University of Siegen. Following research projects for Airbus were focused on the optimization of aircraft structures. Thereafter he worked in the CAE methods development department of Adam Opel AG as project leader for structural optimization. From 2003 - 2012 he was a professor at the University of Applied Sciences in Hamburg and taught structural design, passive safety and structural optimization. Since 2012 he has been professor at the University of Wuppertal, where he holds the chair for optimization of mechanical structures.

Dates

DATE	COURSE ID	VENUE	DURATION	PRICE	LANGUAGE
04.-05.05.2020	188/3465	Alzenau	2 Days	1.340,- EUR till 06.04.2020, thereafter 1.590,- EUR	German
08.-09.09.2020	188/3599	Alzenau	2 Days	1.340,- EUR till 11.08.2020, thereafter 1.590,- EUR	English
07.-08.12.2020	188/3600	Alzenau	2 Days	1.340,- EUR till 09.11.2020, thereafter 1.590,- EUR	German

Roof Crush



IIHS

Testing Protocol Version III (July 2016)

Platen Displacement: 127 mm

Feed Rate: 5 mm/s

Single Side Test: Lab selects worst case

Assessment:
based on Strength-to-weight ratio (SWR) = F_{max} / m x g

SWR	Rating
≥ 4.00	Good
≥ 3.25 till < 4.00	Acceptable
≥ 2.50 till < 3.25	Marginal
< 2.50	Poor

A „Good“ rating in the roof crush test is a requirement for the *Top Safety Pick* award.

SafetyWissen by carhs

FMVSS 216a

TP-216a-00, May 2009

Application:
Vehicles with a GVWR ≤ 4536 kg

Applied Force:
for vehicles with a GVWR ≤ 2722 kg:
F = 3.0 x UVW x 9.8 m/s^2
for vehicles with a GVWR > 2722 kg:
F = 1.5 x UVW x 9.8 m/s^2

Feed Rate: ≤ 13 mm/s

Double Sided Test

Requirements:
Platen displacement ≤ 127 mm
Load on headform located at head position of 50 % male ≤ 222 N

UVW = Unloaded Vehicle Weight
GVWR = Gross Vehicle Weight Rating

SafetyWissen by carhs

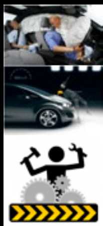
FIVE STARS SUPPLIER

★ ★ ★ ★ ★

SAFETY FIRST

SAFETY FIRST

- OCCUPANTS
- PEDESTRIANS
- EMPLOYEES



WIDE EXPERIENCE

☆ #70% of TOP 10 OEMs

☆ #400 systems delivered in 30+ years

EXTENDED COMPETENCIES

☆ #8 Core competencies

- Special civil works, definitions & supervision
- Dynamic System Simulations
- Electromechanical design
- Lighting systems
- Real time control loops
- Data measurement & Analysis
- Software development
- Servo-hydraulic & electric systems

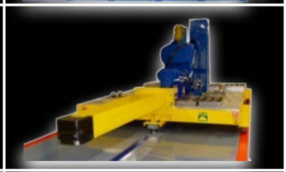
☆ #4 stages, FULL Follow-up from Design to Turnkey & Support

Design | Build | Install | Support

GLOBAL PRESENCE

☆ #40 countries installed and supported

CRASH TEST FACILITIES & EQUIPMENT

FULL SCALE CRASH TEST LABORATORIES	32	
LIGHTING SYSTEM	5	
PEDESTRIAN PROTECTION TESTS	20	
SLED	20	
STATIC & DYNAMIC COMPONENTS TESTS	300	
TOTAL # SYSTEMS	±400	

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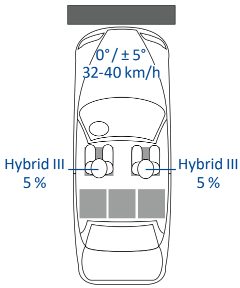
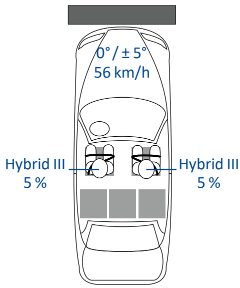
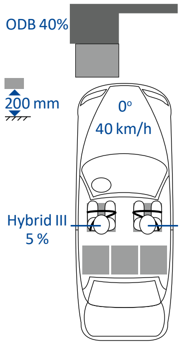
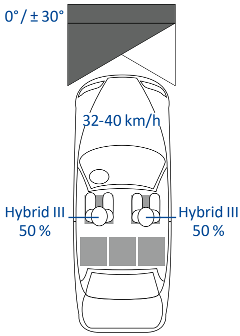
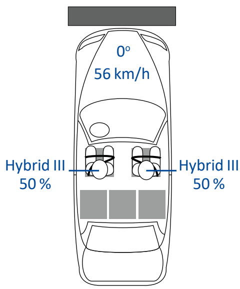
FMVSS 208: Frontal Impact Requirements: In-Position

TP-208-14, April 2008

In-Position – Test Configurations			
	Full-Width Test		ODB Test
	unbelted	belted	
5 % Female Dummy			
50 % Male Dummy			SafetyWissen by carhs

FMVSS 208: Frontal Impact Requirements: Out of Position

Front seat	Dummy	Test configuration
Driver side	Hybrid III 5 % female	chin on airbag module in steering wheel chin on top of steering wheel
Passenger side	CRABI 12 m	in 23 defined CRS / positions
	Hybrid III 3 y/o	chest on instrument panel head on instrument panel
	Hybrid III 6 y/o	chest on instrument panel head on instrument panel

Development of Frontal Restraint Systems meeting Legal and Consumer Protection Requirements

Course Description

Belts, belt-load limiters, airbags, steering column, knee bolster, seat ... - only if all the components of a frontal restraint system are in perfect harmony it is possible to meet the different legal limit values as well as the requirements of consumer tests. However, these requirements, e.g. FMVSS 208, U.S. NCAP, Euro NCAP et al. are manifold and extensive, partly contradict each other, or the requirements superpose each other. Therefore it is a challenge for every development engineer to develop a restraint system by a clear, strategic procedure; time-saving and target-oriented with an optimal result. In this 2-day seminar this strategic way of development will be shown. You will learn a procedure how to ideally solve the complex development task of a typical frontal restraint-system design within the scope of the available tools test and simulation. Especially the importance and the influence of individual system components (e.g. belt-load limiters) for the accomplishment of development-sub tasks (e.g. minimum chest deflection) will be covered. In addition the influence of the airbag module design on the hazards of Out-of-Position (OoP) situations is going to be discussed, and a possible development-path for the compliance with the OoP requirements according to the FMVSS 208 legislation will be shown. The possibilities and limits of the development tools test and simulation will be discussed and communicated. Last but not least tips and tricks for a successful overall system design will be part of this seminar.

In this seminar you will become familiar with a procedure for the successful development of a frontal restraint system. Furthermore you will learn which development tool, simulation or test, is best suited for the respective sub task. Moreover you will be made aware of the influence of the individual components of a restraint system (belts, belt-load limiters, airbags, steering column, knee bolster, seat, ...) on the efficiency of the entire system. Finally future topics such as the compatibility of vehicles as well as pre-crash preparation and prevention of accidents are integrated into the seminar.

Who should attend?

The seminar addresses simulation and test engineers, project engineers and project managers as well as the heads of development departments in the field of passive safety who work on the design of restraint-systems for vehicles.

Course Contents

- Identification of the relevant development load cases
- Procedures for the development of a restraint system
- Influence and importance of individual system components on the overall performance
- Development strategy for UN regulations and NAR restraint systems
- Development path for the conformance to the OoP requirements according to FMVSS 208

Instructor

Kai Golowko (Bertrandt Ingenieurbüro GmbH) has been working in the area of vehicle safety since 1999. He started his career as a test engineer for passive safety at ACTS. Since 2003 he has been working as senior engineer for occupant safety and pedestrian protection. Since 2005 he has managed the department vehicle safety at Bertrandt in Gaimersheim. He has also been responsible for active and passive vehicle safety for the Bertrandt Group since 2017.

Dates

DATE	COURSE ID	VENUE	DURATION	PRICE	LANGUAGE
05.-06.03.2020	20/3601	Gaimersheim	2 Days	1.340,- EUR till 06.02.2020, thereafter 1.590,- EUR	
15.-16.06.2020	20/3602	Alzenau	2 Days	1.340,- EUR till 18.05.2020, thereafter 1.590,- EUR	
05.-06.11.2020	20/3603	Tappenbeck	2 Days	1.340,- EUR till 08.10.2020, thereafter 1.590,- EUR	

Protection Criteria for Frontal Impact Tests

Configuration	Criterion	Rigid Barrier In-Position					Deformable Barrier In-Position		Out of Position			
Requirements		CMVSS 208 (old), ADR 69/00, FMVSS 208 (old)	FMVSS 208 CMVSS 208		UN R137		UN R94, ADR 73/00	FMVSS 208 CMVSS 208	FMVSS 208 CMVSS 208			
Dummy		Hybrid III	Hybrid III	Hybrid III	Hybrid III	Hybrid III	Hybrid III	Hybrid III	Hybrid III	Hybrid III	Hybrid III	CRABI
Size		50 % male	50 % male	5 % female	50 % male	5 % female	50 % male	5 % female	5 % female	6 year	3 year	1 year
Head	HIC_{36} /HPC_{36} [-]	1000 (FMVSS, ADR)			1000	1000	1000					
	HIC_{15} [-]	700 (CMVSS)	700	700				700	700	700	570	390
	a_{3ms} [g]				80	80	80					
Neck	N_{ij} [-] (4 Values)		1.0	1.0				1.0	1.0	1.0	1.0	1.0
	$F_{x,shear}$ [kN]				3.1	2.7	3.1 @ 0 ms 1.5 @ 25-35 ms 1.1 @ ≥ 45 ms					
	$F_{z,tension}$ [kN]		4.17	2.62	3.3	2.9	3.3 @ 0 ms 2.9 @ 35 ms 1.1 @ ≥ 60 ms	2.62	2.07	1.49	1.13	0.78
	$F_{z,compr.}$ [kN]		4.0	2.52				2.52	2.52	1.82	1.38	0.96
	M_y [Nm]				57	57	57					
Chest	a_{3ms} [g]	60	60	60				60	60	60	55	50
	Deflection [mm]	76.2 (FMVSS. ADR) 50 (CMVSS)	63	52	42	34	34	52	52	40	34	30[1]
	VC [m/s]				1.0	1.0	1.0					
Femur	Axial Force [kN]	10	10	6.805	9.07	7	9.07 @ 0 ms 7.58 @ > 10 ms	6.805	6.8			
Knee	Displacement [mm]						15					
Tibia	TI [-]						1.3 (4 Values)				SafetyWissen by carhs	
	Axial Force$_{compr.}$ [kN]						8.0					

[1] currently no measurement possible

Early Increase of Design Maturity of Restraint System Components in the Reduced Prototype Vehicle Development Process

Course Description

The number of hardware prototypes available for the development of restraint systems and restraint system components is declining steadily due to an increasing cost pressure in automotive development. In the project schedule the availability of hardware (restraint system components and / or vehicle environments) shifts to the late vehicle development phases. As a result, ensuring the required degree of maturity of restraint system components, in addition to the sole functional development of seat belts and airbag, necessitates new strategies and development paths. In this seminar, current risks in the development of seat belts and airbags are addressed and ideas for the early increase of maturity are elucidated. This is done by explaining the link between milestones in the development schedule, the functional requirements of restraint system components, the development duration of restraint system components and the description of approaches for the creation of substitutes of vehicle environments in the early development process. In addition the project schedules of conventional vehicle development processes and prototype-reduced development processes of base line models and derivatives are shown. Interactions of the development of seatbelts and airbags with surrounding components (e.g. trim parts) are also discussed.

Course Objectives

The course provides thoughts and ideas for a successful approach in the development of restraint systems within vehicle development processes in which only a small number of prototypes are available for verification and optimization of the systems.

Who should attend?

The seminar is aimed at engineers and project managers of restraint systems and restraint system components development, as well as heads of teams or departments in the field of passive safety, which want to gain, in addition to the pure functional development of restraint systems, an overview of the requirements of the prototype-reduced restraint system development with regard to achieving and ensuring the necessary degree of maturity of belts and airbags.

Course Contents

- Overview and differences of vehicle development schedules
  - Standard project schedule
  - Prototype-reduced development of lead series
  - Prototype-reduced development of derivatives
- Safety belts
  - Examples of requirements for safety belts
  - Prerequisites and timing for functional development
  - Timing for homologation and certification
  - Ideas / possibilities for creating vehicle environments
  - Interactions with surrounding components
- Airbags
  - Examples of requirements for airbags
  - Prerequisites and timing for functional development
  - Ideas / possibilities for creating vehicle environments
  - Interactions with surrounding components

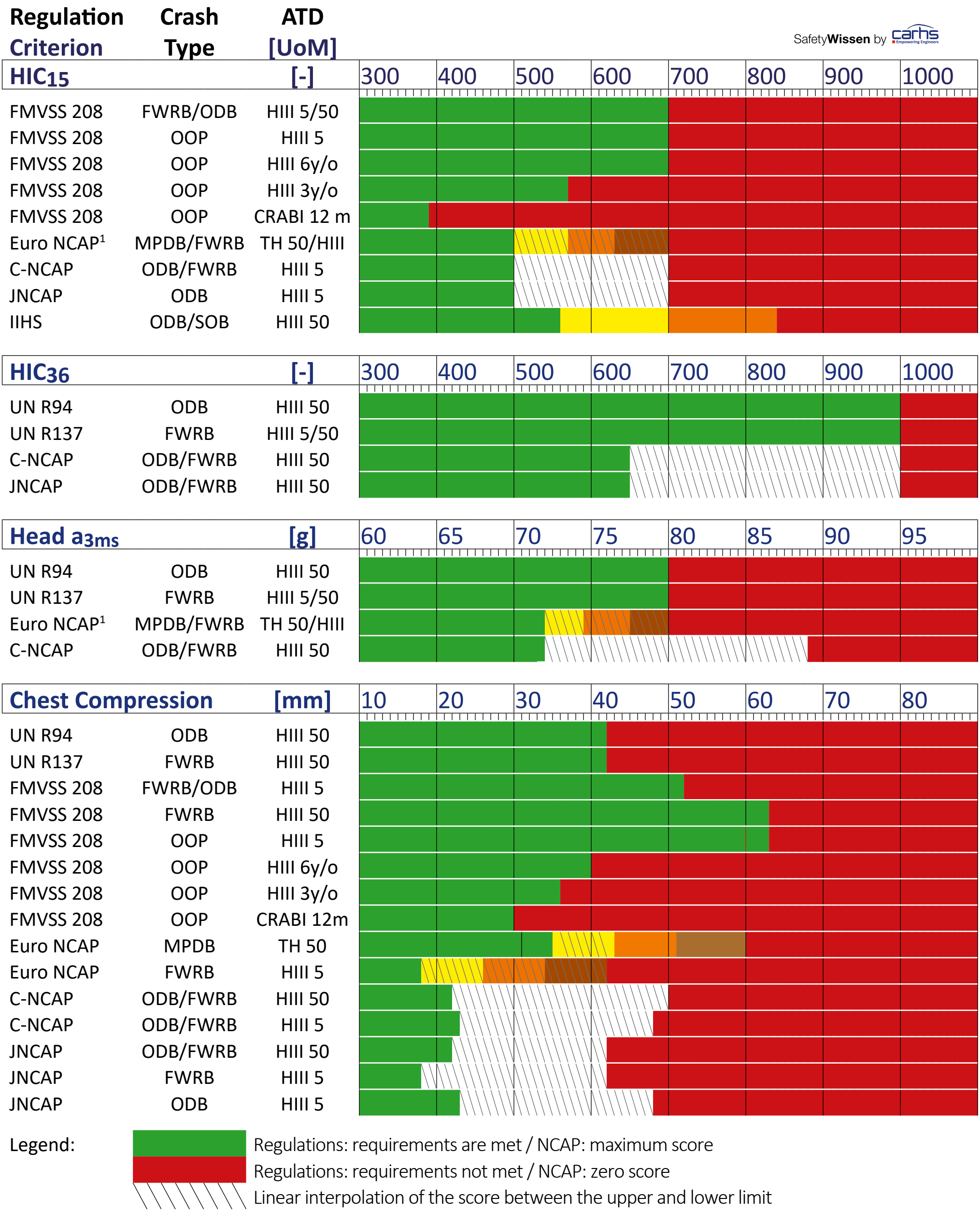
Instructor

Sandro Hübner (EDAG Engineering GmbH) studied mechanical engineering at the University of Applied Sciences Schmalkalden. After completing his studies he worked as an engineer in the FEM laboratory of Schmalkalden University of Applied Sciences. From 2003 he worked as a CAE engineer for occupant safety at EASi Engineering GmbH. In 2006, he moved to EDAG Engineering GmbH as a CAE engineer for vehicle safety and has been project manager for vehicle safety and CAE since 2013.

Dates

DATE	COURSE ID	VENUE	DURATION	PRICE	LANGUAGE
08.06.2020	166/3556	Alzenau	1 Day	790,- EUR till 11.05.2020, thereafter 940,- EUR	
12.10.2020	166/3555	Alzenau	1 Day	790,- EUR till 14.09.2020, thereafter 940,- EUR	

Frontal Impact Protection Criteria Compared



[1] assessed only if Head $a_{res\ peak}$ > 80 g

Please note that the values indicated in this graph may be rounded and that additional criteria may exist. Please take exact values and additional criteria from the tables for the respective regulation.

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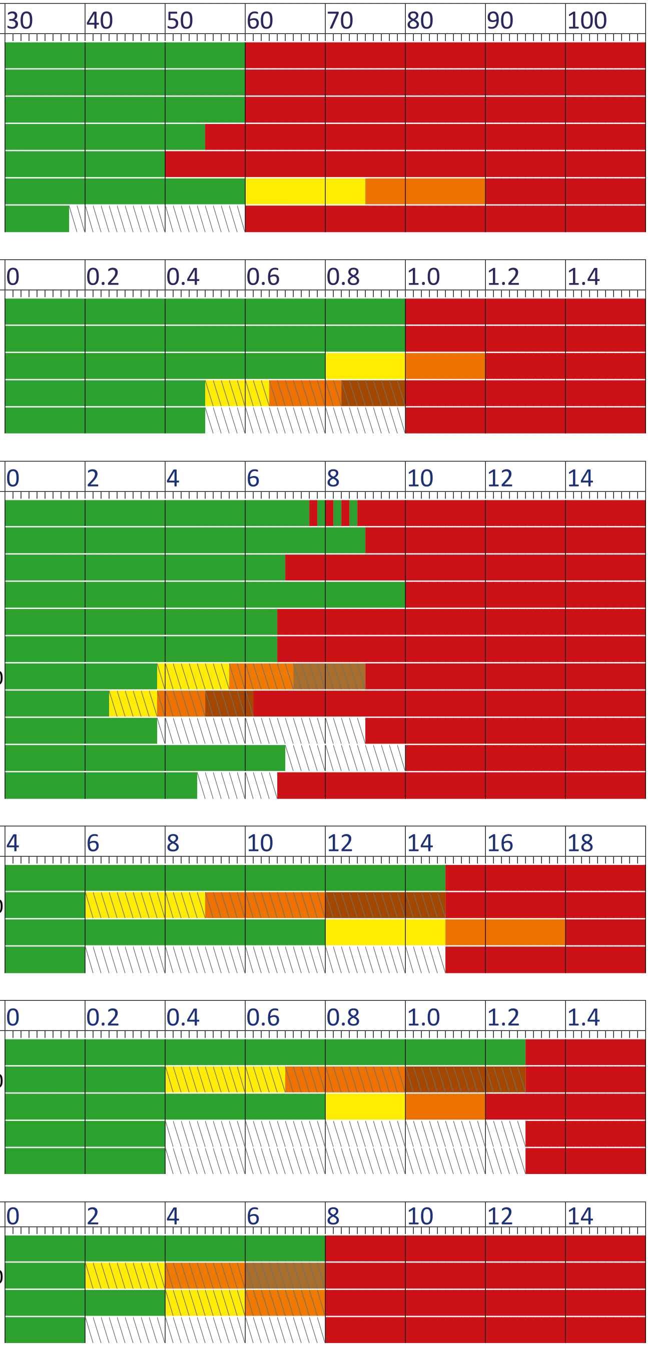
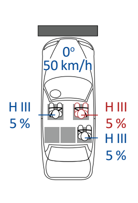
Regulation / Criterion	Crash Type	ATD [UoM]
Chest a3ms		**[g]**
FMVSS 208	FWRB/ODB	HIII 5/50
FMVSS 208	OOP	HIII 5
FMVSS 208	OOP	HIII 6y/o
FMVSS 208	OOP	HIII 3y/o
FMVSS 208	OOP	CRABI 12 m
IIHS	ODB/SOB	HIII 50
JNCAP	ODB/FWRB	HIII 50
Chest VCmax		**[m/s]**
UN R94	ODB	HIII 50
UN R137	FWRB	HIII 5/50
IIHS	ODB/SOB	HIII 50
Euro NCAP	MPDB/FWRB	HIII 5/50
C-NCAP	ODB/FWRB	HIII 50
Femur Faxial		**[kN]**
UN R94	ODB	HIII 50
UN R137	FWRB	HIII 5
UN R137	FWRB	HIII 50
FMVSS 208	ODB	HIII 50
FMVSS 208	ODB/FWRB	HIII 5
FMVSS 208	OOP	HIII 5
Euro NCAP	MPDB	TH 50/HIII 50
Euro NCAP	FWRB	HIII 5
C-NCAP	ODB	HIII 50
JNCAP	ODB/FWRB	HIII 50
JNCAP	ODB	HIII 5
Knee Displacement		**[mm]**
UN R94	ODB	HIII 50
Euro NCAP	MPDB	TH 50/HIII 50
IIHS	ODB/SOB	HIII 50
C-NCAP	ODB/FWRB	HIII 50
Tibia Index		**[-]**
UN R94	ODB	HIII 50
Euro NCAP	MPDB	TH50 /HIII 50
IIHS	ODB/SOB	HIII 50
C-NCAP	ODB/FWRB	HIII 50
JNCAP	ODB/FWRB	HIII 50
Tibia Compression		**[kN]**
UN R94	ODB	HIII 50
Euro NCAP	MPDB	TH 50/HIII 50
IIHS	ODB/SOB	HIII 50
C-NCAP	ODB/FWRB	HIII 50

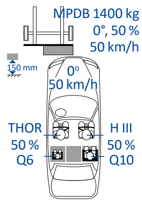


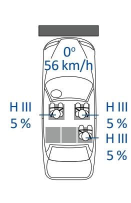
Safety Requirements for Rear Seats and Restraint Systems

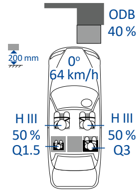
Frontal impact tests with rear seat occupants

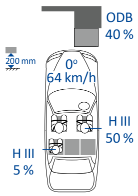
2020 2022

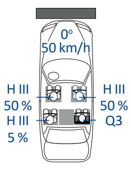
Euro NCAP FWRB


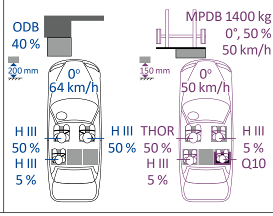
Euro NCAP / ANCAP MPDB


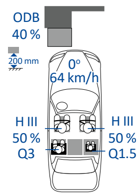
KNCAP FWRB


ASEAN NCAP ODB


JNCAP ODB


C-NCAP FWRB


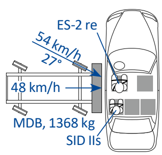
C-NCAP ODB


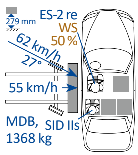
Latin NCAP ODB


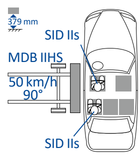
FMVSS 201: Head impact on belt anchorages
FMVSS 207: Seat stability
FMVSS 208: Belt system
FMVSS 209: Belt system
FMVSS 213: Child seats
FMVSS 225: ISOFIX anchorages

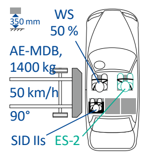
UN R14: Belt
UN R16: Belt system
UN R17: Seat anchorages
UN R21: Head impact
UN R25: Head rests
UN R44: Child seats
UN R129: Child seats
UN R145: ISOFIX anchorages

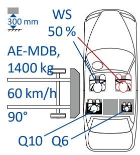
Side impacts tests with rear seat occupants

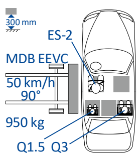
FMVSS 214


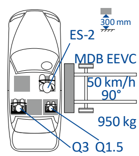
U.S. NCAP


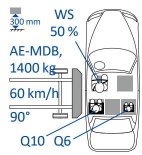
IIHS / C-IASI


C-NCAP


Euro NCAP MDB


Latin NCAP MDB


ASEAN NCAP


KNCAP


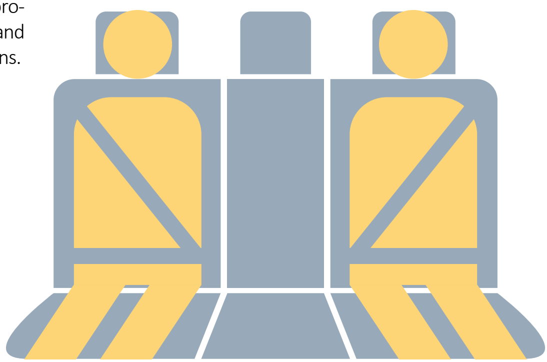
Rear Seat Occupant Protection in Frontal Impact

Course Description
While the design of restraint systems for the rear seats used to be a secondary issue, it has moved in the focus of research and development since the introduction of occupant safety assessments on adult and child dummies in rear seats in consumer protection tests. In addition to looking at Euro NCAP, however, requirements of other NCAPs as well as legal requirements must be considered for a sensible design of the restraint system. Last but not least, a system design must also consider real life aspects. Starting from knowledge on typical injury patterns in real-world accidents, this 1-day seminar discusses both NCAP and legal requirements for the frontal crash. In addition, the dummies to be used in the vehicle rear will be presented, in particular the Q6 and Q10 dummies will be discussed. For the most important load cases, the most relevant protection criteria and possibilities for influencing them through the restraint parameters are being examined. The seminar will be rounded off by approaches for designing restraint systems for the back seat and an outlook on new seating positions possible in the context of automated driving.

Course Objectives
The objective of the seminar is to provide an understanding of the requirements and specifics in rear seat occupant protection, to provide the knowledge of test configurations and dummies, and to provide a view on state-of-the-art solutions.

Who should attend?
The seminar addresses simulation and test engineers, project engineers and project managers as well as the heads of development departments in the field of passive safety who work in R&D of occupant restraint-systems.

Course Contents
- Typical injury patterns in real accident events and injury risk curves
- Legal requirements
- Requirements from consumer testing
- Dummies on the rear seat; Q6 and Q10 child dummies, Hybrid III 5 %
- Relevant protection criteria for the most important load cases
- Solutions for restraint system design and optimization
- Overview: Safety of occupants in new seating positions (automated driving)



Instructor

Dr.-Ing. Burkhard Eickhoff (Autoliv B.V. & Co. KG) studied mechanical engineering in Hannover (Germany) focusing on vehicle engineering and applied mechanics. Starting from 1999 he worked with Autoliv B.V. & Co. KG as a test engineer for sled and crash tests. Since 2003 he has been project manager in systems development (safety belt) of the same company. He was involved in the definition and assessment of new restraint systems and he conducted feasibility studies using system simulation as well as dynamical tests. Moreover he had a consultant role regarding restraint system design. He finished his doctoral thesis at the Helmut Schmidt University Hamburg in 2012 on the reduction of belt induced thorax deflection in frontal crashes. Since 2016 he has been head of the department Virtual & System Engineering, Homologation at Autoliv B.V. & Co. KG.

Date

DATE	COURSE ID	VENUE	DURATION	PRICE	LANGUAGE
25.11.2020	146/3588	Alzenau	1 Day	790,- EUR till 28.10.2020, thereafter 940,- EUR	

Crash-Sensing and Intelligent Restraint Systems

Course Description

Sensors are the organs of perception of vehicle safety: Recognizing accident risks in split of seconds, they control accident mitigation systems and occupant protection systems accurately, reliably and effectively. Mechanical Electrical Micro Systems (MEMS) such as micro-oscillators or gyros on the scale of micrometers sense even the most subtle movements and shocks and will stabilize the car, prevent vehicle roll and activate the occupant protection systems such as seat belt pre-tensioners, airbags and other protection devices according to crash type and severity. Predictive surround sensors such as radar, LiDAR, cameras and ultrasonic detect accident risks at an early stage and do not only mitigate accidents by automatic emergency braking or evasive maneuvers, but also optimize the effectiveness of occupant protection systems. Since the introduction of seat belt pre-tensioners and driver airbags in the early 80ies the requirements to crash sensors and restraint control electronics have been increased continuously: Starting with single point sensing and focus on frontal crashes with full barrier overlap to trigger driver airbags and seat belt pre-tensioners, all real world accident types and crash severities must be discriminated today utilizing up to a dozen peripheral crash satellites in order to control appropriately up to two dozens of occupant protection devices. New crash tests such as the lateral pole impact or the frontal small overlap crash mandated by regulations and consumer ratings have permanently tightened the requirements to crash sensing and smart restraint control. Above and beyond utilizing the predictive sensors of accident avoidance and advanced driver assistance systems (ADAS), the protection of occupants can be increase significantly: protection devices can be pre-triggered while a crash is imminent, and new protection measures are possible. Last but not least the occupant protection can be adapted and tailored to the occupant size, weight and position (out-of-position) which will be particularly important in autonomous cars with variable seat positions and other new vehicle interior variances. In the seminar, (predictive-) crash sensors, restraint (pre-) triggering crash algorithms and (pre-crash) occupant protection systems are discussed for the following accident scenarios: Frontal- and rear-end collisions, side impact, vehicle rollover, and accidents with pedestrians and cyclists. From scratch, the seminar explains simply and understandably the physical principles of sensors and measuring systems, their properties and application specific benefits and drawbacks, the restraint triggering algorithms in particular. A specific focus is on future safety systems and technologies, such as artificial intelligence / neural networks, and new occupant protection systems in autonomous cars.

Who should attend?

The seminar addresses all engineers, technicians and experts working in the development, application and research of vehicle safety, both at automobile manufacturers and tier 1 / 2 / 3 suppliers, system engineers, project engineers and project leaders in particular. Basically, all experts somehow dealing with vehicle safety and being interested in current and future sensor and actuator technologies in passive and active safety are very welcome.

Course Contents

- Sensors for frontal-, rear and side impacts, roll-over, collisions w/ pedestrians & cyclists, occupant recognition & monitoring
- Predictive (surround) sensors (radar, LiDAR, cameras, ultrasonic)
- Intelligent restraint control and triggering, artificial intelligence and neural networks
- Structure and function of sensors and electronic control units, system-architectures
- Today's and future occupant protection systems, integrated safety

Instructor

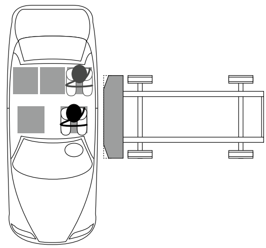
Dr. Lothar Groesch (Groesch Automotive Safety Consulting) For more then 44 years, Dr. Lothar Groesch has been working in vehicle safety, both passive (crash sensing and electronics, occupant protection) and active safety (surround sensors, accident avoidance). First of all working for 18 years for one of the leading OEMs in vehicle safety, another 16 years followed in automotive safety sensors and electronics at one of the major automotive suppliers. Working as a Product Director for Automotive Safety Systems in the US from 2000 through 2009, he is particularly familiar with the specific requirements of the US market, legislation and product liability. Since 2009, Dr. Groesch has been doing consulting business under the name Automotive Safety Consulting with focus on driver assistance, accident avoidance and autonomous driving. Last but not least, he is teaching automotive safety at several universities and has conducted numerous in-house seminars about automotive safety.

Dates

DATE	COURSE ID	VENUE	DURATION	PRICE	LANGUAGE
30.03.2020	175/3605	Alzenau	1 Day	790,- EUR till 02.03.2020, thereafter 940,- EUR	German
28.09.2020	175/3606	Alzenau	1 Day	790,- EUR till 31.08.2020, thereafter 940,- EUR	English

MDB Side Impact Test Procedures according to UN R95, Euro NCAP and IIHS

Requirement	UN R95	Euro NCAP	IIHS
Impact angle	lateral 90°		
MDB velocity	50 km/h	60 km/h	50 km/h
Barrier (MDB)	EEVC	AE-MDB	IIHS
Mass	950 kg	1400 kg as of 2020	1500 kg
Ground clearance	300 mm	300 mm (bumper 350 mm)	379 mm (bumper 430 mm)
Upper edge height	800 mm	800 mm	1138 mm
Width	1500 mm	1700 mm	1676 mm
Dummy front seat	ES-2 impact side	WS 50 % impact side, optional WS 50 % on far side (dual occupancy test)	SID IIs impact side
Dummy rear seat		Q10 impact side Q6 far side	SID IIs impact side
Protection Criteria	Head HPC < 1000 Chest VC < 1.0 m/s Rib deflection D < 42 mm Abdomen Σ APF < 2.5 kN Pelvis PSPF < 6.0 kN	➲ page 41 (Adults) ➲ page 109 (Children)	➲ page 53



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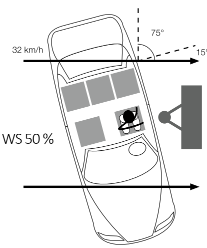
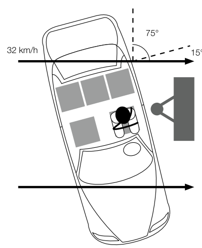
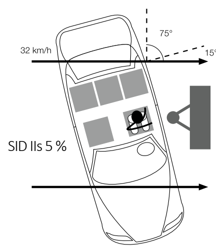
Pole Side Impact Tests according to Euro NCAP, UN R135, GTR 14, FMVSS 214 and CMVSS 214

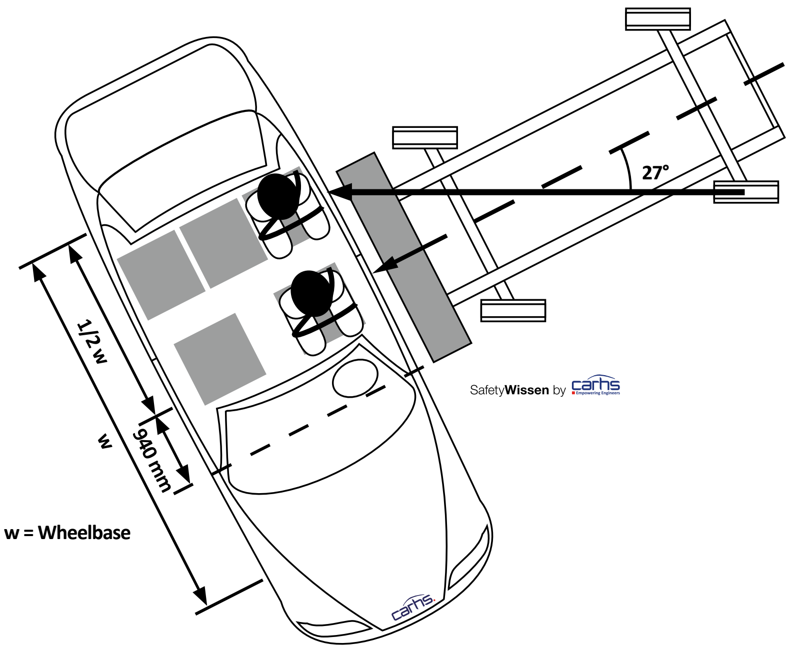
Requirement	Euro NCAP	UN R135 / GTR 14	FMVSS 214 / CMVSS 214	U.S. NCAP
Vehicle Velocity (on Flying Floor)	32 km/h	up to 32 km/h (26 km/h for vehicles up to 1.5 m width[1])	up to 32 km/h	32 km/h
Impact angle	oblique 75° on fixed pole			
Pole diameter	254 mm			
Dummy	WorldSID 50 % on impact side Euro NCAP: optional WS 50 % on far side (dual occupancy test)		ES-2 re or SID IIs (Build Level D) on impact side	SID IIs 5 % on impact side
Protection Criteria	➲ page 41	Head HIC_{36} < 1000 Shoulder $F_{lateral}$ < 3.0 kN Chest deflection < 55 mm Abdomen deflection < 65 mm Lower Spine Acc. < 75 g PSPF < 3.36 kN	SID IIs: HIC_{36} < 1000 Lower Spine Acc. < 82 g Pelvis Force < 5.525 kN ES-2 re: HIC_{36} < 1000 Chest deflection < 44 mm Abdominal Force < 2.5 kN PSPF < 6 kN	➲ page 48
Test Configuration	 SafetyWissen by carhs		 	

[1] GTR 14 only

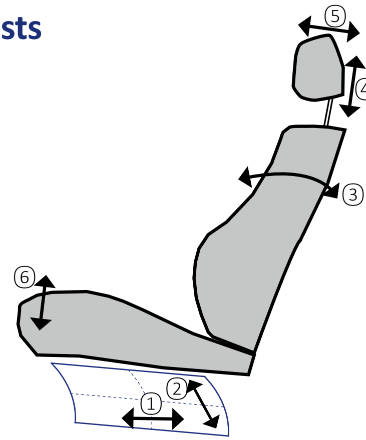
MDB Side Impact Tests according to FMVSS 214, CMVSS 214 and U.S. NCAP

Requirement	FMVSS 214 / CMVSS 214	U.S. NCAP	U.S. NCAP Upgrade[1]
Impact angle	lateral 90°, 27° crab angle		
Impact velocity	53 ±1 km/h (33.5 mph) (~47 km/h in 90° direction)	61.9 ±0.8 km/h (~55 km/h in 90° direction)	
Barrier	NHTSA MDB		
Mass	1368 kg		
Ground clearance	279 mm (bumper 330 mm)		
Upper edge height	838 mm		
Width	1676 mm		
Dummy front seat	ES-2 re impact side	ES-2 re impact side	WorldSID 50 % (SBL F) impact side
Dummy rear seat	SID IIs (Build Level D) impact side	SID IIs (Build Level D) impact side	SID IIs (Build Level D) impact side
Protection Criteria	SID IIs: HIC_{36} < 1000 Chest acceleration < 82 g Pelvis force < 5.525 kN ES-2 re: HIC_{36} < 1000 Chest deflection < 44 mm Abdominal force < 2.5 kN Pelvis force < 6 kN	➲ page 48	Criteria not yet defined

[1] planned



Seat Adjustments for Side Impact Tests



	① Seat Fore/Aft	② Seat Height	③ Seat Back Angle	④ Head Restraint Height	⑤ Head Restraint Fore/Aft	⑥ Seat Base Tilt
Euro NCAP MDB	mid + 20 mm	lowest	manuf. design position or 23°	mid	mid[1]	mid
Euro NCAP Pole	mid + 20 mm passenger[3]: rearmost[4]	lowest	manuf. design position or 23°	mid	mid[1]	mid
UN R95	mid	height of non-adjustable passenger seat or mid	manuf. design position or 25°	top surface level with head COG or uppermost	mid	mid
UN R135	mid + 20 mm	lowest	manuf. design position or 23°	uppermost or manuf. design position.	most rearward	mid
U.S. NCAP / FMVSS 214 ES-2re	mid	lowest[2]	manuf. design position or 25°	uppermost	most forward	„absolute“ mid[2]
U.S. NCAP / FMVSS 214 SID-IIs	most forward position	mid	head at 0°	lowest	most forward	„absolute“ mid[2]
U.S. NCAP / WorldSID 50	mid + 20 mm	lowest[2]	manuf. design position or 25°	uppermost	most forward	„absolute“ mid[2]
ISO WorldSID 50	mid + 20 mm	lowest	manuf. design position or 23°	uppermost or manuf. design position.		

[1] If there is any interference with the rear of the dummy head, move the HR to the most rearward position.
[2] Seat base tilt adjustment ⑥ has priority w. r. t. seat height adjustment ②.
[3] For dual occupancy test to prove that interaction between driver and passenger in side impact is prevented
[4] The head center of gravity must be no further rearward than the pole impact line

Side Impact - Requirements and Development Strategies

Course Description

In addition to the frontal impact, the protection in a side impact has a fixed place in the development of vehicles. Continuous aggravation of consumer tests and legal regulations, due to new pole tests (UN ECE R135 and U.S. NCAP), enhanced deformable barriers and the introduction of World-SID Dummies (5 / 50%ile) with test specific measuring methods are causing a need to further improve side impact protection. In order to achieve this enhancement, it is necessary to get a much more profound understanding of the highly complex phenomena and modes of action in a side impact which goes far beyond the simple application of additional airbags. The seminar provides a comprehensive overview of today's standard test procedures including country-specific variations, the legal regulations and the requirements of consumer protection as well as an outlook on changes in the near future. In addition, tools, measuring methods and criteria, and virtual methods such as crash and occupant simulation, as well as the analysis of the performance of the restraint systems will be discussed. Furthermore it will be explained how a target-oriented use of CAE-simulation and hardware tests can lead to optimal passenger values, while at the same time obeying to boundary conditions such as costs, weight and time-to-market. A workshop with crash-data analysis finally deepens the understanding.

Who should attend?

The seminar addresses development engineers who are new in the field of side crash, or who have already gained some experience in the field of safety, as well as developers of assemblies that have to fulfil a sidecrash-relevant function. Furthermore it is also interesting for project managers and managers, who deal with side impact and who would like to gain a deeper understanding of this topic in order to use it for an improvement of procedures.

Course Contents

- Challenges of side impacts
- Explanation of the different measuring means, in particular the different dummies
- Overview of current test procedures and side impact relevant protection criteria
  - Legal tests (FMVSS 214, UN ECE R95, UN ECE R135, ...)
  - Other tests (Euro NCAP, U.S. NCAP, further NCAPs, IIHS, manufacturer specific tests)
- Development methods and tools:
  - Crash and occupant simulation, range of application and limitations.
  - Analysis of the performance of protection and restraint systems in side impact. Discussion of the boundary conditions, limits, conflicts and problems
  - Development strategy for an optimal restraint system for side impact
  - Target oriented use of CAE-simulation and hardware tests to develop optimal occupant load values
- Workshop with analysis of crash-data and discussion of the results

Instructors

Stephanie Wolter (BMW AG) studied engineering physics at the University of Applied Sciences Munich. Since 1995 she has been working at BMW AG in different functions in the field of side protection, such as pre-development, development of side airbags and as a project engineer in various car lines. Moreover, she represents BMW Group in various national and international bodies that deal with side impact and other aspects of side protection, e. g. ISO Working Groups, etc.

Bart Peeters Weem (BMW AG) studied mechanical engineering at the University of Technology in Eindhoven with focus on system and control. Since 2003 he has worked at BMW on passive safety development. First as Simulation Engineer, later as team leader and project referent. Since 2015 he is head of the development of full vehicle side impact protection for BMW 1-, 2- and 3-series, MINI and BMW-i. In 2019 he was elected as Pilot of the new ACEA-Expertgroup on virtual testing of passive safety.

Dates

DATE	COURSE ID	VENUE	DURATION	PRICE	LANGUAGE
23.-24.04.2020	28/3537	Gaimersheim	2 Days	1.340,- EUR till 26.03.2020, thereafter 1.590,- EUR	German
08.-09.07.2020	28/3538	Alzenau	2 Days	1.340,- EUR till 10.06.2020, thereafter 1.590,- EUR	English
27.-28.10.2020	28/3539	Alzenau	2 Days	1.340,- EUR till 29.09.2020, thereafter 1.590,- EUR	German

Side Impact Protection Criteria Compared

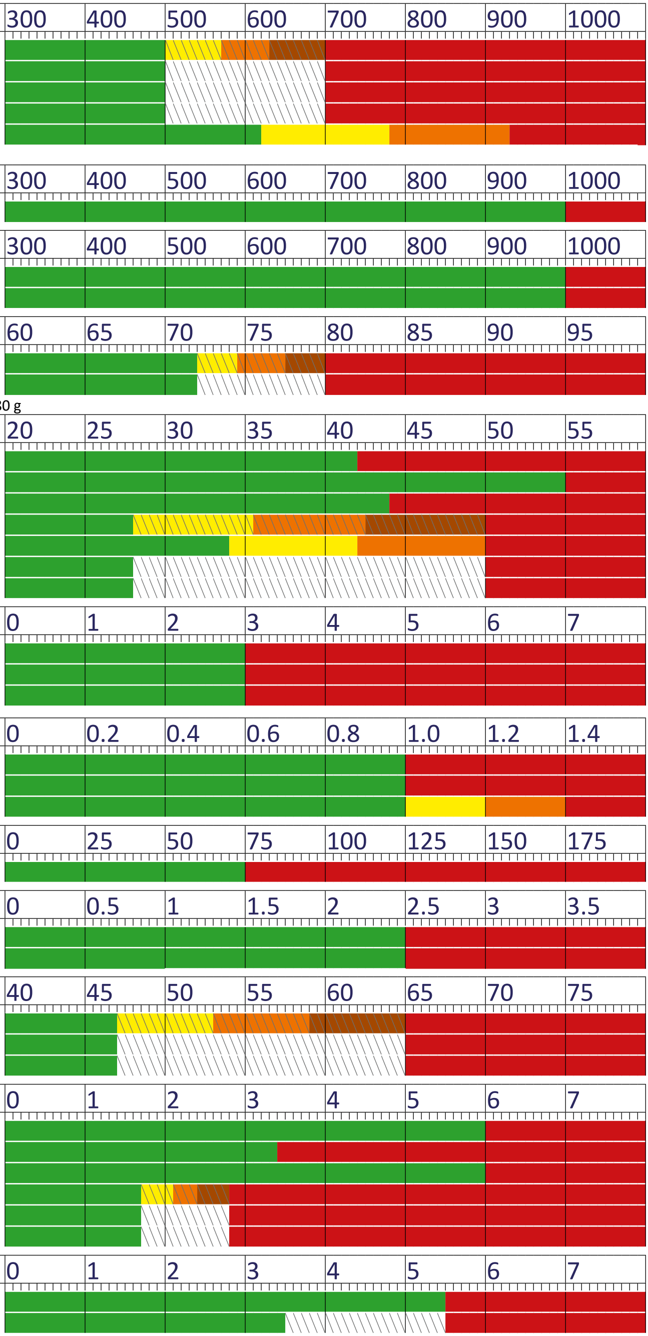
Regulation	Crash	ATD
HIC_{15}		**[-]**
Euro NCAP	MDB/Pole[1]	WS 50
JNCAP	MDB	WS 50
C-NCAP	MDB	WS 50
C-NCAP	MDB	SID 2s
IIHS	MDB	SID 2s

[1] Pole: no sliding scale but capping only for HIC > 700

Regulation	Crash	ATD
HPC		**[-]**
UN R95	MDB	ES-2
HIC_{36}		**[-]**
UN R135	Pole	WS 50
FMVSS 214	MDB/Pole	ES-2/SID 2s
Head a_{3ms}		**[g]**
Euro NCAP	MDB/Pole[2]	WS 50
C-NCAP	MDB	WS 50

[2] Pole: no sliding scale but capping only for $a_{res,\ peak}$ > 80 g

Regulation	Crash	ATD
Chest Compression		**[mm]**
UN R95	MDB	ES-2
UN R135	Pole	WS 50
FMVSS 214	MDB/Pole	ES-2
Euro NCAP	MDB/Pole	WS 50
IIHS	MDB	SID 2s
C-NCAP	MDB	WS 50
JNCAP	MDB	WS 50
Shoulder Lateral Force		**[kN]**
UN R135	Pole	WS 50
Euro NCAP	MDB/Pole	WS 50
C-NCAP/JNCAP	MDB	WS 50
Chest VC_{max}		**[m/s]**
UN R95	MDB	ES-2
C-NCAP	MDB	WS 50
IIHS	MDB	SID 2s
Lower Spine a_{3ms}		**[g]**
UN R135	Pole	WS 50
Abdomen Force		**[kN]**
UN R95	MDB	ES-2
FMVSS 214	MDB/Pole	ES-2
Abdomen Compression		**[mm]**
Euro NCAP	MDB/Pole	WS 50
C-NCAP	MDB	WS 50
JNCAP	MDB	WS 50
PSPF		**[kN]**
UN R95	MDB	ES-2
UN R135	Pole	WS 50
FMVSS 214	MDB/Pole	ES-2
Euro NCAP	MDB/Pole	WS 50
C-NCAP	MDB	WS 50
JNCAP	MDB	WS 50
Pelvis Force		**[kN]**
FMVSS 214	MDB/Pole	SID 2s
C-NCAP	MDB	SID 2s



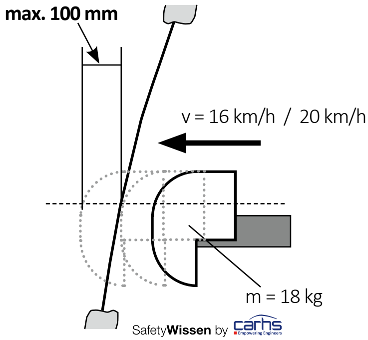
Legend:
- (green) Regulations: requirements are met / NCAP: maximum score
- (red) Regulations: requirements not met / NCAP: zero score
- (hatched) Linear interpolation of the score between the upper and lower limit

Please note that the values indicated in this graph may be rounded and that additional criteria may exist. Please take exact values and additional criteria from the tables for the respective regulation.

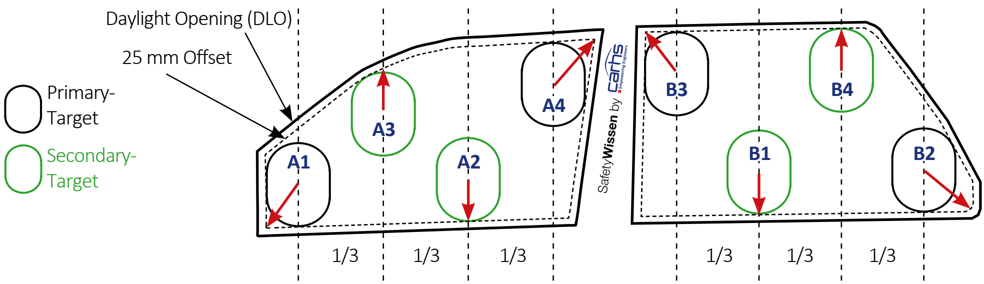
FMVSS 226, CMVSS 226 - Ejection Mitigation

Requirements:

- At up to 4 impact test locations on each side window in the first 3 rows of seats the head excursion may not exceed 100 mm
- Tests at two impact velocities: 16 km/h and 20 km/h
- Head protection systems (e.g. curtain airbags) must be fired before the impact:
  - at 20 km/h with a time delay of 1.5 s prior to the impact
  - at 16 km/h with a time delay of 6 s prior to the impact
- Tests are done without glazing or with pre-damaged glazing
  - pre-damage: perforation in a 75 mm grid pattern
- Valid for vehicles with GVWR ≤ 4536 kg



Locating Targets:



Steps	Front Row Window	Rear Row Windows SafetyWissen by carhs
1	Set Primary Target A1 in lower front corner	Set Primary Target B3 in upper front corner
2	Set Primary Target A4 in upper rear corner	Set Primary Target B2 in lower rear corner
3	Divide horizontal distance between A1 and A4 in thirds	Divide horizontal distance between B3 and B2 in thirds
4	Move A3 at the first third vertically upward	Move B1 at the first third vertically downward
5	Move A2 at the second third vertically downward	Move B4 at the second third vertically upward
6	Measure Distances D_x (horizontal) and D_z (vertical) of the target center points	
7	If D_x (A2 - A3) < 135 mm and D_z (A2 - A3) < 170 mm ⇨ Eliminate A3	If D_x (B1 - B4) < 135 mm and D_z (B1 - B4) < 170 mm ⇨ Eliminate B4
8	If D_x (A4 - A3) (or A2 if A3 was eliminated in step 7) < 135 mm and D_z (A4 - A3/2) < 170 mm ⇨ Eliminate A3/2	If D_x (B3 - B4) (or B1 if B4 was eliminated in step 7) < 135 mm and D_z (B3 - B4/1) < 170 mm ⇨ Eliminate B4/1
9	If D_x (A4 - A2) (or A3 if A2 was eliminated in step 8) < 135 mm and D_z (A4 - A2/3) < 170 mm ⇨ Eliminate A2/3	If D_x (B2 - B1) (or B4 if B1 was eliminated in step 8) < 135 mm and D_z (B2 - B1/4) < 170 mm ⇨ Eliminate B1/4
10	If D_x (A1 - A4) < 135 mm and D_z (A1 - A4) < 170 mm ⇨ Eliminate A4	If D_x (B3 - B2) < 135 mm and D_z (B3 - B2) < 170 mm ⇨ Eliminate B3
11	If only 2 targets remain: Measure absolute distance D the center points of the targets	
12	If D > 360 mm, set additional 3rd target on the center of the line connecting the targets	
13	If less than 4 targets remain, repeat steps 1-12 with the impactor rotated by 90 degrees. If this results in a higher number of targets use the rotated targets.	
14	If no target is found rotate the impactor in 5 degree steps, until it is possible to fit the impactor in the DLO-offset. Then place the center of the target as close to the geometric center of the DLO as possible.	

U.S. Test Procedure TP-226-00, Mar 2011 **CAN. Test Procedure TSD-226 Rev. 0, Nov 2016**

Head Impact on Vehicle Interiors

UN R21

UN R21, 01 Series, Supplement 3

Test Procedure

A pendulum equipped with a spherical impactor (165 mm) hits the interior parts in front of the driver and passenger (side, pedal and steering wheel excluded) with a velocity of 24.1 km/h.

Protection Criteria

$a_{3ms} < 80$ g; no failure of structure and sharp edges in impact zone

Pendulum test is not necessary, if it can be shown that there is no contact between head and the instrument panel in case of a frontal impact.

This can be done by crash tests, sled tests and/or numerical occupant simulation.
(See app. 8 of UN R21)

FMVSS 201U

Test Procedure TP-201U-02, Jan 2016

Test Procedure

A Free Motion Headform (FMH) impactor hits the upper interior parts with a velocity of 24 km/h (A-, B-, C-pillar, roof etc.).

FMH Impactor Data

Mass of FMH impactor: 4.54 kg
Head form according to SAE J 921 and J 977 including triaxial acceleration sensor.

Protection Criteria

HIC Calculation

$$HIC = sup_{t_1,t_2}\left\{\left[\frac{1}{(t_2-t_1)}\int_{t_1}^{t_2} a\,dt\right]^{2,5}(t_2-t_1)\right\}$$

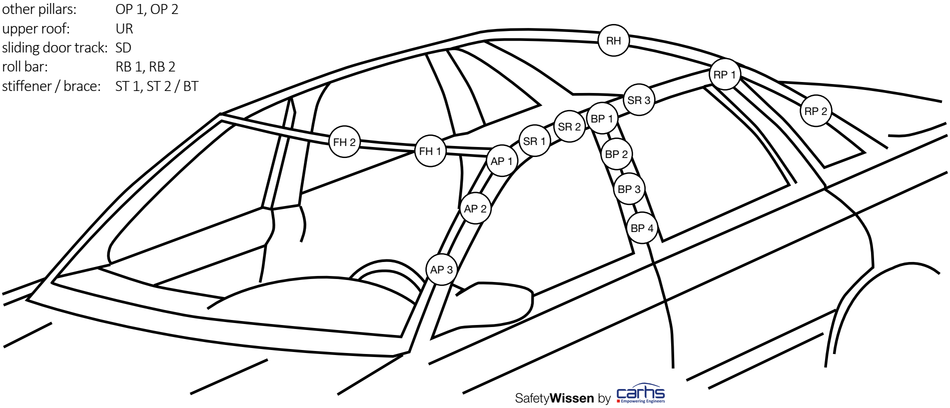
$t_2-t_1 < 36$ ms; a [g]; t [s]

HIC value for FMH $HIC(d) = 0.75446\ HIC + 166.4$

HIC(d) must not exceed 1000.

24 points defined for impact according Test Procedure TP-201U-02 (each side, left and right)

other pillars: OP 1, OP 2
upper roof: UR
sliding door track: SD
roll bar: RB 1, RB 2
stiffener / brace: ST 1, ST 2 / BT



Head Impact on Vehicle Interiors: FMVSS 201 and UN R21

Course Description

To prevent injuries resulting from impacts of the occupants' heads on vehicle interior parts, these parts need to be designed in a way which allows sufficient deformation space to reduce the loads on the head. Internationally there are two important regulations regarding the design of interiors, such as cockpits, roof and door liners: The U.S. FMVSS 201 and the Regulation UN R21. Both regulations stipulate requirements concerning the maximum head acceleration or the HIC in impacts on interior parts.

The objective of this course is to provide an overview of the legal requirements and to show how these can be fulfilled. The focus of the seminar is on the development process and the development tools and methods. In particular the interaction of testing and simulation will be described and different design solutions will be discussed. Typical conflicts of objectives in the design - e.g. to fulfil NVH requirements, static stiffness, or mis-use, while fulfilling the safety standards at the same time - are addressed in this seminar. Examples of practical solutions will be shown and discussed.

In addition, the development according to the head impact requirements in the overall-context of vehicle development is described in this seminar.

In a workshop exemplary head impact locations in a vehicle interior and impact areas on a dashboard are determined.

Who should attend?

This seminar is especially suited for engineers and technicians who work on the development of vehicle interior parts and who want to become familiar with the safety requirements that are relevant for these parts.

Course Contents

- Introduction
- Rules and regulations concerning head impact
  - FMVSS 201
  - UN R21
- Development tools
  - Numerical simulation
  - Test
- Workshop: Determination of impact locations in a vehicle
- Development process and methods
  - Solving of conflicts of objectives
  - Typical deformation paths, padding materials

Instructor

Torsten Gärtner (Opel Automobile GmbH) has been working as a simulation expert since 1997. From numerous projects he has extensive experience in the field of occupant simulation and interior safety. He is Technical Lead Engineer Safety Analytics at Opel Automobile GmbH. Before that he worked as department manager for safety with TECOSIM GmbH and spent 10 years in various management positions with carhs gmbh.

Date

DATE	COURSE ID	VENUE	DURATION	PRICE	LANGUAGE
03.04.2020	46/3531	Alzenau	1 Day	790,- EUR till 06.03.2020, thereafter 940,- EUR	German
19.06.2020	46/3532	Alzenau	1 Day	790,- EUR till 22.05.2020, thereafter 940,- EUR	English
16.10.2020	46/3533	Alzenau	1 Day	790,- EUR till 18.09.2020, thereafter 940,- EUR	German

Test Procedures and Protection Criteria for Pedestrian Protection

Test Method	Parameter	Euro NCAP / ANCAP U.S. NCAP[8] max. score	Euro NCAP / ANCAP U.S. NCAP[8] zero score	JNCAP max. score	JNCAP zero score	KNCAP C-NCAP max. score	KNCAP C-NCAP zero score	EU Regulations 78/2009 and 631/2009 Phase 2	UN R127 KMVSS 102-2	GTR No. 9	Japan Article 18 Attachment 99
1 Adult Headform 4.5 kg Ø 165 mm	α_A (°)	65		65		65		65	65	65	65
	V_A (km/h)	40		40		40		35	35	35	35
	WAD (mm)	1700 (1500)[1] - 2100		1700 - 2100		1700 - 2100		1700 - 2100[10]	1700 - 2100[10]	1700 - 2100[10]	1700 - 2100
	on Windscreen	yes		yes		yes		no	no	no	no
	HPC/HIC (-)	650	1700	650	1700	650	1700	1000 / 1700[3]	1000 / 1700[3]	1000 / 1700[3]	1000 / 1700[3]
2 Child Headform 3.5 kg Ø 165 mm	α_C (°)	50		50 (20[2])		50		50	50	50	50
	V_C (km/h)	40		40		40		35	35	35	35
	WAD (mm)	1000 - 1700 (1500)[1]		1000 - 1700		1000 - 1700		1000 - 1700[10]	1000[9] - 1700[10]	1000 - 1700[10]	1000 - 1700
	on Windscreen	yes		yes		yes		no	no	no	no
	HPC/HIC (-)	650	1700	650	1700	650	1700	1000 / 1700[3]	1000 / 1700[3]	1000 / 1700[3]	1000 / 1700[3]
3 Upper Legform 10.5 kg	α_U (°)	90 w.r.t. IBRL[4] - WAD 930									
	V_U (km/h)	20 - 33									
	Sum of forces (kN)	5 kN	6 kN								
	Bending Moment (Nm)	285 Nm	350 Nm								
4 Lower Legform[7]	Legform	Flex PLI		Flex PLI		Flex PLI		EEVC	Flex PLI	Flex PLI	Flex PLI
	V_L (km/h)	40		40 (44)[5]		40		40	40	40	40
	Ground clearance d (mm)	75		75		75		25	75	75	75
	Acceleration (g)							170 (250)[6]			
	Bending angle (°)							19			
	Shearing (mm)							6			
	Tibia Bending (Nm)	282	340	202	306	282	340		340 (380)[6]	340 (380)[6]	340 (380)[6]
	MCL Elongation (mm)	19	22	14.8	19,8	19	22		22	22	22
	ACL/PCL Elongation (mm)	10	10	0	13	10	10		13	13	13
5 Upper Legform[7] 9.5 kg	V_L (km/h)	40				40		40	40	40	40
	Sum of forces (kN)	5	6			5	7.5 / 6[11]	7.5	7.5	7.5	7.5
	Bending Moment (Nm)	285	350			300 / 285[11]	510 / 350[11]	510	510	510	510

1 Points to be tested that lie between WAD 1500 and 1700 are tested with child-/small adult headform impactor, if the points are on the moveable/hinged bonnet top. Otherwise the adult headform is used.
2 Between "Blue Line" and 1000 mm
3 The HPC shall not exceed 1000 over one half of the child headform test area and, in addition, shall not exceed 1 000 over 2/3 of the combined child and adult headform test areas. The HPC for the remaining areas shall not exceed 1700 for both headforms.
4 IBRL = Internal Bumper Reference Line
5 Test velocity will be increased when leg impact is introduced in legal test.
6 In an area no wider than 264 mm.
7 For vehicles with a lower bumper height < 425 mm the lower legform test 4 is applied. For vehicles with a lower bumper height ≥ 500 mm the upper legform test 5 is applied. For vehicles with a lower bumper height ≥ 425 mm an < 500 mm the impactor is at the choice of the manufacturer.
8 Proposed U.S. NCAP rating
9 Minimum 82.5 mm rearward of Bonnet Leading Edge
10 Maximum 82.5 mm forward of Bonnet Rear Reference Line
11 C-NCAP

15th PraxisConference
Pedestrian Protection

The PraxisConference Pedestrian Protection is held every June or July with about 170 participants, including delegates from all major OEMs. It is the world's largest expert meeting in the field of pedestrian protection. The intensive discussions at the info-points and between the presentations show that the participants value the innovative conference concept. Highlights of the event are the demonstrations in the laboratory of Germany's Federal Highway Research Institute and the OEM's presentations of pedestrian protecting solutions implemented in current car models.

Although the industry has been working on pedestrian protection for many years now, the constant development of the requirements (regulations and NCAP) continuously raises new questions that will be answered during this conference.
Expert speakers provide concentrated information regarding current and future requirements, latest research findings and technical solutions. Both, testing and numerical simulation are covered in the conference presentations.
In addition to this the conference offers hands-on praxis session in the laboratory. Here, test equipment and impactors are demonstrated and explained in detail. The preparation, execution and analysis of pedestrian impact tests are shown in live demonstrations.

Conference Topics:

- Current status and future development of the regulations (UN R127, GTR 9)
- Global consumer protection requirements for pedestrian protection
- Future development of impactors (e.g. aPLI)
- Pedestrian, Cyclist and PTW AEB systems
- Pedestrian safety technologies (active bonnets, airbags)
- Test equipment

Who should attend?

The PraxisConference is suited for pedestrian protection experts from throughout the industry. Even beginners will find the event an excellent opportunity to quickly acquire theoretical and practical knowledge and become part of the expert community.

FACTS

DATE	24.-25. June 2020
HOMEPAGE	www.carhs.de/pkf
VENUE	Bundesanstalt für Straßenwesen, Brüderstraße 53, 51427 Bergisch Gladbach
LANGUAGE	German with translation into English
PRICE	1.490,- EUR till 27.05.2020, thereafter 1.750,- EUR

Co-hosted with

BGS Böhme & Gehring GmbH

SAFETY WISSEN

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Pedestrian Protection

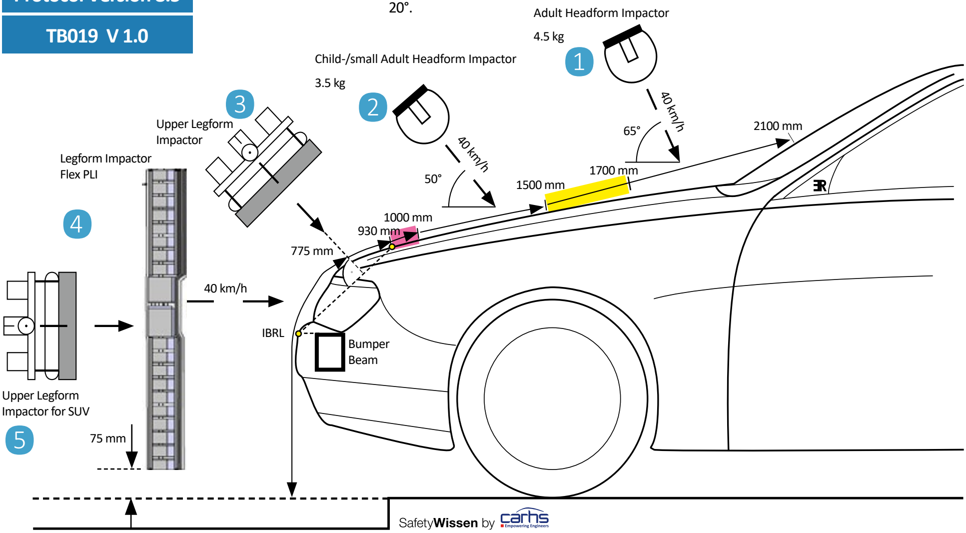
Pedestrian Protection Test Procedures in Euro NCAP / ANCAP

Protocol Version 8.5

TB019 V 1.0

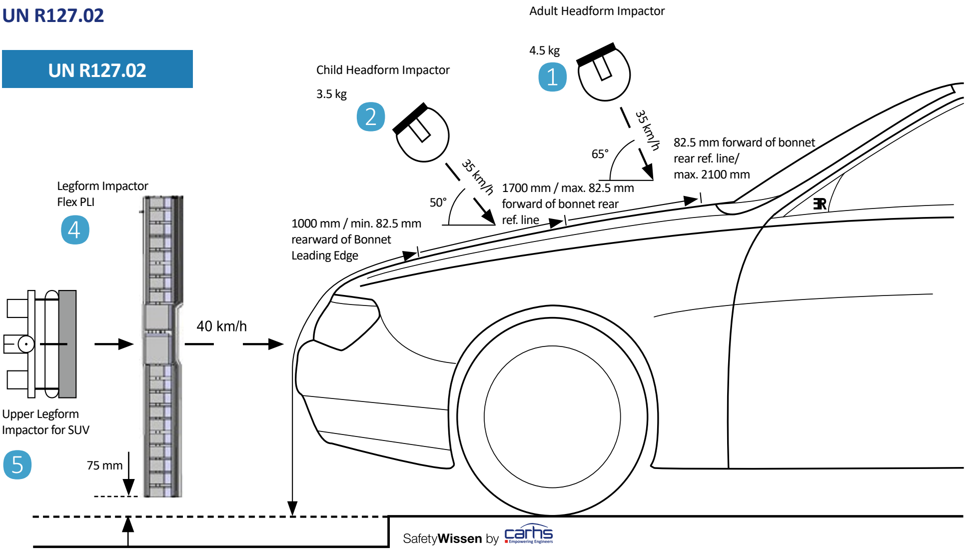
Where the bonnet leading edge reference line (BLERL) is located between WAD 930 mm and WAD 1000 mm, an additional test with the child headform will be performed on the BLERL at a speed of 40 km/h under 20°.

Points to be tested that lie between WAD 1500 und 1700 are tested with child-/small adult headform impactor, if the points are on the moveable/hinged bonnet top. Otherwise the adult headform is used.



Pedestrian Protection Test Procedures according to UN R127.02

UN R127.02



Euro NCAP / ANCAP Pedestrian Protection: Head and Leg Impact Grid Method

Head Impact

Between WAD 1000 and WAD 2100 impact points are located on a fixed 100 mm grid, the selection of "Worst Case" points by the test institute is no longer required. The manufacturer provides a result prediction (points) for the Grid-Points. Euro NCAP verifies 10 randomly selected points, the manufacturer can nominate up to 10 additional randomly selected points. A tolerance of 10 % is applied to the verification tests, i.e. even if the actual HIC is 10 % above or below the margins of the predicted score, the predicted score is applied. At the verification points the actual test result is divided by the manufacturer's prediction. This so called correction factor is applied to all the grid points to obtain the final score:

$$\frac{\text{Actual tested score}}{\text{Predicted score}} = \text{Correction Factor}$$

Per Grid-Point 0 - 1 points are available according to the following scheme:

	HIC_{15}	< 650	1.00 Point
650 ≤	HIC_{15}	< 1000	0.75 Points
1000 ≤	HIC_{15}	< 1350	0.50 Points
1350 ≤	HIC_{15}	< 1700	0.25 Points
1700 ≤	HIC_{15}		0.00 Points

„Default" Results

Grid points on the A-pillars are defaulted to red = 0 points. Grid points on the windscreen that have distance of more than 165 mm from the windscreen base are defaulted to green = 1 point. Defaulted locations are not included in the random selection of verification tests. Where the vehicle manufacturer can provide evidence that shows an A-pillar is not red, those grid points will be considered in the same way as other points.

Unpredictable Grid Locations: Blue Zones

In the following areas

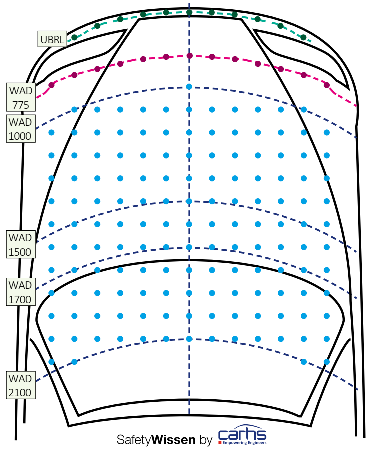
- Plastic scuttle
- Windscreen wiper arms and windscreen base
- Headlamp glazing
- Break-away structures

the manufacturer may define a "blue zone" consisting of up to 2 adjacent grid points, for which no prediction is made. A maximum of eight zones may be blue over the entire Headform impact area.

The laboratory will choose one blue point to assess each zone. The test results of blue points will be applied to all the grid point(s) in each zone.

Assessment Protocol Version 10.0.3

Testing Protocol Version 8.5



Total Score:

The total score will be calculated as follows:

	∑Predicted Score x Correction Factor
+	∑Default Scores
+	∑Scores from Blue Zones
=	Total
÷	Number of Grid Points
=	Percentage of max. achievable score
x	24 (Maximum achievable score)
=	Total Score for Headform Test

Leg Impact

For leg impact a 100 mm grid on WAD 775 (Upper Legform) respectively on Upper Bumper Reference Line (Flex PLI Legform) is used. Euro NCAP selects either the centerline point or an adjacent point as a starting point for testing. Starting from this position every second grid point will be tested. Symmetry is applied across the vehicle. Grid points that have not been tested will be awarded the worst result from one of the adjacent points. Manufacturers may sponsor additional test for those points that are not tested (in advance). Per Grid point up to 1 point is awarded. For the Upper Legform the score is based upon the worst performing parameter (Sum of Forces / Bending moment). For the Legform the 1 point per grid point is divided into two independent assessment areas of equal weight (0.5 Pts. / each): Tibia moments and ligament elongations.

Total Score:

The total score for the Upper/Lower Legform tests will be calculated as follows:

	∑Scores of all Grid Points
÷	Number of Grid Points
=	Percentage of max. achievable score
x	6 (Maximum achievable score)
=	Total Score for Legform Test

more about the impactors ➲ page 124

Pedestrian Protection - Development Strategies

Course Description

Euro NCAP annually adjusts details in its pedestrian rating protocols and even U.S. NCAP plans to introduce a pedestrian protection assessment. Stricter injury criteria, modified testing areas and the testing of vehicles that were previously not tested because of their weight, require the thorough knowledge of the requirements and a strict implementation of the requirements in the development process. In the introduction the seminar informs about the different impactors that are used for pedestrian safety testing. Thereafter the various requirements (regulations and consumer tests) are explained and compared. The focus of the seminar is on the development strategy: Which decisions have to be taken in which development phase? What are the tasks and priorities of the person in charge of pedestrian protection? As a background, ideas and approaches towards the design of a vehicle front end in order to meet the pedestrian protection requirements are discussed. In addition to that, the seminar explains how the function of active bonnets can be proven by means of numerical simulation. This includes both, the pedestrian detection that need to be proven with various impactors or human models, as well as the proof that the bonnet is fully deployed at the time of impact.

Who should attend?

The seminar is intended for development, project or simulation engineers working in the field of vehicle safety, dealing with the design of motor vehicles with regard to pedestrian protection.

Course Contents

- Introduction with an overview of current requirements regarding pedestrian protection
  - Legal requirements (EU, UN Regulations, Japan, GTR)
  - Consumer tests (e. g. Euro NCAP, U.S. NCAP, JNCAP, KNCAP)
- Presentation and discussion of the design and application of the impactors
  - Leg impactors (Flex PLI, Upper Legform, aPLI)
  - Head impactors (Child head, Adult head)
- Methods in numerical simulation, testing and system development
- Requirements on the design of vehicle front ends for pedestrian protection
- Development strategy
  - Interaction between simulation and testing
  - Integration in the vehicle development process
- Solutions to fulfill the requirements
  - Passive solutions
  - Active solutions (active bonnets, airbags)

Instructor

Maren Finck (carhs.training gmbh) is a Project Manager at carhs.training gmbh. From 2008 - 2015 she worked at EDAG as a project manager responsible for passive vehicle safety.

Previously, she worked several years at carhs GmbH and TECOSIM as an analysis engineer with a focus on pedestrian safety and biomechanics.

Date

DATE	COURSE ID	VENUE	DURATION	PRICE	LANGUAGE
17.02.2020	152/3576	Gaimersheim	1 Day	790,- EUR till 20.01.2020, thereafter 940,- EUR	
05.10.2020	152/3577	Alzenau	1 Day	790,- EUR till 07.09.2020, thereafter 940,- EUR	
23.11.2020	152/3578	Alzenau	1 Day	790,- EUR till 26.10.2020, thereafter 940,- EUR	

Whiplash Requirements Front Seats

	Requirement	FMVSS 202a		Euro NCAP	IIHS/ IIWPG/ C-IASI	JNCAP	C-NCAP	ANCAP	KNCAP
	Applicable in								
	Option	static	dynamic						
STATIC REQUIREMENTS	Geometrical Measurements	■		■	■			■	■
	Backset	■		■	■			■	■
	Horizontal Load App. (Backward Displacement)	■							
	Vertical Load App. (Height Retention)	■							
	Integrated/Fixed HR, no Height Lock Modifier								■
	Minimum Height	■							
	Minimum Width	■	■						
	Gaps	■							
	Energy Absorption (Pendulum Test)	■							
	Head Interference Space of Head Restraint						■		
DYNAMIC REQUIREMENTS	ATD		H III	BioRID	BioRID	BioRID	BioRID	BioRID	BioRID
	Delta Theta		■						
	HIC_{15}		■						
	Head Contact Time HCT			■[1]	■			■	■
	Head Rebound Velocity			■[1]				■	■
	Upper Neck Force F_{X+}			■	■	■	■	■	■
	Upper Neck Force F_{Z+}			■	■	■	■	■	■
	NIC			■		■	■	■	■
	Nkm			■[1]				■	■
	T1 Acceleration			■[1]	■			■	■
	Seatback Deflection Angle			■[1]			■	■	
	Dummy Artefact Modifier			■				■	
	Seat Track Dynamic Displacement						■		
	Upper Neck Tension F_Z + UN Momentum My			■					
	Lower Neck Force F_{X+}			■[1]		■	■		
	Lower Neck Force F_{Z+}					■	■		
	Upper Neck Momentum M_Y			■[1]		■	■		
	Lower Neck Momentum M_Y			■[1]		■	■		

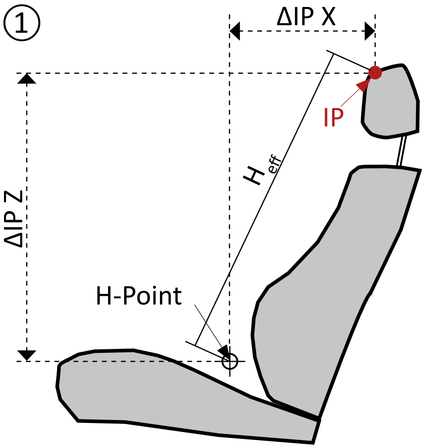
This table is based on material generated by: LEAR Whiplash Applied Research Group

[1] Capping only

Euro NCAP / ANCAP Rear Seat Whiplash Assessment

Assessment Protocol Version 9.1.2

Testing Protocol Version 1.1

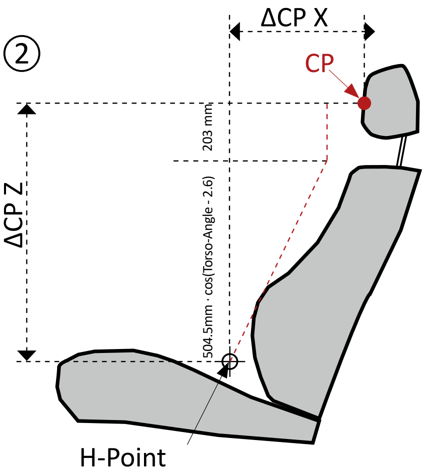


① Effective Height H_{eff} requirements for the headrest:

in highest position ≥ 770 mm
<u>and</u>
in worst case position ≥ 720 mm

Calculation of H_{eff}:
H_{eff}= ΔIP X · sin (Torso-Angle) + ΔIP Z · cos (Torso-Angle)
IP: Intersection Point

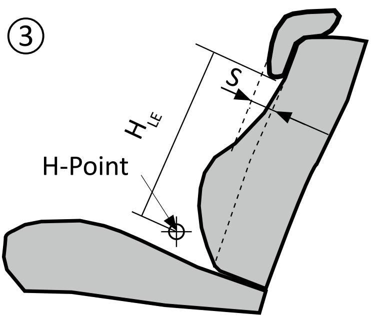
Determination of IP X and IP Z:
IP X = 88.5 · sin (Torso-Angle- 2.6) + 5 + CP X
IP Z = uppermost intersection of the headrest contour in the seat centerline with a vertical line through IP X



② Backset ΔCP X requirements for the headrest

in mid position
<u>and</u>
in worst case position:

ΔCP X ≤ 7.128 · Torso-Angle + 153
CP: Contact Point



③ Requirements for the non-use position of the headrest:

1) Automatic Return Head Restraint, or
2) > 60° rotation of the headrest in non-use position, or
3) Δ Torso-Angle use / non-use > 10°, or
4) Height of lower edge of the headrest H_{LE}:
   250 mm ≤ H_{LE} ≤ 460 mm
   with H_{LE} = ΔX · sin (Torso-Angle) + ΔZ · cos (Torso-Angle), or
5) Thickness of the lower edge of the headrest S ≥ 40 mm

Score if the Requirements (see above) are met:

The outboard seating positions of rear seating rows are assessed. Any centre seating position needs to comply with the requirements of UN R17.08.

Parameter	Points per seat
① H_{eff}	1.5
② ΔCP X_{mid}	1*
② ΔCP $X_{worstcase}$	0.5*
③ Non-Use	1*
max. total	4
Scaling	1/8n (n = number of seats)

* only if H_{eff} requirements are met

Euro NCAP / ANCAP Front Seat Whiplash Assessment

Assessment Protocol Version 9.1.2 **Testing Protocol Version 4.1**

Dynamic Assessment

Whiplash Test	Medium Severity Pulse			High Severity Pulse		
SafetyWissen by carhs	Higher Limit	Lower Limit	Capping Limit	Higher Limit	Lower Limit	Capping Limit
NIC	11.00	24.00	27.00	13.00	23.00	25.50
Nkm			0.69			0.78
Rebound velocity (m/s)			5.2			6.0
Upper Neck $F_{x,shear(+ve)}$ (N)	30	190	290	30	210	364
Upper Neck $F_{x,shear(-ve)}$ (N)			360			360
Upper Neck $F_{z,tension}$ (N)	360	750	900	470	770	1024
Upper Neck $M_{y,extension+flexion}$ (Nm)			30			30
Lower Neck $F_{x,shear(ABS)}$ (N)			360			360
Lower Neck $M_{y,extension+flexion}$ (Nm)			30			30
T1 acceleration (g)			15.55			17.80
T-HRC (ms)			92			92
Seatback Deflection (°)						32

* All parameters, except rebound velocity, are calculated until THRC-end (= End of Head Restraint Contact Time).

If the Higher Performance Limit is reached, **1 point** is awarded **per criterion**. A sliding scale is used between Higher and Lower Performance Limit (1 .... 0 points). If the capping limit is exceeded by one criterion, the entire test is rated with zero points.

Modifiers

Seatback Dynamic Deflection: A **-3 point** modifier will be applied where the seat has a dynamic deflection ≥ 32° in the high severity pulse test.

Dummy Artefact Loading: A **-2 point** modifier will be applied as a means of penalizing any seat that, by design, places unfavorable loading on other body areas or exploits a dummy artefact.

Static Assessment

	Head Restraint Geometry in Test Position (mid range locking position)		Head Restraint Geometry in Worst Case Position (= lowest & rearmost)
	Higher Limit	Lower Limit	Limit
Score	+1 Point	-1 Point	+1/n Points per front seat (n = number of front seats)
Effective Height (mm)	825	755	> 790
Backset (mm)	< 45	≥ 45	< 70

The assessments are based on the worst performing parameter from either the height or backset.

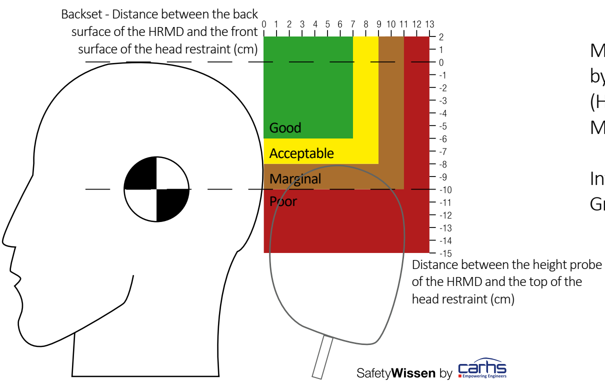
Overall Rating

For the overall rating the total of max. 8 points (3 per pulse + 1 Geometry + 1 Worst Case Geometry) is scaled by the factor 0.375 to a maximum of 3 points and is part of the Adult Occupant Protection rating.

Static Geometry Assessment by IIWPG / IIHS

RCAR Version 3 (Mar 2008)

IIHS Version V (Dec 2019)



Measurement of the head restraint position by a „Head Restraint Measuring Device“ (HRMD) and rating as Good, Acceptable, Marginal or Poor.

International Insurance Whiplash Prevention Group (IIWPG)

Learn more about IIHS's static and dynamic assessment ➲ page 52

SafetyWissen by carhs

Whiplash Testing and Evaluation in Rear Impacts

Course Description

In real-world accidents, distortions of the cervical spine or so-called whiplash injuries following a rear impact are among the most expensive injuries for the insurance industry. About 75 % of all injury costs of the insurers are caused by whiplash injuries in highly-motorized countries. About 80 % of all injuries in a rear impact are whiplash-injuries. This is why this type of injury - even though it is neither very serious nor lethal - has reached a high priority in the endeavors to develop test procedures and assessment criteria which help in designing constructive measures in the car in order to avoid this type of injury. As an introduction, this seminar refers to the different accident data for whiplash injuries, which offer many realizations but no consistent pattern with regard to the biomechanical injury mechanisms. However, some organizations - mainly from the field of consumer information and insurance institutes - are working on the development of test procedures and assessment criteria. The most active ones are Thatcham (UK) and IIHS (USA) which are united in the group IIWPG (International Insurance Whiplash Prevention Group), SNRA and Folksam (Sweden) and the German ADAC. In 2008 Euro NCAP has introduced a whiplash test procedure as part of its rating system. In 2014 an additional static assessment for the rear seats was added. In 2020 Euro NCAP applies a new Whiplash assessment on front seats. Where concepts and methods from the future legal requirement the Global Technical Regulation No. 7 Phase II (Head Restraints) can be recognized. The Euro NCAP assessment will be explained in detail in the seminar. Furthermore, the EEVC working group 20 is active as a consulting authority concerning whiplash injuries for the legislation in Europe. The Global Technical Regulation No. 7 Phase I (Head Restraints, short GTR 7) is unsatisfactory from the European point of view. Therefore the United Nations work on a second phase of this regulation. The content of the GTR 7 Phase II gives the legal base for the future HR development requirements. The focus of this work is on improving the BioRID dummy and on the definition of so called Seat Performance Criteria. All discussions about the assessment of whiplash injuries within the framework of consumer information have in common, that the protection effect in a rear-end impact needs to be examined in an isolated vehicle seat by means of a sled test using a generic acceleration pulse. It turns out to be problematic, however, that presently there is no traumato-mechanical explanation of the phenomenon "whiplash injury" and that all the currently discussed dummy criteria with the respective limit values follow a so-called "black-box approach". Experts try to correlate the measured dummy criteria with the findings from accident data and to thus derive limit values. In this context the available dummy-technology with the different measuring devices and criteria, as well as the proposed limit values are going to be presented. In the last part of the seminar different seat design concepts (energy-absorbing, respectively geometry-improving), subdivided into active and passive systems will be introduced, and their advantages and disadvantages will be discussed.

Who should attend?

The seminar addresses development engineers who are new in the field of rear impacts or who have already got some experience in the field of safety, as well as developers of subassemblies which have to fulfill a crash-relevant function. It is furthermore especially interesting for project managers and managers who deal with the topic of rear-end impacts and who would like to obtain a better knowledge of this subject in order to use it for an improvement of procedures.

Course Contents

- Introduction into the characteristics of a rear-end impact
- Overview of the most important whiplash requirements
- Injury criteria
- Dummy-technology for rear impacts
- Presentation of the Euro NCAP and FMVSS 202-dynamic test procedures
- Outlook on possible harmonization-tendencies
- Explanation of the possible design measures in car seats

Instructor

Thomas Frank (LEAR Corporation GmbH) joined the passive safety department of LEAR Corporation in 2002 after graduating from the Technical University of Berlin in physical engineering sciences. At LEAR Thomas Frank initially worked as a test engineer in crash testing, later he developed head rests. Today he is expert for head restraints and low speed rear impact safety. In his position he guides the seat development with respect to meet whiplash protection requirements in regulations and consumer tests.

Date

DATE	COURSE ID	VENUE	DURATION	PRICE	LANGUAGE
12.02.2020	50/3551	Alzenau	1 Day	790,- EUR till 15.01.2020, thereafter 940,- EUR	
16.09.2020	50/3552	Alzenau	1 Day	790,- EUR till 19.08.2020, thereafter 940,- EUR	

Euro NCAP / ANCAP Child Occupant Protection

Test Protocol Version 7.3 | **Assessment Protocol Version 7.3**

Dynamic Assessment

max. 49 points

Testing:

Q6: The Q6 dummy shall be seated in an appropriate CRS for a six year old child or a child with a stature of 125 cm. This will be either the CRS recommended by the vehicle manufacturer, or if there is no recommendation, a suitable CRS from the top pick list.

Q10: The Q10 dummy shall be seated on a booster cushion only. This will be the booster cushion recommended by the vehicle manufacturer. Where the vehicle manufacturer recommends a high back booster with detachable backrest it will be used without backrest. If there is no recommendation for a booster cushion, one will be chosen by Euro NCAP from a list of suitable options contained in the Technical Bulletin TB012.

Preconditions: Where any of the following events occur zero points will be awarded to the dummy.

Frontal impact: During the forwards movement of the dummy only, the diagonal belt slips off the shoulder.

Frontal impact: The pelvis of the dummy submarines beneath the lap section of the belt or the lap section does not prevent the dummy from moving upwards during rebound and is no longer restraining the pelvis.

Frontal and side impacts: The dummy pelvis does not remain in the booster seat / cushion and is not correctly restrained by the lap section of the seatbelt.

Frontal and side impacts: CRS does not remain within the same seating position or is no longer correctly restrained by the adult belt.

Frontal and side impacts: There is any breakage or fracturing of load-bearing parts of the belt system including buckles, webbing and anchorage points.

Frontal and side impacts: There is any breakage or fracturing of any seat belt lock-offs, tethers, straps, ISOFIX anchorages or any other attachments which are specifically used to anchor the CRS to the vehicle fail.

Modifier: If, during the forwards movement of the dummy, the diagonal belt moves into the gap between the clavicle and upper arm with folding of the belt webbing, a penalty of **-4 points** will be applied to the overall dummy score of the impact in which it occurs.

	Dummy	Region	Points	Criteria
max. 24 points	**Frontal Impact (MPDB)**			
	Q6 / Q10	Head	4	HIC_{15}[1] ≤ 500; a_{3ms} ≤ 60 g
			0 + Capping	HIC_{15}[1] ≥ 700; a_{3ms} ≥ 80 g
			-2 (Modifier[2])	Head forward excursion > 450 mm
			-4 (Modifier)	Head forward excursion > 550 mm
		Upper Neck	2	F_z ≤ 1.7 kN
			0	F_z ≥ 2.62 kN; My ≥ 36 (Q6) / 49 (Q10) Nm
		Chest	2	a_{3ms} ≤ 41 g (Q10); Deflection ≤ 30 mm (Q6)
			0 + Capping[3]	a_{3ms} ≥ 55 g (Q10); Deflection ≥ 42 mm (Q6)
	Side Impact (MDB)			
	Q6 / Q10	Head	2	HIC_{15}[1] ≤ 500, a_{3ms} ≤ 60 g
			0 + Capping	HIC_{15}[1] ≥ 700 (capping: 800), a_{3ms} ≥ 80 g
		Upper Neck	1	F_{res} < 2.4 kN (Q6); F_{res} < 2.2 kN (Q10)
			0	F_{res} ≥ 2.4 kN (Q6); F_{res} ≥ 2.2 kN (Q10)
		Chest	1	a_{3ms} < 67 g
			0	a_{3ms} ≥ 67 g

Installation of CRS

max. 12 pt.	Universal CRS	points	4
	ISOFIX CRS	points	2
	i-Size CRS	points	4
	manufacturer recommended CRS	points	2

Vehicle Based Assessment

Preconditions:

Provision of three-point seat belts on all passenger seats

Tables in the vehicle handbook stating clearly, which seating positions are suitable or not suitable for Universal / ISOFIX / i-Size CRS

Where a passenger frontal airbag is fitted (both front and rear seats if applicable), the CRS tables in the vehicle handbook must clearly indicate that when these passenger airbags are active the seat is NOT suitable for any rearward facing CRS.

max. 13 points	Compatibility of the 2nd row outboard seats with Gabarit according to UN ECE R16 Annex 17 - Appendix 1	points	1
	Compatibility of all other passenger seats with Gabarit according to UN ECE R16 Annex 17 - Appendix 1	points	1
	2 seats with i-Size & TopTether marking (for ISO/B2 i-Size fixture defined in UN ECE R16 sup. 9)	points	2
	3 independent seats with i-Size and TopTether marking	points	1
	2 or more seating positions are suitable for fully independent use with the largest size of rearward facing (Class C) ISOFIX CRS, Fixture (CRF) ISO/R3,	points	1
	passenger airbag warning marking and manual / automatic disabling	points	2 / 4
	integrated CRS	points	1 (1 CRS) / 3 (2 or more CRS)

[1] HIC_{15} is only applied if there is hard head contact, otherwise the score is based on a_{3ms} only
[2] Q10 only
[3] capping applied for Q10 a_{3ms} only

Latin NCAP Child Occupant Protection

Protocol 2020 V1.1.2

Requirements for points for Child Protection Rating: Child seats (CRS) for 1½ & 3 y/o children must be recommended by the vehicle manufacturer. CRS must be available for purchase from dealers in the 3 big Latin NCAP markets (AR, BR, MX) and in every other market where the vehicle is sold. CRS must be available at the 3 most important cities of each of the 3 big markets in at least 2 retailers per city. CRS manufacturer must be officially represented in each of the 3 big markets.

	Dynamic Assessment		Dummy	Q1½		Q3	
max. 49 points	**Requirements for Points in Dynamic Assessments:** no partial or full ejection of child dummy out of CRS / CRS must not be partially or wholly unrestrained by any of the vehicle interfaces						
	Head Contact with the vehicle: any head contact with the vehicle results in 0 points for the head performance						
max. 16 points	Frontal Impact						
	Head		points	4	0	4	0
worst score from	**no head contact with CRS** **head contact with CRS**	no direct evidence + Head a_{res} peak Head $a_{res\ 3ms}$	g	< 80 ≤ 72	≥ 88	< 96 ≤ 87	≥ 100
	Forward Facing CRS		points	4	0	4	0
	forward head excursion	relative to Cr point	mm	≤ 549	≥ 550	≤ 549	≥ 550
	Rearward Facing CRS		points	4	0	4	0
	head exposure	no compressive load on top of head, head fully contained within CRS		no exposure	exposure	no exposure	exposure
			points	2	0	2	0
	Neck	upper Neck F_z	kN	≤ 1.7	≥ 2.62	≤ 1.7	≥ 2.62
	Chest	$a_{res\ 3ms}$	g	≤ 41	≥ 55	≤ 50	≥ 66
max. 8 points	Side Impact						
	Requirements for Points in Side Impact: head containment within shell of CRS, also there must be no fracturing of the CRS						
	Head		points	4	0	4	0
	no head contact with CRS **head contact with CRS**	no direct evidence + Head a_{res} peak Head $a_{res\ 3ms}$	g	< 80 ≤ 72	≥ 88	< 80 ≤ 72	≥ 88
	Installation of CRS						
12	CRS from the reference list		points	10			
	CRS recommended by the manufacturer		points	2			
	Vehicle Based Assessment						
max. 13 points	provision of three-point seat belts		if any passenger seat is not equipped with a 3 point belt 0 points are awarded for the vehicle based assessment				
	compatibility of all passenger seats with Gabarit according to UN ECE R16.05		points	2			
	3 seating positions that can simultaneously accommodate any reference list CRS		points	1			
	3 seating positions that can simultaneously accommodate i-Size CRS		points	1			
	2 passenger seats equipped with ISOFIX according to UN ECE R14		points	1			
	+ these 2 passenger seats meet i-Size requirements		points	+1			
	2 seating positions comply with requirements for largest size of rearward facing ISOFIX seats		points	1			
	no passenger airbag		points	2			
	passenger airbag warning and disabling		points	max. 4			
	1 integrated CRS		points	1			
	1 integrated "Group I-III" CRS		points	1			

ASEAN NCAP Child Occupant Protection 2021 - 2025

Protocol Version 2.0

	Dynamic Assessment: Frontal Impact		Dummy	Q1½		Q3	
max. 51 points / max. 16 points	**Head**		points	4	0	4	0
worst score from	**no head contact with CRS** **head contact with CRS**	no direct evidence + Head a_{res} peak Head $a_{res\ 3ms}$	g	< 80 ≤ 72	≥ 88	< 96 ≤ 87	≥ 100
	Forward Facing CRS		points	4	0	4	0
	forward head excursion	relative to Cr point	mm	≤ 549	≥ 550	≤ 549	≥ 550
	Rearward Facing CRS		points	4	0	4	0
	head exposure	no compressive load on top of head, head fully restrained within CRS		no exposure	exposure	no exposure	exposure
			points	2	0	2	0
	Neck	upper Neck F_z	kN	≤ 1.7	≥ 2.62	≤ 1.7	≥ 2.62
	Chest	$a_{res\ 3ms}$	g	≤ 41	≥ 55	≤ 50	≥ 66
max. 8 pt.	Dynamic Assessment: Side Impact						
	Head		points	4	0	4	0
	no head contact with CRS **head contact with CRS**	no direct evidence + Head a_{res} peak Head $a_{res\ 3ms}$	g	< 80 ≤ 72	≥ 88	< 96 ≤ 72	≥ 88
12	Installation of CRS						
13	Vehicle Based Assessment						
2	Child Presence Detection						

more about Latin NCAP ➲ page 57 & ASEAN NCAP ➲ page 61

KNCAP Child Occupant Protection

Protocol 2019

Dummy	Region	Points	Criteria	
Frontal Impact against ODB with 40 % Overlap @ 64 km/h				
Q6	Head[1]	4	$HIC_{15} < 500$; $a_{3ms} < 60$ g	max. 16 points
		0	$HIC_{15} \geq 700$; $a_{3ms} \geq 80$ g	
		-4	Modifier: Head forward excursion ≥ 550 mm	
	Neck[2]	2	$M_{y,extension} < 36$ Nm; $F_{z,tension} < 1.7$ kN	
		0	$M_{y,extension} \geq 36$ Nm; $F_{z,tension} \geq 2.62$ kN	
	Chest	2	Deflection < 30 mm	
		0	Deflection > 42 mm	
Q10	Head[1]	4	$HIC_{15} < 500$; $a_{3ms} < 60$ g;	
		0	$HIC_{15} \geq 700$; $a_{3ms} \geq 80$ g;	
		-2 / -4	Modifier: Head forward excursion ≥ 450 mm / 550 mm	
	Neck[2]	2	$M_{y,extension} < 49$ Nm; $F_{z,tension} < 1.7$ kN	
		0	$M_{y,extension} \geq 49$ Nm; $F_{z,tension} \geq 2.62$ kN	
	Chest	2	$a_{3ms} < 41$ g	
		0	$a_{3ms} \geq 55$ g	
Barrier Side Impact (AE-MDB) @ 55 km/h				
Q6	Head[1]	4	$HIC_{15} < 500$; $a_{3ms} < 60$ g	max. 16 points
		0	$HIC_{15} \geq 700$; $a_{3ms} \geq 80$ g	
	Neck	2	$F_{z,tension} < 2.4$ kN	
		0	$F_{z,tension} \geq 2.4$ kN	
	Chest	2	$a_{3ms} < 67$ g	
		0	$a_{3ms} \geq 67$ g	
Q10	Head[1]	4	$HIC_{15} < 500$; $a_{3ms} < 60$ g;	
		0	$HIC_{15} \geq 700$; $a_{3ms} \geq 80$ g;	
	Neck	2	$F_{z,tension} < 2.2$ kN	
		0	$F_{z,tension} \geq 2.2$ kN	
	Chest	2	$a_{3ms} < 67$ g	
		0	$a_{3ms} \geq 67$ g	
Modifier		-4	If, during the forwards movement of the dummy, the diagonal belt moves into the gap between the clavicle and upper arm with folding of the belt webbing, a penalty of -4 points will be applied to the overall dummy score of the impact in which it occurs.	

max. 32 points scaled down to 8 points in the overall rating

Preconditions: Where any of the following events occur, **zero points** will be awarded to the dummy.
Frontal impact: During the forwards movement of the dummy only, the diagonal belt slips off the shoulder.
Frontal impact: The pelvis of the dummy submarines beneath the lap section of the belt or the lap section does not prevent the dummy from moving upwards during rebound and is no longer restraining the pelvis.
Frontal and side impacts: The dummy pelvis does not remain in the booster seat / cushion and is not correctly restrained by the lap section of the seatbelt.
Frontal and side impacts: CRS does not remain within the same seating position or is no longer correctly restrained by the adult belt.
Frontal and side impacts: There is any breakage or fracturing of load-bearing parts of the belt system including buckles, webbing and anchorage points.
Frontal and side impacts: There is any breakage or fracturing of any seat belt lock-offs, tethers, straps, ISOFIX anchorages or any other attachments which are specifically used to anchor the CRS to the vehicle fail.

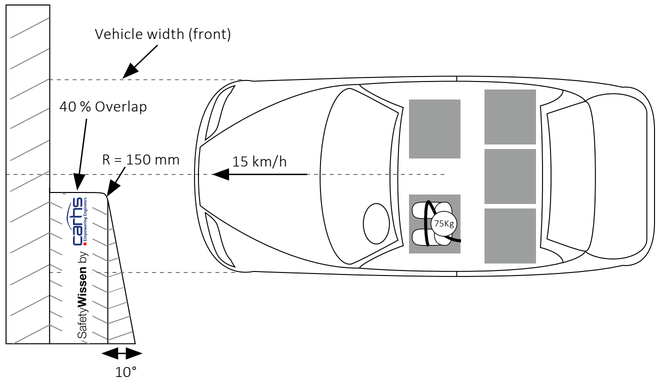
[1] In the absence of hard contacts the score is based on a_{3ms} only.
[2] In the absence of hard contacts the score is based on neck tension force only.

RCAR Insurance Tests

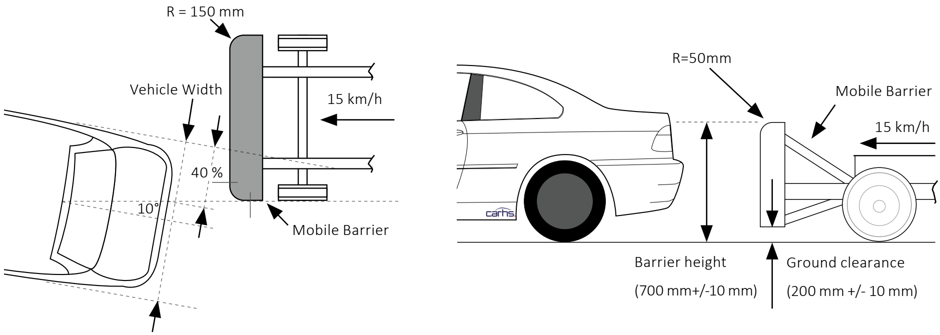
Lowspeed Structural Crash Tests

Protocol Version 2.3 (Oct 2017)

Front

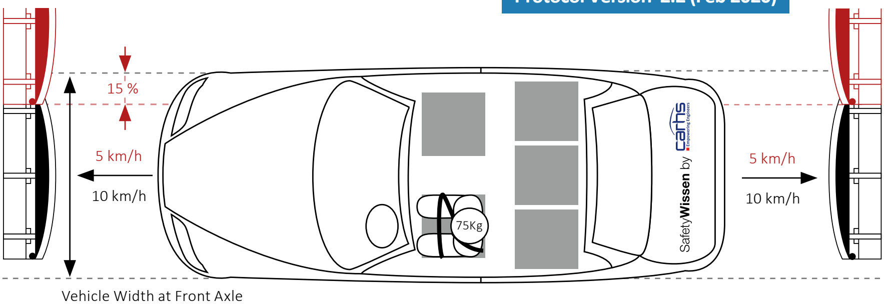


Rear



Bumper Test

Protocol Version 2.2 (Feb 2020)



Barrier ground clearance measured from the track surface to the lower surface of the bumper barrier:

Test	Ground Clearance
Front 100 % & 15 %	$455^{\pm3}$ mm
Rear 100 % & 15 %	$405^{\pm3}$ mm

UNECE Vehicle Classification

Consolidated Resolution on the Construction of Vehicles (R.E.3), Revision 6

Category	Wheels	Engine Capacity	Maximum Design Speed	Unladen Mass	Power	Seats	Maximum Mass
L1	2	≤ 50 cm^3	≤ 50 km/h				
L2	3	≤ 50 cm^3	≤ 50 km/h				
L3	2	> 50 cm^3	> 50 km/h				
L4	3[1]	> 50 cm^3	> 50 km/h				
L5	3[2]	> 50 cm^3	> 50 km/h				
L6	4	≤ 50 cm^3	≤ 45 km/h	≤ 350 kg [3]	≤ 4 kW		
L7	4			≤ 400 kg [3,4]	≤ 15 kW		
M	Vehicles used for the carriage of passengers						
M1	≥ 4					≤ 9	
M2	≥ 4					> 9	≤ 5 t
M3	≥ 4					> 9	> 5 t
N	Vehicles used for the carriage of goods						
N1	≥ 4						≤ 3.5 t
N2	≥ 4						3.5 t < m ≤ 12 t
N3	≥ 4						> 12 t
O	Trailers (including semi-trailers)						
O1							≤ 0.75 t
O2							0.75 t < m ≤ 3.5 t
O3							3.5 t < m ≤ 10 t
O4							> 10 t
T	Agricultural or forestry vehicles						
G	Off-road vehicles						

[1] asymmetrically arranged in relation to the longitudinal median plane
[2] symmetrically arranged in relation to the longitudinal median plane
[3] not including the mass of the batteries in case of electric vehicles
[4] ≤ 550 kg for vehicles intended for carrying goods

Applicabilty of selected UN Regulations to Vehicle Categories:

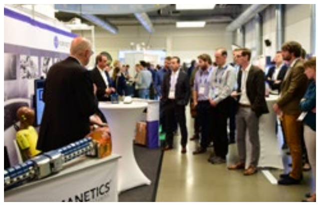
UN R	L1	L2	L3	L4	L5	L6	L7	M1	M2	M3	N1	N2	N3	O1	O2	O3	O4
11								●			●						
12								●			●						
14								●	●	●	●	●	●				
16		●		●	●	●	●	●	●	●	●	●	●	●	●	●	●
17								●	●	●	●	●	●				
21								●									
25		●		●	●	●	●	●	●	●	●	●	●				
32								●									
33								●									
42								●									
94								●									
95								●			●						
100								●	●	●	●	●	●				
127								●			●						
135								●	●[1]		●	●[1]					
137								●									
145								●									

[1] optional up to 4500 kg

SAFETYTESTING
+active

Crash and Safety Testing are key elements in the product development cycle of any new vehicle development.
The partners of **SafetyTesting*+active*** are leading companies in crash and safety testing technology serving the global automotive markets.

You can expect a full day of expert presentations focussing on the hot topics in crash and safety testing, presented by the technology leaders in the industry. The **SafetyTesting*+active*** conference that has been established in 2011 is part of the SafetyWeek in Würzburg, Germany.



Conference Topics

The **SafetyTesting*+active*** conference will feature presentations on the following topics:

- Full scale crash testing technologies
- Advanced sled simulation
- Measuring technologies and data acquisition
- Lighting and video technology
- Testing for ADAS development
- AEB testing (Car-to-Car, VRU, ...)

Who should attend?

The **SafetyTesting*+active*** conference is suited for engineers and decision makers from testing departments for active and passive safety. Both experts and newcomers get an overview over the latest innovations in test equipment and software tool and find ample opportunity to share their own experiences with industry colleagues.

Facts

DATE	28. July 2020
HOMEPAGE	www.carhs.de/safetytesting
VENUE	VCC Vogel Convention Center, Würzburg
LANGUAGE	German with translation into English
PRICE	890,- EUR till 30.06.2020, thereafter 990,- EUR

Introduction to Data Acquisition in Safety Testing

Course Description

Sensor technology and data acquisition are central elements of safety testing. A 100 % reliability of the used technology in combination with the highest accuracy of the employed sensors are the basis for the success and usefulness of the tests in vehicle development. The course first presents a short overview on the historical development of data acquisition technology in the safety field and continues by going into details of current technologies of sensors, data acquisition as well as dummy and vehicle instrumentation. Based on the procedures of a safety test, the different tasks of calibration and certification of sensors, filtering and evaluation of signals, as well as the calculation and evaluation of measurement errors will be explained. The course provides the basic knowledge in crash data acquisition and gives a comprehensive overview on the procedures employed in data acquisition in the crash testing environment.

Course Objectives

The course participants will learn about the technology and terminology of sensor and data acquisition technology used in safety testing. They will be qualified to define tests, to supervise tests and to interpret and evaluate test results.

Who should attend?

This introductory course aims at new test engineers and project engineers as well as engineers from simulation departments at automotive OEMs, suppliers and engineering service providers.

Course Contents

- Sensors
  - Basic sensor principles
  - Sensors in safety testing
  - Selection of sensor systems
- Systems for data acquisition (DAS)
  - State of the art in DAS technology
  - InDummy and Onboard DAS
  - Filtering
- Instrumentation
  - Overview dummy instrumentation
  - Overview vehicle instrumentation
  - Overview instrumented barriers
- Evaluation & Measuring Errors
  - Error calculation (set-up of sensors, sensors, DAS, evaluation ...)
  - Sources of errors in crash testing
  - Interpretation of signals
- Calibration and Certification
  - Dummy certification
  - Sensor calibration
  - SAE J211
- Procedures
  - Test preparation
  - Test execution
  - Test evaluation

Instructor

Thomas Wild (Continental Safety Engineering International GmbH) studied Electrical and Tele-Communications Engineering at the Technical University Darmstadt. Since 1996 he has been employed at Continental Safety Engineering International as a measurement engineer. 1998 - 2001, he assumed additional responsibilities as an application engineer in the algorithm development. Since 2003 he is team leader measurement and video technology. Since 1997 he works in the working group Data Processing in Vehicle Safety (MDVFS).

Date

DATE	COURSE ID	VENUE	DURATION	PRICE	LANGUAGE
29.-30.06.2020	123/3571	Alzenau	2 Days	1.340,- EUR till 01.06.2020, thereafter 1.590,- EUR	

Practical Seminar on biofidelic PRIMUS-Dummy

With Live Crashtest

Course Description

In modern accident reconstruction dummies are used to achieve the most accurate possible reproduction of movements, damages and injuries. The dummies used to date in the scope of standardised crash tests were developed with the aim of reproducibly determining measurements and thus enabling comparability in various tests. For all applications, which deviate from the standard, the use of such dummies is not appropriate due to their unidirectionality and high costs. The PRIMUS-dummy offers an alternative, especially in the field of vibration tests, autonomous driving and in the airbag industry.

The new biofidelic PRIMUS-dummy from CTS is constantly being developed in cooperation with HTW Dresden and TU Berlin and is produced using state-of-the-art technology in a specially designed dummy laboratory at CTS.

In this workshop the PRIMUS-dummy is presented, which due to ist design, the materials used and the resulting human-like behaviour outlines nothing other than a revolution in dummy-technology.

Course Objectives

The aim is to give the participants an extensive first experience with the revolutionary PRIMUS-dummy. This will be presented in detail, before ist exceptional abilities are demonstrated under the direction of test manager Dipl.-Ing. R. Bührmann in the scope of two live crash tests to demonstrate the forces acting upon the vehicle occupant and pedelec drivers.

Who should attend?

This workshop is aimed at those who are professionally engaged with crash test dummies. In particular for accident researchers/analysts, experts and engineers/technicians from the automotive industry, seat and belt manufacturers who are searching for new solution approaches in dummy technology or are confronted with the challenges of non-standardised further development.

Course Contents

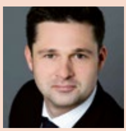
- Introduction in the field of crash tests (Dipl. Ing. P. Schimmelpfennig)
- Performance of the PRIMUS-dummy (Dr. M. Weyde)
- Live crash test - PRIMUS-dummy vs. passenger car
- Analysis of the damages to the PRIMUS-dummy after crash test (Dr. M. Dobberstein)
- Application in automotive engineering (Prof. L. Hannawald)

Instructors

Peter Schimmelpfennig (crashtest-service.com GmbH)
Managing Partner
crashtest-service.com GmbH

Dr.-Ing. Mirko Dobberstein (crashtest-service.com GmbH)
Managing Director
crashtest-service.com GmbH

Dr. Michael Weyde (Priester & Weyde - Büro für Unfallrekonstruktion)
Expert in Road Traffic Accidents, working as a lecturer at the HTW Dresden



Prof. Dr.-Ing. Lars Hannawald (Dresden University of Applied Sciences)
Professor Safety of Motor Vehicles and Accident Analytics

Date

DATE	COURSE ID	VENUE	DURATION	PRICE	LANGUAGE
24.09.2020	761/3612	Münster	1 Day	790,- EUR till 27.08.2020, thereafter 940,- EUR	German flag

Current Dummy Landscape

	Dummies	Frontal Impact HIII 50 %	Frontal Impact HIII 5 %	Frontal Impact HIII 95 %	Frontal Impact THOR 50 %	Side Impact ES-2	Side Impact ES-2re	Side Impact SID-IIs	Side Impact World SID	Rear Impact HIII 50 %	Rear Impact BioRID II	Child CRABI	Child CAMI	Child HIII	Child P Series	Child Q Series
Europe	UN R94	●														
Europe	UN R95					●										
Europe	UN R44														●	
Europe	UN R129															●
Europe	UN R135								●							
Europe	UN R137	●	●													
Europe	Euro NCAP	●	●	(●)	●				●		●					●
America	FMVSS 208	●	●									●		●		
America	FMVSS 214						●	●	○							
America	FMVSS 213											●	●	●	●	○
America	FMVSS 202a									●						
America	FMVSS xxx (OMDB)				○											
America	U.S. NCAP	●	●		○		●	●	○							
America	IIHS	●	● (2022)					●			●					
America	Latin NCAP	●				●										●
Asia	Japan Regulations	●	●			●			●						●	
Asia	JNCAP	●	●						●		●					
Asia	China Regulations	●				●	●		●							
Asia	C-NCAP	●	●		● (2021)	● (2021)		●	●		●					●
Asia	KNCAP	●	●		● (2022)				●		●					●
Asia	ASEAN NCAP	●				●										●
AUS	ADR (Frontal, Side)	●				●			●							
AUS	ANCAP	●	●	(●)	●				●		●					●
GTR	GTR 7 (Head Restr.)	●									●					
GTR	GTR 14 (Pole Side)								●							

SafetyWissen by carhs

2020 2021 2022 ○ = planned, no date specified

THOR 50 % Male: Injury Criteria, Risk Functions and proposed Limits

Region	Criterion	Calculation[1]	Risk Function[1]	Limits for U.S. NCAP[1]		Limits for Euro NCAP 2020	
				Full score	Zero score	Full score	Zero score
Head	HIC_{15} (-)	$\left\|(t_2-t_1)\left[\frac{1}{(t_2-t_1)}\int_{t_1}^{t_2}a(t)dt\right]^{2.5}\right\|_{max}$	$p(AIS \geq 4) = 1 - e^{-\left(\frac{BrIC-0.523}{0.647}\right)^{1.8}}$	500	700	500	700
	Brain Injury Criterion BrIC (-)	$\sqrt{\left(\frac{\max(\|\omega_x\|)}{\omega_{xC}}\right)^2+\left(\frac{\max(\|\omega_y\|)}{\omega_{yC}}\right)^2+\left(\frac{\max(\|\omega_z\|)}{\omega_{zC}}\right)^2}$ with $\omega_{[x,y,z]}$ = Angular velocity (rad/s) ω_{xC} = 66.25 rad/s ω_{yC} = 56.45 rad/s ω_{zC} = 42.87 rad/s	$p(AIS \geq 3) = \Phi\left[\frac{\ln(HIC_{15}) - 7.45231}{0.73998}\right]$	0.71	1.05	-	-
	a3ms [g]			-	-	72	80
Neck	N_{ij} (-)	$\frac{F_z}{F_{zc}}+\frac{M_y}{M_{yc}}$ with F_{ZC} = 4200 N / -6400 N (tension/compression) M_{yC} = 88.1 Nm / -117 Nm (flexion/extension)	$p(AIS \geq 2) = \frac{1}{1+e^{(4.3085-5.4079N_{ij})}}$ $p(AIS \geq 3) = \frac{1}{1+e^{(4.9372-4.5294N_{ij})}}$	0.39	0.85	-	-
	F_{Shear} [kN]			-	-	1.9	3.1
	$F_{Tension}$ [kN]			-	-	2.7	3.3
	$M_{Extension}$ [Nm]			-	-	42	57
Chest	Multi-point Thoracic Injury Criterion R_{max} (mm)	$max(UL_{max}, UR_{max}, LL_{max}, LR_{max})$ with $[U/L\|R/L]_{max} = max\left(\sqrt{[L/R]X^2_{[U/L]S} + [L/R]Y^2_{[U/L]S} + [L/R]Z^2_{[U/L]S}}\right)$ $[L/R][X/Y/Z]^2_{[U/L]S}$: Time-History of the [left / right] chest deflection along the [x / y / z] axis relative to the [upper / lower] spine segment	$p(AIS \geq 3) = 1 - e^{-\left(\frac{R_{max}}{59.865}\right)^{2.7187}}$	37.9	52.3	35	60
Abdomen	Compression δ_{max} (mm)	max(δL,δR): Peak X-axis deflection of the [left / right] abdomen	$p(AIS \geq 3) = \frac{1}{1+e^{(7.849-0.0886\delta_{max})}}$	-	88.6	-	88
Pelvis	res. Actetabulum Load F_R (kN)	$\sqrt{F_x^2+F_y^2+F_z^2}$	$p(Hip\ fracture) = \Phi\left[\frac{\ln 1.429F_{AR} - 1.6058}{0.2339}\right]$	2.583	3.486	3.28	4.1
Femur	Axial Load F_z (kN)	-	$p(AIS \geq 2) = \frac{1}{1+e^{5.7949-0.6748F_{LC}}}$	5.331	8.588	3.8	9.07
Tibia	$F_{z,upper}$ (kN)	-	$p(AIS \geq 2) = \frac{1}{1+e^{(5.6654-0.8189F_{upper\ tibia})}}$	4.235	5.577	-[2]	-[2]
	$F_{z,lower}$ (kN)	-	$p(AIS \geq 2) = \frac{1}{1+e^{(3.9121-0.48F_{lower\ tibia})}}$	3.573	5.861	-[2]	-[2]
	M_{res} (Nm)		$p(AIS \geq 2) = 1 - e^{-e^{\left(\frac{\ln M_{res}-5.8492}{0.2965}\right)}}$	178	240	-[2]	-[2]

[1] as proposed in NHTSA's Request for Comments published in January 2017

[2] Euro NCAP uses the lower leg of the Hybrid III dummy

Overview Dummies
Weights, Dimensions and Instructions for Calibration

Adult Dummies for Frontal / Rear Impact

	Weight (kg)	Seating Height (cm)	Instruction for Calibration
THOR 50 % Male	76.7	90.7	THOR 50th Percentile Male (THOR-50M) Qualification Procedures Manual, September 2018 (NHTSA)
THOR 5 % Female	46.9	81.3	
Hybrid II 50 % Male	74.4	90.7	CFR 49 Part 572, Subpart B
Hybrid III 5 % Female	49.1	78.7	SAE J2862, J2878 CFR 49 Part 572, Subpart O
Hybrid III 50 % Male	77.7	88.4	SAE J2779, J2876 CFR 49 Part 572, Subpart E 1999/98/EC
Hybrid III 95 % Male	101.3	91.9	SAE J2860
BioRID II	77.7	88.4	User Manual

Adult Dummies for Side Impact

	Weight (kg)	Seating Height (cm)	Instruction for Calibration
Eurosid 1	72.0	90.4	Eurosid 1 Certification Procedure 1996/27/EC, UN R95
ES-2	72.0	90.9	FTSS- User Manual / UN R95
ES-2 re	72.4	90.9	CFR 49 Part 572, Subpart U
US-SID	76.7	89.9	CFR 49 Part 572, Subpart F
US-SID/Sid-H3	77.2	89.9	CFR 49 Part 572, Subpart M
SID IIs	44.12	78.0	CFR 49 Part 572, Subpart V
WorldSID 5 % Female	48.27		User Manual
WorldSID 50 % Male	73.91	86.9	User Manual

Child Dummies

	Weight (kg)	Seating Height (cm)	Instruction for Calibration
P0. P¾. P6. P10	3.4 - 32.0	34.5 - 72.5	User Manual
P3	15.0	56.0	User Manual
P1½	11.0	49.5	P1½ User Manual
Q1	9.6	47.9	Q1 User Manual
Q1½	11.1	49.9	Q1.5 User Manual
Q3	14.5	54.4	Q3 User Manual
Q6	23.0	63.6	Q6 User Manual
Q10	35.5	73.4	Q10 User Manual (Rev. A Draft)
CRABI 12 m	10.0	46.4	CFR 49 Part 572, Subpart R
Hybrid II - 3 y/o	15.1	57.2	CFR 49 Part 572, Subpart C
Hybrid II - 6 y/o	21.5	64.5	CFR 49 Part 572, Subpart I
Hybrid III - 3 y/o	16.19	54.6	CFR 49 Part 572, Subpart P
Hybrid III - 6 y/o	23.4	63.5	CFR 49 Part 572, Subpart N
Hybrid III - 6 y/o - weighted	27.92	64.06 - 66.6	CFR 49 Part 572, Subpart S
Hybrid III - 10 y/o	35.2	71.6	CFR 49 Part 572, Subpart T

Dummy-Trainings

Course Description

The seminars give you the opportunity to gain efficiency and security in the use and handling of dummies.
After a short theoretical introduction you are going to be trained in the handling of the respective dummy-type in a dummy lab in practical exercises in work groups.

Course Contents

- Introduction of the respective dummy-type
  History, development, assemblies, standard instruments, optional measuring points, recent modifications, regulations for application/test, calibration
- Complete disassembly of the dummies in work groups
  Explanation of the functions of the assemblies and the individual parts, special features, deviations from other dummy-types, practical hints for the handling of individual assemblies, sensors and cabling, special tools, other devices, cleaning
- Complete assembly of the dummies in work groups
  work steps, possible assembly errors, mounting of the sensors, cabling, adjustments of joints, storing / transport
- Dummy calibration
  Demonstration and explanation of the calibration tests

Course Objectives

- Efficiency and security in use and handling of dummies
- Exact knowledge about assembly, mechanics and sensor positions
- Understanding of the measuring possibilities and limits

Who should attend?

- Project and test engineers, technicians, mechanics



DUMMY	Hybrid III 5 %, 50 %, 95 %	
DATE	10.-11.02.2020	05.-06.10.2020
COURSE ID	707/3633	707/3634
PRICE	1.590,- EUR each	
DUMMY	THOR	
DATE	23.-25.03.2020	23.-25.11.2020
COURSE ID	721/3649	721/3650
PRICE	2.450,- EUR each	
DUMMY	BioRID II	
DATE	17.-18.02.2020	27.-28.10.2020
COURSE ID	708/3639	708/3640
PRICE	1.590,- EUR each	
DUMMY	WorldSID 50 %	
DATE	16.-17.03.2020	16.-17.11.2020
COURSE ID	718/3647	718/3648
PRICE	1.750,- EUR each	
DUMMY	ES-2 / ES-2re	
DATE	04.-05.03.2020	04.-05.11.2020
COURSE ID	709/3643	709/3644
PRICE	1.590,- EUR each	
DUMMY	SID IIs	
DATE	10.-11.03.2020	10.-11.11.2020
COURSE ID	710/3645	710/3646
PRICE	1.590,- EUR each	
DUMMY	P- / Q-Child Dummy	
DATE	14.02.2020	09.10.2020
COURSE ID	711/3637	711/3638
PRICE	875,- EUR each	
DUMMY	Q6 / Q10	
DATE	02.03.2020	02.11.2020
COURSE ID	720/3641	720/3642
PRICE	875,- EUR each	
DUMMY	Hybrid III 3 and 6 y/o	
DATE	13.02.2020	08.10.2020
COURSE ID	712/3635	712/3636
PRICE	875,- EUR each	
VENUE	Bergisch Gladbach	
LANGUAGE		

Instructors

Dummy Specialists, BGS Böhme & Gehring GmbH

BGS operates the dummy calibration laboratory of the German Federal Highway Research Institute (BASt). BGS calibrates crash test dummies for the automotive industry. The seminars are held by experienced engineers from BGS' team.

Impactors for Pedestrian Protection

advanced Pedestrian Legform Impactor: aPLI

Instrumentation:
Upper body mass:
1 accelerometer 3-axial[1]
1 angular rate sensor 3-axial[1]

Femur:
3 strain gauges

Knee:
3 potentiometers
1 angular rate sensor 1-axial (X)[1]
1 accelerometer 1-axial (Y)[1]

Tibia:
4 strain gauges

Length	Total Mass.	Upper Body Mass
1096 mm	~25 kg	11.8 kg

[1] not assessed

Flexible Pedestrian Legform Impactor: Flex PLI

Instrumentation:

Femur:
3 strain gauges

Knee:
3 potentiometers
1 accelerometer 1-axial (Y)[1]

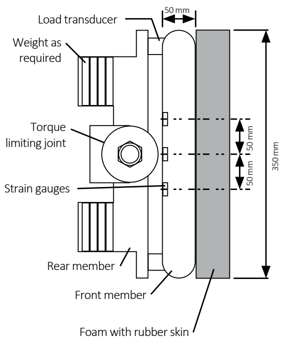
Tibia:
4 strain gauges

Injury Criteria

Criterion
Tibia bending Moment
MCL Elongation
ACL / PCL Elongation

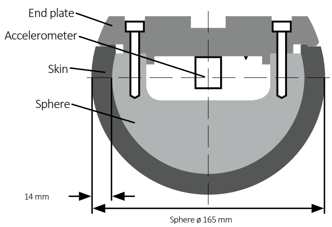
Length	Diameter	Mass
975 mm	132 - 140 mm	13.4 kg

Upper Legform



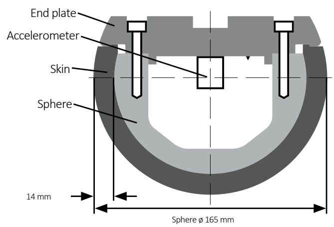
Length	Width	Mass
350 mm	~ 155 mm	11 - 18 kg

Adult Headform Impactor



	Diameter	Mass
Adult Headform	165 mm	4.5 kg

Child Headform Impactor



	Diameter	Mass
Child Headform	165 mm	3.5 kg

more on pedestrian protection ➲ page 100

Pedestrian Protection - Test Procedures

Course Description

A basic prerequisite for successful implementation of pedestrian protection is a detailed knowledge of test requirements. This seminar provides the complete knowledge regarding the test methods as defined by the EU regulation on pedestrian protection and Euro NCAP's pedestrian protection assessment in theory and praxis.

Compact presentations explain the basics and technical details of the regulation and the test protocols. Practical exercises the BASt's test laboratory include test preparation, vehicle marking, selection of test points, handling of the impactors and the actual testing with head and legform impactors.

Course Contents

- Basics and current status of the regulations (presentations)
- Euro NCAP - Rating (presentation)
- Test preparation according to Euro NCAP testing protocol and EU regulation (practical exercises)
- Test demonstrations: Head, Upper Legform and Legform impact (demonstrations and practical exercises)
- Discussion

Who should attend?

- Project, test and simulation engineers,
- Technicians, mechanics

DATE	27.-29.04.2020	22.-24.09.2020
COURSE ID	713/3665	713/3666
VENUE	Bergisch Gladbach	
PRICE	2.250,- EUR each	
LANGUAGE	German	

Pedestrian Protection Workshop: Flex PLI

Course Objectives

- Detailed Knowledge of the new Impactor
- Experience with Handling and Usage of the Impactor
- Understanding of the Impactor's Functionality

Course Contents

- History, Biomechanics, Evaluation, Legislation
- Assembly, Transducers, Onboard Data Acquisition, Technical Details
- Disassembly along with Comments on Function of Components
- Assembly along with practical Tips and Pointers to Specialities and possible Mistakes
- Adjustments of the Compound Springs, Clamping Bolts, Stopper Cables, etc.
- Demonstration of both Certification Procedures
- Data Analysis and Interpretation of Test Results

Who should attend?

- Project, test and simulation engineers,
- Technicians, mechanics

DATE	24.04.2020	18.09.2020
COURSE ID	717/3671	717/3672
VENUE	Bergisch Gladbach	
PRICE	875,- EUR each	
LANGUAGE	German	

Pedestrian Protection Workshop: Vehicle Mark-Up

Course Objectives

- Experience with the new Vehicle Markup
- Certainty in its Application
- Deep Understanding of the Procedure

Course Contents

- Basics, Background and Development of the Procedure
- Test Area Determination, Borders, Exemption Zones, Special Cases
- Necessary Laboratory Equipment, Helpful Tools
- Exemplification by a complete Mark-up of a Vehicle
- Color Scheme, Manufacturers Predictions, allowed Tolerances
- Default Green / Default Red Definitions
- Result Analysis, Point Assessment
- Adaption of the Principle to Upper- and Lowerleg Areas

Who should attend?

- Project, test and simulation engineers,
- Technicians, mechanics

DATE	21.04.2020	15.09.2020
COURSE ID	716/3669	716/3670
VENUE	Bergisch Gladbach	
PRICE	875,- EUR each	
LANGUAGE	German	

Introduction to Active Safety of Vehicles

Course Description

Increasing demands on the protection of vehicle occupants have led to a continuous reduction in the number of injured and killed persons. While more than 20,000 persons have been killed on German roads in the early 1970s, this number is now just over 3,000. Passive safety, i.e. measures which are designed to minimize the consequences of an accident, has made a significant contribution to this achievement. While the potential of passive safety is considered to be largely exhausted and huge efforts are required to achieve further progress in occupant protection, active safety has become increasingly important in recent years. Active Safety means measures which prevent an accident or at least reduce the collision speed and thus the energy input. While technologies such as ABS or ESC have been established years ago and have proven their effectiveness, new techniques such as the emergency brake or the lane keeping assist and numerous other driver assistance systems are just entering the market. It can be assumed that these systems will be widely used in the next few years and will lead to a further decrease in the number of traffic victims. Automated driving can be seen as the next step of active safety. Although there is still a lot of development needed in this area, it can be assumed that vehicles which will driven at least partially automatically in certain traffic scenarios will enter the market over the next ten years. In the seminar first a brief introduction to active safety, in contrast to passive safety is given. This is followed by a presentation of current active safety systems and an overview of the requirements of legislation and consumer protection organizations. In addition, current and upcoming developments in the area of driver assistance systems and automated driving are presented.

Who should attend?

The seminar is aimed at new and experienced engineers working in the field of active vehicle safety in research and development departments of automotive OEMs or suppliers, as well as for all other interested parties, which want to receive an overview of current and future developments in the areas of active vehicle safety, driver assistance and automated driving.

Course Contents

- Fundamentals of active safety
  - Basic principles of action
  - Legal requirements
  - Euro NCAP requirements
- Current active safety systems
  - ABS
  - ESC
  - Brake assist
  - Pre-crash systems
- Driver assistance systems
  - Basic requirements and design strategies
  - Current and future driver assistance systems
- Automated driving
  - State of the art
  - Opportunities and risks
  - Human machine interface
  - Market introduction strategies

Instructor

Dr. Gerd Müller (Technical University Berlin) has been working at the department automotive technology of the Technical University of Berlin since 2007. From 2007 to 2015 he was a research assistant. Since 2015 he has been a senior engineer of the same department. His research focuses on vehicle safety and friction coefficient estimation. Dr. Müller gives the lecture "Fundamentals of Automotive Engineering" and conducts parts of the integrated course "Driver Assistance Systems and Active Safety".

Date

DATE	COURSE ID	VENUE	DURATION	PRICE	LANGUAGE
04.05.2020	51/3583	Alzenau	1 Day	790,- EUR till 06.04.2020, thereafter 940,- EUR	German
09.11.2020	51/3584	Alzenau	1 Day	790,- EUR till 12.10.2020, thereafter 940,- EUR	English

NCAP Tests for Active Safety and Driver Assistance

Euro NCAP / ANCAP

Safety Assist Assessment based on:

Occupant Status Monitoring (OSM)			Total	3.00
Driver Status Monitoring (DSM)				1.00
Seat Belt Reminder (SBR) on rear seats (n = number of rear seating positions)				1.0/n per seat
SBR on rear seats with occupant detection (n = number of rear seating positions)				1.0/n per seat

Speed Assist Systems (SAS)		Total	3.00
Speed Limit Information Function (SLIF)	Basic SLIF	0.50	**1.50**
	Advanced SLIF	0.50	
	System Accuracy	0.25	
	Warning Function	0.25	
Speed Control Function	Speed Limitation Function (SLF)		**1.50**
	For cars without SLIF	1.25	
	For cars with SLIF	0.75	
	Intelligent Speed Assist (ISA) and/or intelligent ACC	1.50	

Lane Support Systems (LSS)		more ➲ page 155	Total		4.00
Human Machine Interface (HMI)	Lane Departure Warning (LDW)			0.25	**0.50**
	Blind Spot Monitoring (BSM)			0.25	
Lane Keep Assist (LKA)	Dashed Line	Single lane marking		0.25	**0.50**
	Solid line	Single lane marking		0.25	
Emergency Lane Keeping (ELK)	Road Edge	Centreline	Road Edge		**3.00**
		no line	no line	0.25	
		dashed	no line	0.25	
		dashed	dashed line	0.25	
		dashed	solid line	0.25	
	solid line	Single lane marking		0.50	
	Oncoming vehicle	Fully marked lanes		1.00	
	Overtaking vehicle	Fully marked lanes		0.50	

AEB Car-to-Car	more ➲ page 152	Total	6.00

- AEB VRU: **max. 18 Points (as part of the VRU Protection assessment)** more ➲ page 143

Latin NCAP

- AEB City (as part of the Adult Occupant Protection assessment): 3 Points
- AEB VRU (as part of the Pedestrian Protection assessment): 12 Points
- Seat Belt Reminder: 10 Points
- Speed Assistance Systems: 3 Points
- AEB Inter-Urban: 9 Points
- ESC: 15 Points
- Lane Support Systems: 3 Points
- Blind Spot Detection: 3 Points more ➲ page 57

ASEAN NCAP

Safety Assist Technology (SAT) Assessment 2021 - 2025

(Weighting: 20 % of the overall rating)

- Effective Braking & Avoidance (EBA): ABS / ESC: **6 Points**
- Seat Belt Reminder Driver / Passenger (with seat occupancy detector) / rear seats: **6 Points**
- AEB: **6 Points**
- Advanced SAT: **2 Points**
- **more assistance systems are assessed in the Motorcyclist Safety box**

more ➲ page 61

NCAP Tests for Active Safety and Driver Assistance

U.S. NCAP

planned: **Crash Avoidance Rating** consisting of

- Forward Collision Warning: **10 Points** more ➲ page 158
- Crash Imminent Braking: **12 Points** more ➲ page 158
- Dynamic Brake Support: **8 Points**
- Low Beam Headlighting: **20 Points**
- Semi-automatic Headlight Beam Switching: **10 Points**
- Amber rear Turn Signal: **5 Points**
- Lane Departure Warning: **12 Points**
- Blind Spot Detection: **5 Points**
- Assessment of the risk for rollover (Static Stability Factor SSF): **18 Points**

Additionally as part of the pedestrian safety assessment:

- AEB Pedestrian
- Rear Auto Braking more ➲ page 159

Planned Crash Avoidance Rating	
Stars	**required points (out of 100)**
★★★★★	**80**
★★★★	**60**
★★★	**40**
★★	**20**
★	**0**

IIHS

- AEB Car-to-Car more ➲ page 157 (part of the Top Safety Pick rating more ➲ page 53)
  - approach to standing vehicle at 20 km/h and 40 km/h
  - assessment of the speed reduction
  - 1 additional point for FCW (Forward Collision Warning) meeting the U.S. NCAP criteria
- AEB Pedestrian more ➲ page 157 (part of the Top Safety Pick rating more ➲ page 53)
  - 3 scenarios: adult nearside, child nearside obstructed, adult longitunial
  - assessment of the speed reduction
  - 1 additional point for FCW (Forward Collision Warning)
- Advanced Lighting (part of the Top Safety Pick rating more ➲ page 53)
  - Assessment of the illumination and glare of high and low beam headlights in various test scenarios. Additional credit is given for systems that automatically switch between high and low beam.

JNCAP

- SBR: **4 Points** more ➲ page 66
- Advanced Safety Award, consisting of: (see table)
  - ASV+ Award for cars achieving ≥ **12 Points**
  - ASV++ Award for cars achieving ≥ **46 Points**
  - ASV+++ Award for cars achieving ≥ **86 Points**

Max. points for adv. safety systems	2020
AEB Inter-Urban	32
AEB Pedestrian (day)	25
AEB Pedestrian (night w/ illumination)	40
AEB Pedestrian (night w/o illumination)	15
LSS	16
Rear View Monitor	6
Headlights	5
Pedal Misapplication	2
max. total	141

KNCAP

- Rollover assessment based on SSF like in U.S. NCAP: **5 Points**
- Braking Performance Tests: Measurement of the stopping distance from 100 km/h on dry and wet road. Check if vehicle stays within the 3.5 m wide track while braking: **5 Points**
- Basic Active Devices:
  - FCW, LDW, SLD, SBR front, SBR rear: **0.5 Points each**
  - AEB Inter-Urban: **1 Points**
  - AEB City: **1.5 Points**
- Additional Active Devices (optional): Max. total points for Additional Active Devices = **2 Points**
  - ASCC, BSD, RCTA, LKA, ISA: **0.5 Points each**
  - AEB Pedestrian, Advanced Airbag: **1 Point each**

C-NCAP

Active Safety Assessment more ➲ page 160 (Weighting: 15 % of the overall rating): more ➲ page 64

- ESC: **4 Points**
- AEB / FCW Car to Car Rear: **7 Points**
- AEB Pedestrian: **3 Points**
- Optional Systems: Lane Departure Warning, Speed Assistance System, Blind Spot Detection (Car-to-Car): **1 Point/ System**

DEKRA Automobil Test Center Klettwitz.
Test regulations for autonomous driving.

The DEKRA Automobil Test Center at EuroSpeedway Lausitz is developing into Europe's largest independent test center for automated and connected driving. We test driver assistant systems, driving dynamics, and vehicle safety.

AEB

Test types
> AEB city tests (stationary vehicle)
> AEB inter-urban tests (stationary, constantly moving, and braking vehicle)
> General ACC tests

Tasks
> Homologation
> CoP tests
> Support for development
> Inspections according to manufacturer's specifications

Regulations
> ECE, ISO, EuroNCAP

ESP

Test types
> Sinus steering maneuver with stop times
> Steering-angle jump test
> Track radius reduction test
> Double lane change

Tasks
> Homologation
> CoP tests
> Support for development
> Inspections according to manufacturer's specifications

Regulations
> ECE, FMVSS

Pedestrian protection

Test types
> Head impact tests
> Leg and hip impact
> Sensor tests for actively triggering systems

Tasks
> Homologation
> CoP tests
> Support for development
> Manufacturer specifications

Regulations
> ECE, EG, GTR, NCAP, TRIAS

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DEKRA
On the safe side.

NCAP Assistance System Rating Matrix

	Euro NCAP / ANCAP	U.S. NCAP	IIHS	Latin NCAP	ASEAN NCAP	C-NCAP	C-IASI	JNCAP	KNCAP
SBR Seat Belt Reminder	● 2020			● 2020	● 2020	● 2020		● 2020	● 2020
OSM / DSM Occupant/Driver Status Monitoring	● 2020					● 2023			
COPD Child Occupant Presence Detection	● 2023				● 2021				
ABS Anti-Lock Braking System					● 2020				
ESC Electronic Stability Control				● 2020	● 2020	● 2020			
MCB Multi Collision Brake	● 2020								
SAS Speed Assistance System	● 2020			● 2020		● 2023			● 2020
LSS Lane Support Systems	● 2020	● 2020		● 2020		● 2020		● 2020	● 2020
BSM Blind Spot Monitoring				● 2020	● 2020	● 2020			● 2020
AEB CCR Car to Car Rear	● 2020	● 2020	● 2020	● 2020	● 2021	● 2020	● 2020	● 2020	● 2020
AEB Tap Turn across path	● 2020								
AEB Pedestrian	● 2020		● 2020	● 2020		● 2020		● 2020	● 2020
AEB Reverse Pedestrian	● 2020								
AEB Cyclist	● 2020					● 2022		● 2021	● 2020
AEB PTW Powered Two Wheeler	● 2023								
FCW Forward Collision Warning	● 2020	● 2020	● 2020	● 2020	● 2020	● 2020	● 2020	● 2020	● 2020
DBS Dynamic Brake Support		● 2020							
AES Autonomous Emergency Steering	● 2020								● 2022
Emergency Call	● 2020			● 2022		● 2022		● 2020	
Rear View Monitor						● 2022		● 2020	
Rear Cross Traffic Alert									● 2020
Headlights			● 2020		● 2021	● 2022		● 2020	● 2022
Pedal Misapplication								● 2020	

● 2020 ● 2021 ● 2022 ● 2023

SAFETY ASSIST
PRAXIS CONFERENCE

The requirements by New Car Assessment Programs regarding safety-supporting driver assistance systems for passenger cars are constantly increasing: Oncoming traffic scenarios, tests in darkness and higher expected speed reductions are some of the prerequisites for a 5-star rating in the Euro NCAP or an IIHS Top Safety Pick.

The introduction of emergency brake assistants for passenger cars is being driven forward by legislation: From 2022 they will be mandatory for passenger cars. The details for proof of cyclist recognition are still being discussed, all other test conditions have already been decided. The lane departure warning functions have also been incorporated into UN R 79.03.

At the **Praxis Conference Safety Assist**, the boundary conditions relevant for development will be presented: Requirements, technical principles and development and release methods on the theory day in the conference hotel, followed by hands-on experience on the test track on the Demo Day. Various test scenarios will be performed and examples of how the test technology can be used will be shown live in the test setup.

This is what awaits you:

- The presentation of current and future requirements on emergency braking, evasion and highly automated driving functions, as well as development strategies that lead to a robust system.
- Face to face talk with the people who set the framework for the development of safety assist functions: Legislative representatives, consumer protection organizations, OEM representatives and suppliers of simulation and testing technologies.
- Practical experience with various test setups, targets, driving robots and control software on the Demo Day.

Who should attend?

The Praxis Conference Safety Assist addresses everyone, who works in the field of safety-related driver assistance systems. The Praxis Conference is the right place to broaden and deepen your network: You will meet key players in development, system integration, regulation and verification of Safety Assist Systems.

FACTS

DATE	02.-03. September 2020
HOMEPAGE	www.carhs.de/safetyassist
VENUE	to be announced, Germany
LANGUAGE	German with translation into English
PRICE	1.490,- EUR till 05.08.2020, thereafter 1.750,- EUR

Briefing on the Worldwide Status of Automated Vehicle Policies

Course Description

Regardless of the hype surrounding "self-driving cars", it is clear that automated driving systems (ADS) will fundamentally change the automotive industry. Moreover, despite widespread expectations that ADS hold the key to achieving substantial reductions in road crashes, injuries, and deaths, these systems also raise concerns among safety authorities. The validation of ADS requires long-duration testing and development to ensure correct behavior under massively variable road conditions. Conventional regulatory methods developed over the past half-century lack methods and tools to assess such performance, forcing safety authorities to look for new ways to ensure that ADS will be safe for public use.

Course Objectives

This seminar reviews current efforts to adapt regulatory systems to meet this challenge, including the vigorous debates over strategies and methods and the roles of regulators and manufacturers in ensuring the safety of automated vehicles.

Who should attend?

The briefing is aimed at employees from the development departments of vehicle manufacturers and suppliers working in the field of automated driving and vehicles equipped with automated driving systems. Given the risks of misuse, it is particularly important for all employees in product strategy and marketing departments.

Course Contents

- Safety authority expectations for automated vehicle safety
- Role and influence of manufacturers on regulatory thinking
- Pressures on current regulatory methods and tools
- Pressure on type approval for near-term framework
- Guidance versus regulation: How and when?
- Hybridization: Merging of self-certification and type approval
- Levels of automation from a regulatory perspective
- Current efforts to establish automated vehicle regulations
- Outlook: Can regulations ensure automated vehicle safety?

Instructor

John Creamer (GlobalAutoRegs.com) is the founder of GlobalAutoRegs.com and a partner in The Potomac Alliance, a Washington-based international regulatory affairs consultancy. In his client advisory role, Mr. Creamer is regularly involved with meetings of the UN World Forum for the Harmonization of Vehicle Regulations (WP.29). Previously, he has held positions with the US International Trade Commission and the Motor & Equipment Manufacturers Association (representing the US automotive supplier industry), as the representative of the US auto parts industry in Japan, and with TRW Inc. (a leading global automotive safety systems supplier).

Date

DATE	COURSE ID	VENUE	DURATION	PRICE	LANGUAGE
15.10.2020	184/3530	Alzenau	1 Day	790,- EUR till 17.09.2020, thereafter 940,- EUR	

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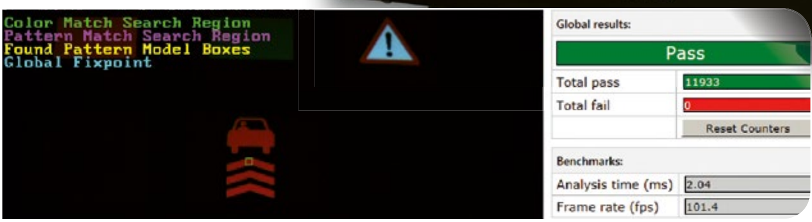
IDEAL for Euro NCAP



Example screen of a Pattern Match detection

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Introduction to Artificial Intelligence and Machine Learning for Advanced Driver Assistance Systems and Automated Driving Functions

Course Description

The functions of automated driving - no matter what degree of automation - usually require the application of modern artificial intelligence techniques in order to be able to realize the desired functionalities at all. The aim of this seminar is to present the basic methods of Artificial Intelligence and Machine Learning. The methods should be demonstrated with concrete examples from the fields of assisted and automated driving. Care is also taken about validation, verification and safeguarding of the related models and AI-based software components.

Course Objectives

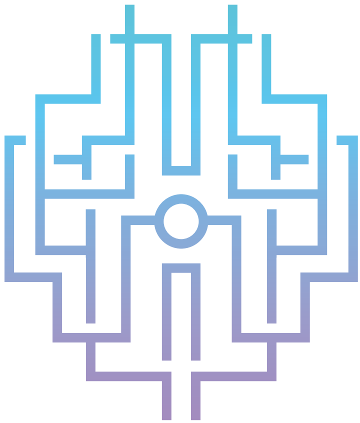
This seminar provides an overview and a brief introduction to the relevant methods of Artificial Intelligence and Machine Learning, so that both developers and managers can clearly decide which methods and procedures are relevant for their applications and which possible pitfalls they should consider in the application.

Who should attend?

Developers and (project) managers who have not yet had deep experience with the methodology and want to get a quick overview and introduction to the use of artificial intelligence.

Course Contents

- Introduction of data-based development versus analytical and rule-based approaches
- Overview of the different procedures and areas of application
- Artificial Neural Networks, Deep Learning, various variants and architectures
- Decision and regression trees
- Support Vector Machines
- Validation and safeguarding of models, sampling procedures, robustness assessment
- Data preparation and problem parameterization
- Meta modeling and model committees



Instructor

Dr. Andreas Kuhn (Andata Entwicklungstechnologie GmbH) studied Technical Mathematics and Mechanical Engineering at the Technical University of Vienna. After his dissertation on the simulation of special satellite formations for the European Space Agency, he began his professional career in crash simulation at BMW. After further years as a consultant for stochastic simulation at EASI Engineering GmbH (today carhs), he founded ANDATA in 2004, where he is responsible for development and research as managing partner. Since 2009 he is also co-owner of Automotive Safety Technologies GmbH in Gaimersheim.

His professional interests are founded in effective and efficient development, validation and assessment methods for complex, safety-critical systems. In particular, he has been working for more than 20 years on the development and combined application of methods from the fields of artificial intelligence, machine learning, advanced simulation methods, scenario-based approaches and according process models in the virtual development of vehicles and autonomous robots. His current activities are the development and implementation of cooperative, networked, automated driving strategies for effective traffic automation.

Date

DATE	COURSE ID	VENUE	DURATION	PRICE	LANGUAGE
22.-23.06.2020	186/3609	Alzenau	2 Days	1.340,- EUR till 25.05.2020, thereafter 1.590,- EUR	
27.-28.10.2020	186/3610	Alzenau	2 Days	1.340,- EUR till 29.09.2020, thereafter 1.590,- EUR	

Scenario-, Simulation- and Data-based Development, Validation and Safeguarding of Automated Driving Functions

Course Description

The complexity of modern driver assistance systems and automated driving functions sometimes requires completely new methods and approaches for their development, validation and testing. In particular, the wide coverage and analysis of functions with numerical simulation over the entire operating range (the so-called Operational Design Domain) is an indispensable tool for the effective and efficient development of appropriate vehicle functions. The course is about presenting the basics of scenario-based and data-based development and putting them in a holistic context.

Course Objectives

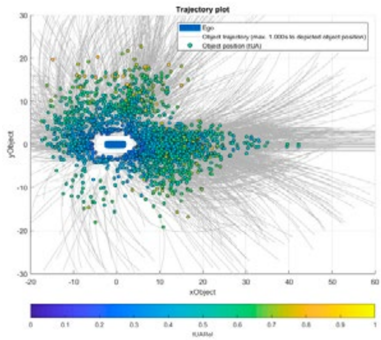
The course provides an overview and a brief introduction to the relevant scenario management methods for simulation and data-centric development and validation of automated driving functions. Some key basic principles in the development of complex systems are to be taught.

Who should attend?

The seminar addresses employees of automotive manufacturers, suppliers, engineering service providers, government agencies and research institutions, who are engaged in the development and validation of automated driving functions. In particular, method and process developers, simulation and test engineers are also addressed, who are responsible to implement corresponding processes and methods in their companies to ensure safe development and assessment of automated driving functions.

Course Contents

- Overview of the basic functions of automated driving
- Basics of Scenario and Data-based development
- Basics in Machine Learning, Data Mining and Artificial Intelligence
- Stochastic Simulation, Monte-Carlo-Simulation, Design-of-Experiments
- Optimization and automated calibration
- Robustness and complexity management
- Anomaly and fault detection
- Development processes for complex systems and software, top-down versus bottom-up
- Functional requirements management
- Validation and verification
- Definitions Operational Design Domain
- Effectiveness assessment of system functions and components
- Quality management for simulation data



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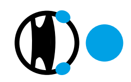
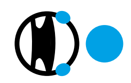
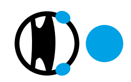
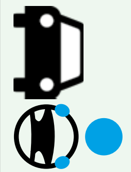
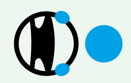
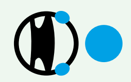
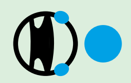
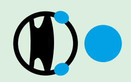
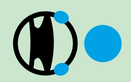
Date

DATE	COURSE ID	VENUE	DURATION	PRICE	LANGUAGE
10.-11.11.2020	187/3611	Alzenau	2 Days	1.340,- EUR till 13.10.2020, thereafter 1.590,- EUR	

Levels of Driving Automation according to BASt, SAE and NHTSA Definitions

Execution of Steering and Acceleration/ Deceleration	Monitoring of Driving Environment	Fallback Performance of Dynamic Driving Task	System Capability	BASt Level	SAE Level	NHTSA Level
			-	Driver only	0 No automation	0 No automation
			Some driving modes	Assisted	1 Driver assistance	1 Functionspecific automation
			Some driving modes	Partially automated	2 Partial automation	2 Combined function automation
			Some driving modes	Highly automated	3 Conditional automation	3 Limited self driving automation
			Some driving modes	Fully automated	4 High automation	3 / 4 Limited self driving automation / Full self driving automation
			All driving modes	-	5 Full automation	

VBOX 3iS

Extraordinary precision and accuracy

The **VBOX 3iS** is a compact GNSS speed sensor with integrated IMU and wheel sensor interface.

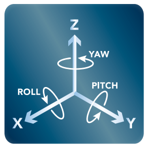
Providing highly accurate measurements of speed, position and attitude, the **VBOX 3iS** is the ideal companion for testing and validating the latest vehicle safety systems, even in areas with poor GNSS.

Available with RTK for positional accuracy better than 2 cm

Multi-constellation GNSS receiver: GPS, GLONASS and Galileo

Cost-effective solution for ADAS and autonomous vehicle testing

Utilises wheel speed data from the vehicle's CAN bus



Integrated IMU for highly accurate pitch, roll and yaw information

Also compatible with steering robots, the **VBOX 3iS** can be used for performance, braking, ADAS and benchmarking tests and has a built-in OLED display for easy configuration and diagnostics.

VBOX RACELOGIC

vboxautomotive.co.uk/vbox3is

NCAP - New Car Assessment Programs: Tests, Assessment Methods, Ratings

Course Description

In 1979 the first New Car Assessment Program (NCAP) was established by NHTSA in the United States. The goal was to motivate competing car manufacturers to enhance the safety level of their cars beyond the minimum safety standards defined by regulations. The same approach has been followed globally by other organizations (e.g. by Euro NCAP, IIHS, ANCAP, JNCAP, KNCAP, C-NCAP, ...) Euro NCAP which has been established in 1997 has taken a leading role and has significantly influenced other countries and regions. The NCAP programs in many cases are highly dynamic, especially in comparison with rulemaking activities. In order to reach the goal to continuously improve the safety level of cars, the requirements need to be permanently adapted to the state of technology. Developers in the automotive industry need to know about upcoming changes at an early stage in order to be able to design or equip their vehicles accordingly. In this seminar attendees get an overview of the organizations in charge of the NCAP programs and become familiar with the various test and assessment methods.

NEW

The seminar is conducted several times a year with changing focuses:

- **Focus passive safety:** Here the focus is on test and assessment methods for passive safety. Frontal and side impact, whiplash, child protection and pedestrian protection are discussed in detail. Tests for active safety are only mentioned in as far as they are relevant for the overall rating.
- **Focus active safety:** Here the focus is on active safety systems such as AEB or lane assistance. The tests and assessments for these systems are explained in detail. Tests for passive safety are only mentioned in as far as they are relevant for the overall rating.

In both focusses the current overall rating methods are described and explained. In addition to that an outlook is given on the roadmaps and future developments of the NCAP programs.

Who should attend?

The seminar addresses design, simulation, testing and project engineers as well as managers who want to get a current overview on the global range of NCAP programs with an outlook on upcoming topics and trends from an insider. Depending on the focus of their work attendees should chose the appropriate focus of the seminar.

Course Contents

- New Car Assessment Programs - overview
- U.S. NCAP
- IIHS
- Euro NCAP
- ANCAP
- JNCAP
- KNCAP
- C-NCAP
- C-IASI
- Latin NCAP
- ASEAN NCAP
- Bharat NCAP
- Global NCAP

Instructor

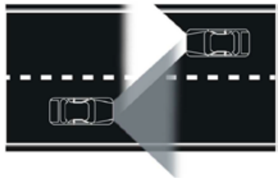
Direktor and Professor Andre Seeck (German Federal Highway Research Institute) is head of the division "Vehicle Technology" with the German Federal Highway Research Institute (BASt). In this position he is responsible for the preparation of European Safety Regulations. Furthermore he represents the German Federal Ministry of Transport and Digital Infrastructure in the Board of Directors of Euro NCAP and he is the chairman of the strategy group on automated driving and of the rating system. These positions enable him to gain deep insight into current and future developments in vehicle safety. In 2017 NHTSA awarded him the U. S. Government Special Award of Appreciation.

Dates

DATE	COURSE ID	VENUE	DURATION	PRICE	LANGUAGE
05.-06.03.2020	164/3468	Alzenau	2 Days	1.340,- EUR till 06.02.2020, thereafter 1.590,- EUR	German
17.-18.06.2020	164/3579	Alzenau	2 Days	1.340,- EUR till 20.05.2020, thereafter 1.590,- EUR	English
30.11.-01.12.2020	164/3580	Alzenau	2 Days	1.340,- EUR till 02.11.2020, thereafter 1.590,- EUR	German

SAFETYLIGHTING

SafetyLighting focusses on the increasing importance of headlights in automotive safety, as new requirements for headlights were introduced recently. IIHS established a new rating for headlights which evaluates both the illumination of the road and the glare of oncoming traffic. To achieve the highest IIHS award in 2020, the IIHS Top SafetyPick+, vehicles need to acquire an “Acceptable” rating for all headlight options. C-NCAP will also include a headlight assessment in its rating in 2021.



Another new challenge is the use of **light for communication between automated vehicles and their environment**. At **SafetyLighting**, the current and future requirements for headlamps will be presented and possible solutions for meeting these requirements will be demonstrated. Experts from the fields of consumer protection, legislation and industry will report on the state of the art in headlight technology.

Conference Topics

- Importance of lighting systems for accident prevention
- Current headlight technologies
- Legal requirements on headlights
- Consumer protection ratings
- Test and development methods
- Solutions and technologies

Who should attend?

SafetyLighting targets automotive development engineers and technicians, who are involved with the development and testing of headlights.

Auto[nom]Mobil

Safe Urban Mobility

Mobility creates quality of life. It is a prerequisite for business and commerce, but also for personal encounters. Urban mobility, however, is increasingly coming across to their limits. There is a threat of traffic collapse. Increasing urbanization is accelerating this trend. Individual mobility is being supplemented or even replaced by new traffic concepts based on autonomous shuttles. Are these shuttles safe? How do they protect their passengers and how do they protect external road users?

Auto[nom]Mobil brings the protagonists of the new mobility together with the experts for vehicle safety and shows ways in which autonomous urban Mobility becomes safe for all concerned.

Conference Topics

- Current projects
- Legal requirements
- Framework conditions of the infrastructure
- Requirements for vehicle and interior

FACTS

	SAFETYLIGHTING	Auto[nom]Mobil
DATE	28. July 2020	28.- 30. July 2020
HOMEPAGE	www.carhs.de/safetyweek	www.carhs.de/safetyweek
VENUE	VCC Vogel Convention Center, Würzburg	VCC Vogel Convention Center, Würzburg
LANGUAGE	Englisch	Englisch
PRICE	890,- EUR till 30.06.2020, thereafter 990,- EUR	2150,- EUR till 14.04.2020, thereafter 2550,- EUR

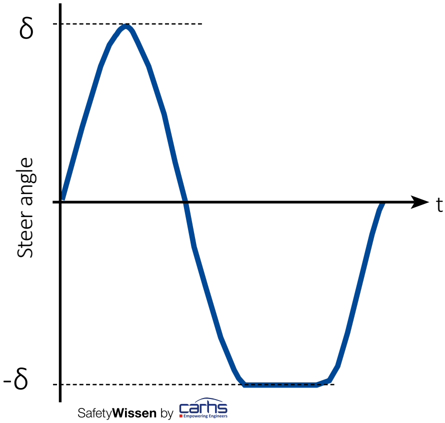
Test of ESC Systems in UN R140, GTR 8 and FMVSS 126

Step 1: Slowly-Increasing-Steer Manoeuvre to determine Parameter A

At a constant velocity of 80 ±2 km/h the steering angle is ramped at 13.5 deg/s until a lateral acceleration of 0.5 g is reached. Out of 2 series (1x left turn / 1x right turn) with 3 repetitions of the manoeuvre the steering angle A (in degrees) at which the lateral acceleration is 0.3 g is determined using linear regression.

Step 2: Sine with Dwell Manoeuvre to assess Oversteer Intervention and Responsiveness

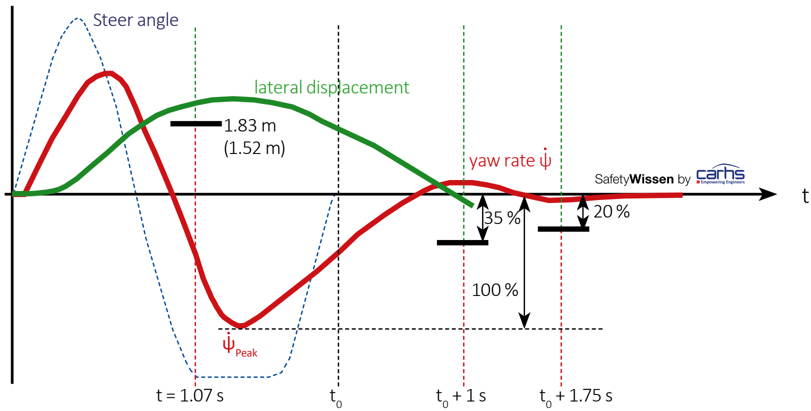
At a velocity of von 80 ±2 km/h the vehicle is subjected to two series of test runs using a steering pattern of a sine wave at 0.7 Hz frequency with a 500 ms delay beginning at the second peak amplitude:



One series uses counterclockwise steering for the first half cycle, and the other series uses clockwise steering for the first half cycle. In each series of test runs, the steering amplitude is increased from run to run, by 0.5 A, starting at 1.5 A. The steering amplitude of the final run in each series is the greater of 6.5 A or 270 degrees, provided the calculated magnitude of 6.5 A is less than or equal to 300 degrees. If any 0.5 A increment, up to 6.5 A, is greater than 300 degrees, the steering amplitude of the final run is 300 degrees.

Performance Requirements:

- Yaw Rate
  - 1 s after completion of the steering input (t_0) < 35 % of the first peak value of yaw rate recorded after the steering wheel angle changes sign.
  - 1.75 s after completion of the steering input (t_0) < 20 % of the first peak value of yaw rate recorded after the steering wheel angle changes sign.
- Lateral displacement of the vehicle center of gravity with respect to its initial straight path when computed 1.07 seconds after the Beginning of Steer (BOS)
  - for vehicles with GVM (GVWR) ≤ 3500 kg > 1.83 m
  - for vehicles with GVM (GVWR) > 3500 kg > 1.52 m



Euro NCAP / ANCAP Test Method for AEB VRU-Pedestrian

Assessment Protocol 10.0.3

Test Protocol 3.0.3

daylight testing

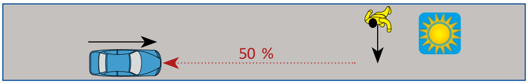
nighttime testing

nighttime testing with streetlights

high beam headlights

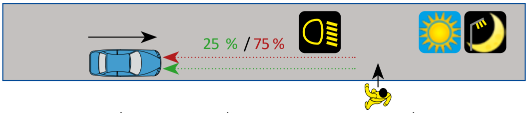
low beam headlights

Adult, Farside, Impact at 50 % of the Vehicle Width (CPFA-50)



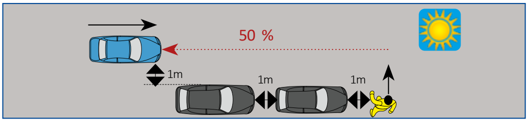
v_0 = 10 km/h ... 60 km/h v = 8 km/h

Adult, Nearside, Impact at 25 & 75 % of the Vehicle Width (CPNA-25/75)



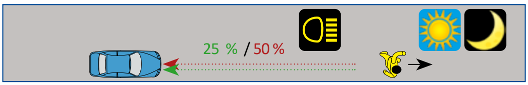
v_0 = 10 km/h ... 60 km/h v = 5 km/h

Child, Obstruction, Nearside, Impact at 50 % of the Vehicle Width (CPNC-50)



v_0 = 20 km/h ... 60 km/h v = 5 km/h

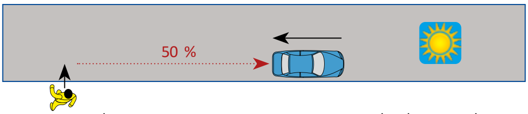
Adult, Longitudinal, Impact at 25 & 50 % of the Vehicle Width (CPLA-25/50)



CPLA-50: v_0 = 20 km/h ... 60 km/h v = 5 km/h

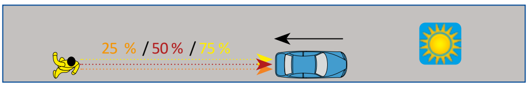
CPLA-25: v_0 = 50 km/h ... 80 km/h v = 5 km/h

Reverse Adult, Nearside, Impact at 50 % of the Vehicle Width (CPRA Moving) NEW 2020



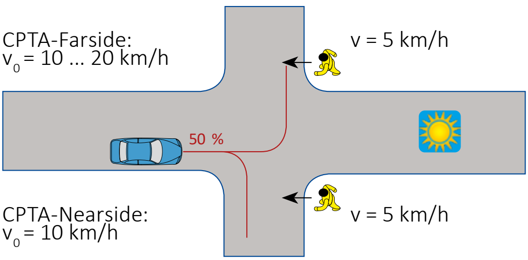
v = 5 km/h v_0 = -4 km/h / -8 km/h

Reverse Adult, Stationary, Impact at 25/50/75 % of the Vehicle Width (CPRA Stationary) NEW 2020



v = 0 km/h v_0 = -4 km/h / -8 km/h

Adult, VUT Turning, Farside, Nearside, Impact at 50 % of the Vehicle Width (CPTA-Farside/Nearside) NEW 2020



Prerequistes for Scoring:

- The AEB system must be default ON at the start of every journey.
- The AEB system must operate from speeds ≥ 10 km/h in the CPNA-75 day + night, must be able to detect pedestrians walking as slow as 3 km/h and reduce speed in the CPNA-75 scenario at 20 km/h.
- The system may not automatically switch off at a speed < 80 km/h.
- The score of the pedestrian impact tests (legforms & head) must be ≥ 18 points.

carhs
Empowering Engineers

Euro NCAP / ANCAP Test Method for AEB VRU-Pedestrian

Assessment Protocol 10.0.3

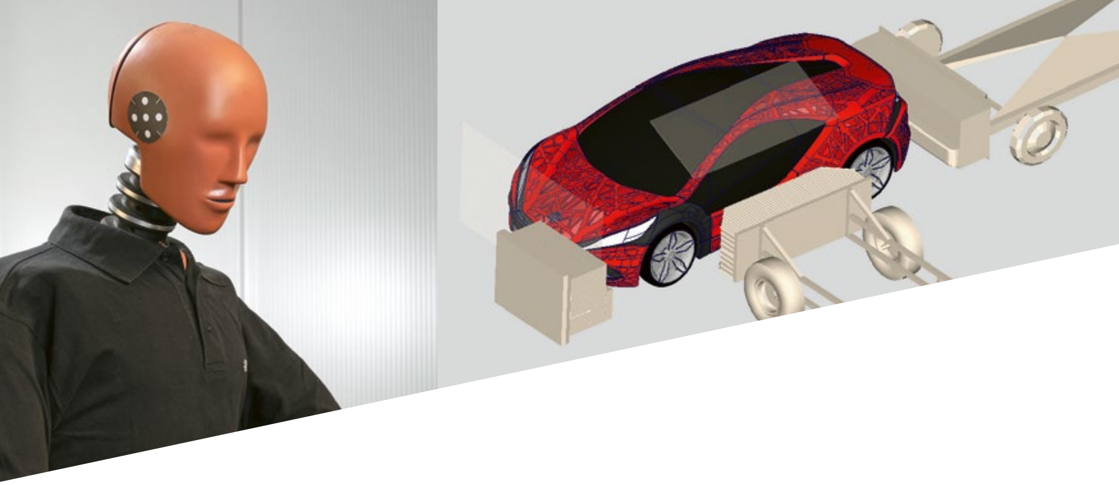
Test Protocol 3.0.3

Scoring Table: NEW 2020

v0 (km/h) / Scenario	CPFA-50	CPNA-25	CPNA-25	CPNA-75	CPNA-75	CPNC-50	CPLA-50	CPLA-25	CPTA Farside	CPTA Nearside	CPRA Stationary	CPRA Moving
	points available per test speed											
light conditions	day	day	night	day	night	day	day & night		day	day	day	day
function assessed	AEB	AEB	AEB	AEB	AEB	AEB	AEB	FCW	AEB	AEB	AEB	AEB
4											1	1
8											1	1
10	1	1	1	1	1	1			1	1		
15	1	1	1	1	1	1			1			
20	1	1	1	1	1	1	1		1			
25	1	1	1	1	1	1	1					
30	2	2	1	2	1	2	1					
35	3	3	2	3	2	3	2					
40	3	3	2	3	2	3	2					
45	3	3	3	3	3	3	3					
50	2	2	3	2	3	2	3	3				
55	2	2	3	2	3	2	3	3				
60	1	1	2	1	2	1	2	2				
65								1				
70								1				
75								1				
80								1				
max. total scenario score (1)	20	20	20	20	20	20	30 day / 30 night		4		2	2
normalized scores (2)	actual score / (1)											
scenario points (3)	0.5	0.25	1	0.25	1	1	1 day / 1 night		1		1	1
AEB Pedestrian total points	Σ(2)·(3) *max. 9 points*											

Scoring method:

- (magenta) pass / fail: points are awarded for full avoidance
- (yellow) score = points x (v_0 - v_{impact}) / v_0
- (light yellow) pass / fail: points are awarded if $v_{impact} \leq v_0$ - 20 km/h
- (orange) pass / fail: points are awarded if Forward Collision Warning (FCW) is issued @ TTC ≥ 1.7 s, or if the manufacturer demonstrates that their ESS (Emergency Steering Support) system provides appropriate support to avoid the collision



VEHICLE SAFETY – SIMULATION AND TESTING

Specialists for the development of vehicle safety – From concept to SOP

- Development of active and passive vehicle safety respecting legal, consumer rating and customer requirements
- Validation of conventional and alternative powertrain variants (HV, H2)
- Functional development and management of safety attributes
- CAE
- Component development of restraint systems
- Testing and coordination of component, system and the complete vehicle
- Execution of certification testing and homologation support

Our support throughout the process chain is reflected in EDAGs complete vehicle development projects.

Contact
EDAG Engineering GmbH
Kreuzberger Ring 40
65205 Wiesbaden
Germany

safety@edag.com

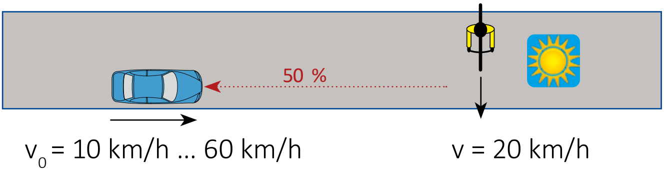
EDAG

Euro NCAP / ANCAP Test Method for AEB VRU-Cyclist

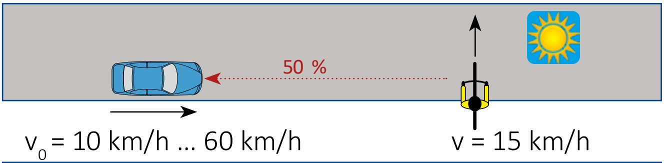
Assessment Protocol 10.0.3

Test Protocol 3.0.3

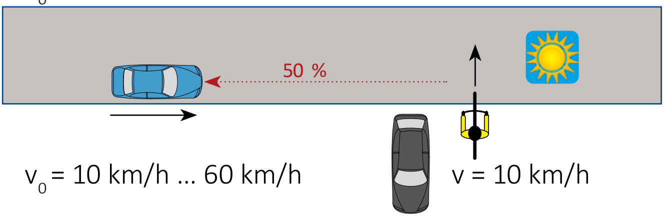
Cyclist, Unobstructed, Farside, Impact at 50 % of the Vehicle Width (CBFA-50) NEW 2020



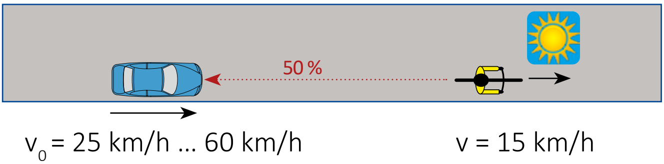
Cyclist, Unobstructed, Nearside, Impact at 50 % of the Vehicle Width (CBNA-50)



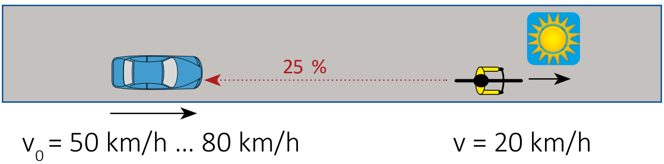
Cyclist, Obstructed, Nearside, Impact at 50 % of the Vehicle Width (CBNAO-50) NEW 2020



Cyclist, Unobstructed, Longitudinal, Impact at 50 % of the Vehicle Width (CBLA-50)



Cyclist, Unobstructed, Longitudinal, Impact at 25 % of the Vehicle Width (CBLA-25)



daylight testing

Prerequisites for Scoring:

- The AEB system must be default ON at the start of every journey.
- The system may not automatically switch off at a speed < 80 km/h.
- The score of the pedestrian impact tests (legforms & head) must be ≥ 18 points.

Euro NCAP / ANCAP Test Method for AEB VRU-Cyclist

Assessment Protocol 10.0.3

Test Protocol 3.0.3

Scoring Table:

v0 (km/h)	Scenario	CBFA-50	CBNA-50	CBNAO-50	CBLA-50	CBLA-25
			points available per test speed			
	light conditions	day	day	day	day	day
	function assessed	AEB	AEB	AEB	AEB	FCW
10		1	1	1		
15		1	1	1		
20		1	1	1		
25		1	1	1	1	
30		1	1	1	1	
35		1	1	1	2	
40		1	1	1	2	
45		1	1	1	3	
50		1	1	1	3	3
55		1	1	1	3	3
60		1	1	1	1	1
65						1
70						1
75						1
80						1
max. total scenario score (1)		11	11	11	27	
normalized scores (2)		actual score / (1)				
scenario points (3)		3	1.5	1.5	3	
AEB Cyclist total points		Σ(2)·(3) *max. 9 points*				

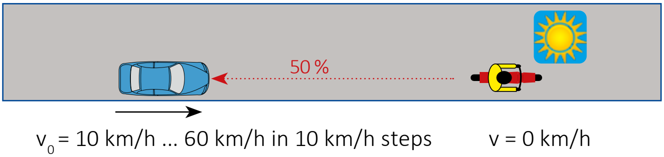
Scoring method:

- score = points x (v_0 - v_{impact}) / v_0
- pass / fail: points are awarded if $v_{impact} \leq v_0$ - 20 km/h
- pass / fail: points are awarded if Forward Collision Warning (FCW) is issued @ TTC ≥ 1.7 s, or if the manufacturer demonstrates that their ESS (Emergency Steering Support) system provides appropriate support to avoid the collision

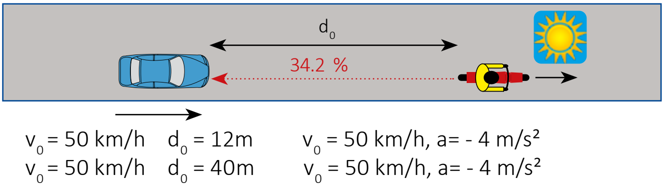
Test Method for AEB PTW

The **MUSE** (Motorbike Users Safety Enhancement) project has developed test and assessment procedures for AEB PTW (Powered Two Wheelers) that are a basis for **Euro NCAP's AEB PTW** assessment starting in 2022. Please note that the actual Euro NCAP protocols are not available at this time and may differ from the information presented here.

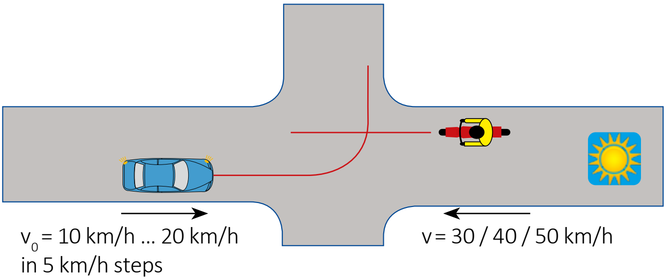
Motorcycle, stationary, Unobstructed, Longitudinal, Impact at 50 % of the Vehicle Width (CMRs)



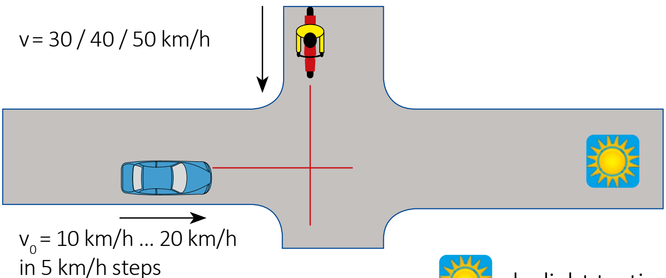
Motorcycle, braking, Unobstructed, Longitudinal, Impact at 34.2 % of the Vehicle Width (CMRb)



CMFtap: Motorcycle, Front turn across path, Impact at 50 % Overlap



CMFscp-L: Motorcycle, Front straight cross path Left, Impact at 81.6 % Overlap



daylight testing

Scoring Table for CMFTap and CMFscp-L:

		points available per test speed		
v_0 (km/h)	v_{GMT}	30 km/h	40 km/h	50 km/h
10		1	1	1
15		1	1	1
20		1	1	1
max. total score (1)		∑ = 9		
normalized scores (2)		actual score / (1)		
scenario points (3)		3		
AEB CMFtap/ CMFscp-L total points		Σ(2)·(3)		

Scoring method:

pass / fail: points are awarded for full avoidance

MOTORBIKE USERS SAFETY ENHANCEMENT

Source: MUSE – UTAC CERAM

Scoring Table for CMR:

v_0 (km/h)	remaining impact speed v_{impact} (km/h)				points available		
					CMRs	CMRb	
					AEB	AEB	FCW
10	0			> 0	1		
20	0			> 0	1		
30	< 5	< 15	< 20	≥ 20	1		
40	< 5	< 15	< 20	≥ 20	1		
50	< 5	< 15	< 20	≥ 20	1	1x2	1x2
60	< 5	< 20	< 20	≥ 20	1		
max. total score (1)					∑ = 6	∑ = 2	∑ = 2
normalized scores (2)					actual score / (1)		
scenario points (3)					0.5	0.3	0.2
AEB CMR total points					Σ(2)·(3)		

Scoring method:

1.0	0.75	0.5	0	

points are awarded depending on v_{impact} levels

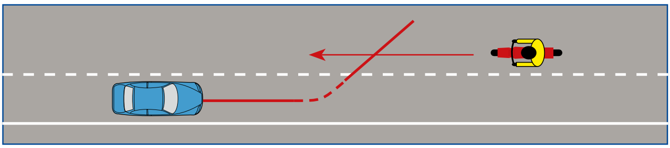
Total AEB Car-to-PTW Score:

The maximum total score for AEB Car-to-PTW is **7.0 points** (1.0 pt. CMR + 3.0 pt. CMFTap + 3.0 pt. CMFscp-L).

Test Method for Lane Support Systems PTW

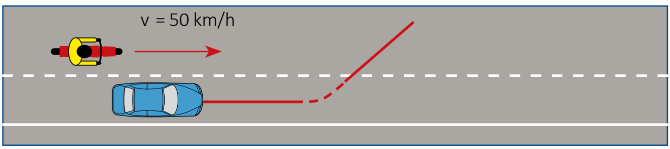
The **MUSE** (Motorbike Users Safety Enhancement) project has developed test and assessment procedures for LSS PTW (Powered Two Wheeler) that are a basis for **Euro NCAP's LSS PTW** assessment starting in 2022. Please note that the actual Euro NCAP protocols are not available at this time and may differ from the information presented here.

Emergency Lane Keeping Oncoming Motorcycle: fully marked lane



v_0 = 72 km/h, v_{lat} = 0.3 - 0.6 m/s in 0.1 m/s steps, R = 1200 m   v = 50 km/h

Emergency Lane Keeping Overtaking Motorcycle: fully marked lane



v_0 = 40 km/h, v_{lat} = 0.6 - 0.9 m/s in 0.1 m/s steps, R = 200 m

Scoring Table for LSS PTW:

Scenario	Criteria	Points
Oncoming vehicle	full avoidance at all v_{lat}	**1.0**
Overtaking vehicle	two different warnings (visual, haptic or acoustic) ≥ 1.2 s TTC or full avoidance at all v_{lat}	**1.0**
	max. total LSS PTW score	**2.0**

Note: The score distribution proposed by the MUSE project (7 points AEB PTW + 2 points LSS PTW) differs from the proposal by the Euro NCAP Rating Group (6 points + 3 points) in the Euro NCAP Rating Review 2018 V1.1.

Source: MUSE – UTAC CERAM

Euro NCAP / ANCAP Test Method for AEB Car-to-Car

Assessment Protocol 9.0.3

Test Protocol 3.0.2

Prerequisites for Scoring in AEB Car-to-Car:

- AEB system needs to be default ON at the start of every journey and de-activation should not be possible with a single push on a button
- AEB and/or FCW may not automatically switch off at speeds below 130 km/h and should have similar performance at the same relative speeds as tested
- audible component of FCW needs to be loud and clear
- for CCRs only: Whiplash score for front seat must be at least “good”, full avoidance must be achieved for speeds ≤ 20 km/h in all overlap situations

Car-to-Car Rear

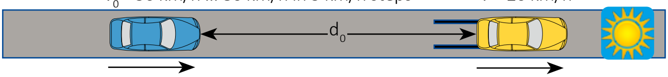
CCRs*: Approach to stationary Target with ± 50 % / ± 75 % / 100 % Overlap
AEB + FCW

v_0 = 10 km/h ... 80 km/h in 5 km/h steps   v = 0 km/h

CCRm*: Approach to slower Target with ± 50 % / ± 75 % / 100 % Overlap
AEB + FCW

v_0 = 30 km/h ... 80 km/h in 5 km/h steps   v = 20 km/h

CCRb*: Approach to braking Target 100 % Overlap
AEB + FCW

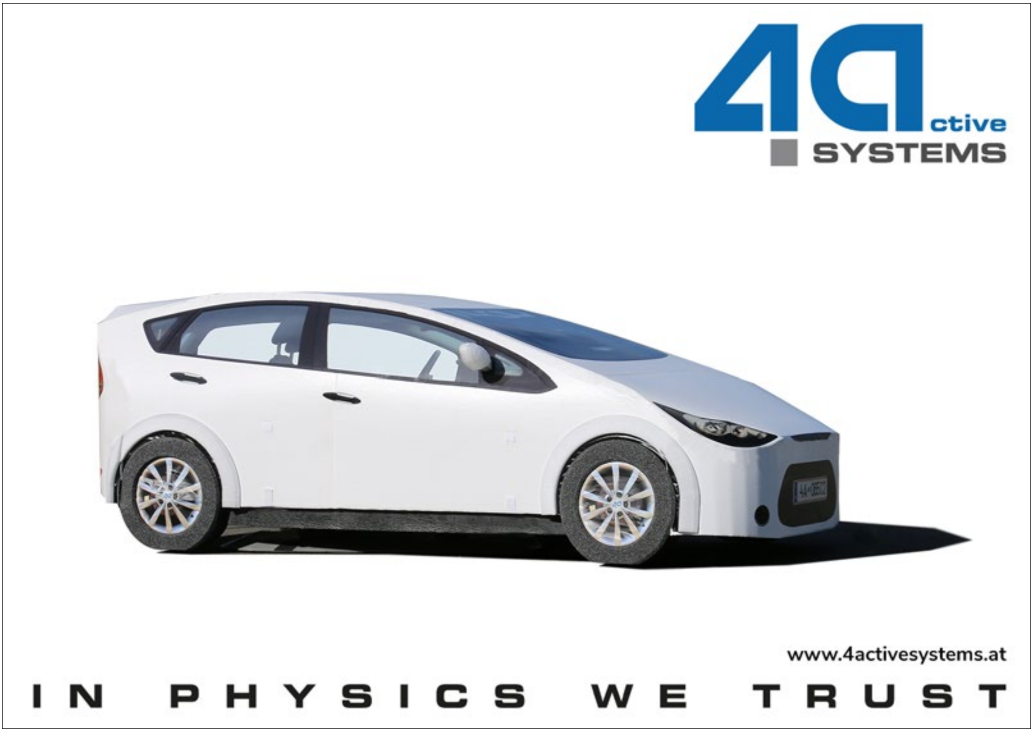


v_0 = 50 km/h	d_0 = 12 m	v_0 = 50 km/h, a = -2 m/s²
v_0 = 50 km/h	d_0 = 40 m	v_0 = 50 km/h, a = -2 m/s²
v_0 = 50 km/h	d_0 = 12 m	v_0 = 50 km/h, a = -6 m/s²
v_0 = 50 km/h	d_0 = 40 m	v_0 = 50 km/h, a = -6 m/s²

* CCR: Car-To-Car Rear; s: stationary; m: moving; b: braking

Scoring Table:

v_0 (km/h)	remaining impact speed V_{impact} (km/h)					Points available				remaining relative impact speed $V_{relative\ impact}$ (km/h)					Points available	
						CCRs		CCRb							CCRm	
						AEB	FCW	AEB	FCW						AEB	FCW
10	0				> 0	1										
15	0				> 0	2										
20	0				> 0	2										
25	< 5		< 15		≥ 15	2										
30	< 5	< 15	< 25		≥ 25	2	2			< 5				≥ 5	1	
35	< 5	< 15	< 25		≥ 25	2	2			< 5				≥ 5	1	
40	< 5	< 15	< 25	< 35	≥ 35	1	2			< 5		< 15		≥ 15	1	
45	< 5	< 15	< 25	< 35	≥ 35	1	2			< 5		< 15		≥ 15	1	
50	< 5	< 15	< 30	< 40	≥ 40	1	3	1x4	1x4	< 5	< 15	< 25		≥ 25	1	1
55	< 5	< 15	< 30	< 45	≥ 45		2			< 5	< 15	< 25		≥ 25	1	1
60	< 5	< 20	< 35	< 50	≥ 50		1			< 5	< 15	< 25	< 35	≥ 35	1	1
65	< 5	< 20	< 40	< 55	≥ 55		1			< 5	< 15	< 25	< 35	≥ 35	2	2
70	< 5	< 20	< 40	< 60	≥ 60		1			< 5	< 15	< 30	< 40	≥ 40	2	2
75	< 5	< 25	< 45	< 65	≥ 65		1			< 5	< 15	< 30	< 45	≥ 45	2	2
80	< 5	< 25	< 50	< 70	≥ 70		1			< 5	< 20	< 35	< 50	≥ 50	2	2
Grid point score	1.0	0.75	0.5	0.25	0	∑=14	∑=18	∑=4	∑=4	1.0	0.75	0.5	0.25	0	∑=15	∑=11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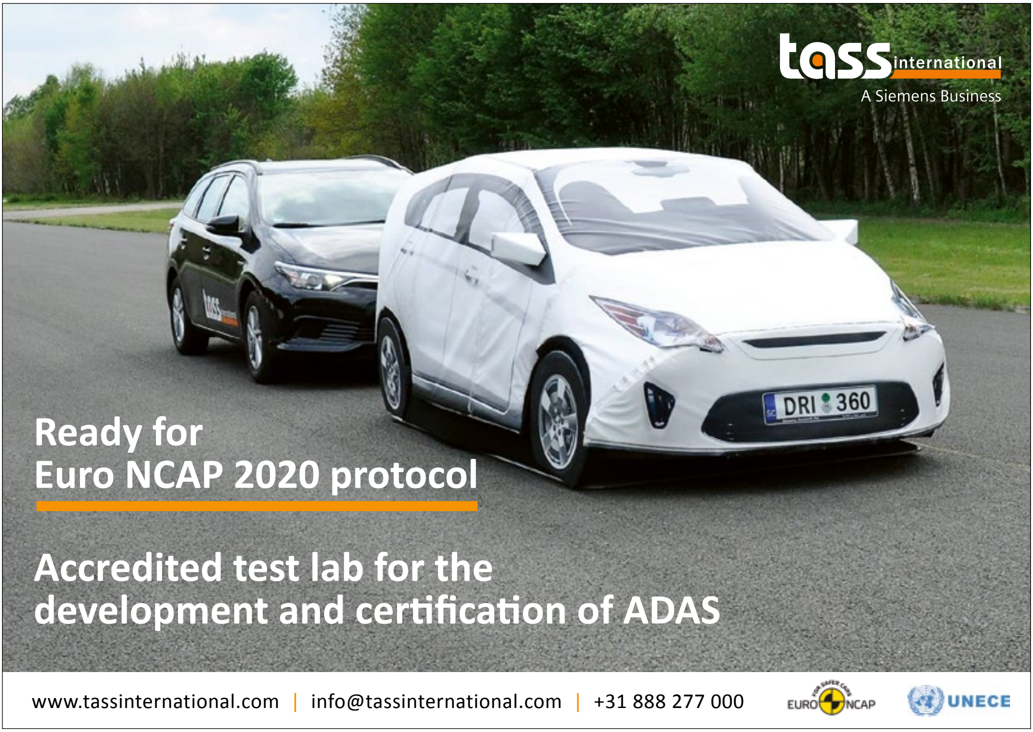
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Euro NCAP / ANCAP Test Method for AEB Car-to-Car

Assessment Protocol 9.0.3

Test Protocol 3.0.2

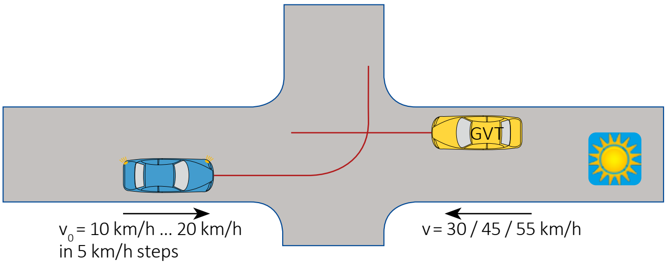
For each test speed **5 grid points** representing the 5 overlap scenarios (-75 %, -50 %, 100 %, +50 %, +75 %) are evaluated.
The **score per test speed v_0** for AEB and FCW is calculated as **∑ grid point scores[1] x points available / 6**
The **score per scenario and system** (AEB/FCW) is calculated as **∑ score per test speed v_0 / ∑ points available**
The **score per system** (AEB/FCW) is the **average score per scenario of that system.** The score per system is multiplied with **2.0 points for AEB** and **1.5 points for FCW**.
Where FCW does not result in full avoidance in the - 50 % overlap[2] grid points, the manufacturer can alternatively demonstrate that their **EES (Emergency Steering Support)** system functions to avoid the collision.
Manufacturers are expected to provide a prediction of the grid point scores. This predicted score per system is multiplied with the correction factor resulting from 10 verification tests for that system conducted by Euro NCAP[3]:

Correction factor = actual tested score / predicted score

Car-to-Car Front turn across path

AEB CCFtap

CCFtap: Front turn across path
Impact at 50 % Overlap
AEB



Scoring Table:

		points available per test speed		
v_0 (km/h)	v_{GVT}	30 km/h	45 km/h	55 km/h
10		1	1	1
15		1	1	1
20		1	1	1
max. total score (1)		9		
normalized scores (2)		actual score / (1)		
scenario points (3)		2		
AEB CCFtap total points		Σ(2)·(3) *max. 2 points*		

Scoring method:

pass / fail: points are awarded for full avoidance

Human Machine Interface

HMI points are added if there is a **supplementary warning** (other than audiovisual) for FCW (1 point) and if there is a **reversible belt pre-pretensioning** in the pre-crash phase (1 point). The HMI score is scaled down to a max. of **0.5 points**.

Total AEB Car-to-Car Score

The maximum total score for AEB Car-to-Car is 6 points (2 pt. CCR AEB + 1.5 pt. CCR FCW + 2.0 pt. CCFtap + 0.5 pt. HMI)

[1] where the score of the 100 % overlap grid point is double counted
[2] + 50 % overlap for RHD vehicles
[3] plus up to 10 additional tests sponsored by the manufacturer

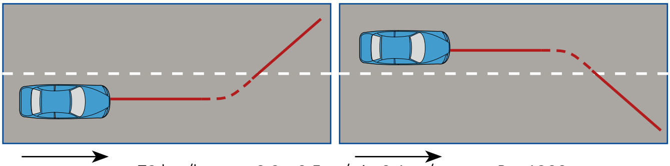
Euro NCAP / ANCAP Test Method for Lane Support Systems

Assessment Protocol 9.0.3

Test Protocol 3.0.2

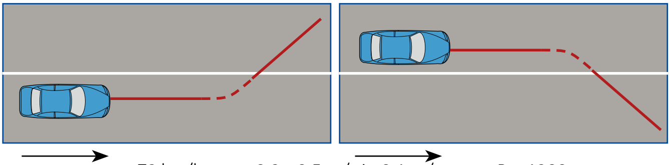
LDW

Lane Departure Warning Dashed Line



v_0 = 72 km/h, v_{lat} = 0.2 - 0.5 m/s in 0.1 m/s steps, R = 1200 m

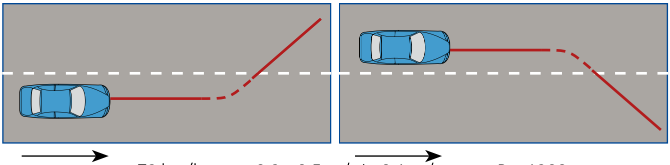
Lane Departure Warning Solid Line



v_0 = 72 km/h, v_{lat} = 0.2 - 0.5 m/s in 0.1 m/s steps, R = 1200 m

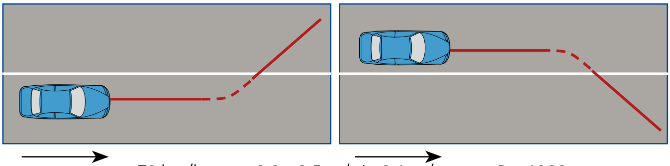
LKA

Lane Keep Assist Dashed Line: Single Line



v_0 = 72 km/h, v_{lat} = 0.2 - 0.5 m/s in 0.1 m/s steps, R = 1200 m

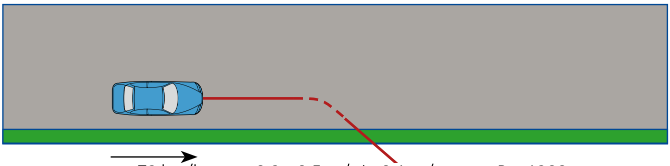
Lane Keep Assist Solid Line: Single Line



v_0 = 72 km/h, v_{lat} = 0.2 - 0.5 m/s in 0.1 m/s steps, R = 1200 m

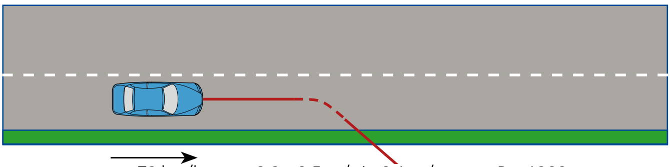
ELK

Emergency Lane Keeping Road Edge: no Centerline & no Line next to Road Edge



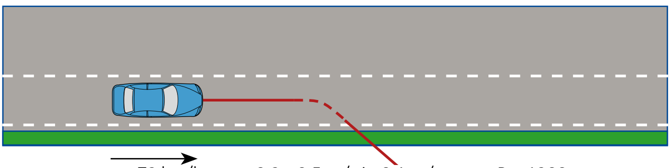
v_0 = 72 km/h, v_{lat} = 0.2 - 0.5 m/s in 0.1 m/s steps, R = 1200 m

Emergency Lane Keeping Road Edge: Dashed/Solid Centerline & no Line next to Road Edge



v_0 = 72 km/h, v_{lat} = 0.2 - 0.5 m/s in 0.1 m/s steps, R = 1200 m

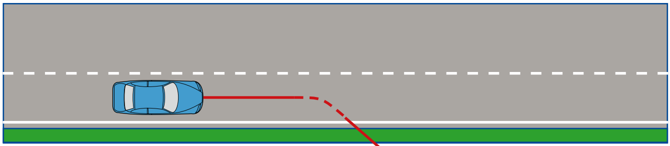
Emergency Lane Keeping Road Edge: Dashed/Solid Centerline & Dashed Line next to Road Edge



v_0 = 72 km/h, v_{lat} = 0.2 - 0.5 m/s in 0.1 m/s steps, R = 1200 m

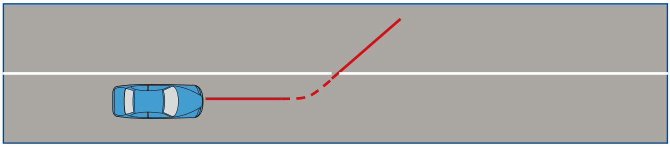
ELK

Emergency Lane Keeping
Road Edge: Dashed/Solid Centerline & Solid Line next to Road Edge



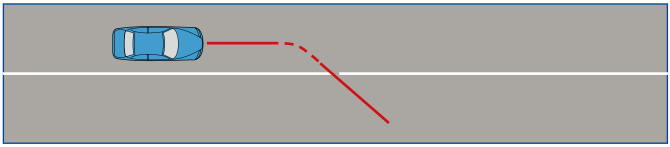
v_0 = 72 km/h, v_{lat} = 0.2 - 0.5 m/s in 0.1 m/s steps, R = 1200 m

Emergency Lane Keeping
Solid Line:
Single Line



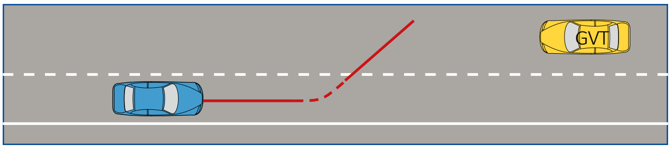
v_0 = 72 km/h, v_{lat} = 0.2 - 0.5 m/s in 0.1 m/s steps, R = 1200 m

Emergency Lane Keeping
Solid Line:
Single Line



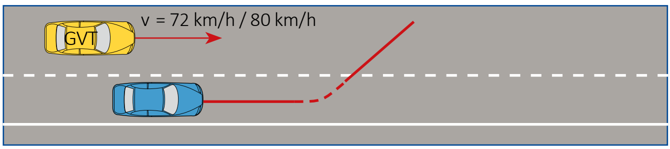
v_0 = 72 km/h, v_{lat} = 0.2 - 0.5 m/s in 0.1 m/s steps, R = 1200 m

Emergency Lane Keeping
Oncoming Vehicle:
Fully Marked Lane



v_0 = 72 km/h, v_{lat} = 0.3 - 0.6 m/s in 0.1 m/s steps, R = 1200 m   v = 72 km/h

Emergency Lane Keeping
Overtaking Vehicle:
Fully Marked Lane



v_0 = 72 km/h, v_{lat} = 0.3 - 0.6 m/s in 0.1 m/s steps, R = 1200 m (unintentional)
v_0 = 72 km/h, v_{lat} = 0.5 - 0.7 m/s in 0.1 m/s steps, R = 800 m (intentional)

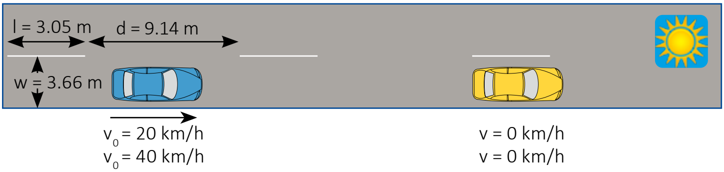
Lane Support Systems (LSS)				DTLE[1]	Points	
Human Machine Interface (HMI)	Lane Departure Warning (LDW)			> -0.2 m	0.50	**0.50[2]**
	Blind Spot Monitoring (BSM)			-	0.50	
Lane Keep Assist (LKA)	Dashed Line	single line		> -0.3 m	0.25	**0.50**
	Solid Line	single line		> -0.3 m	0.25	
Emergency Lane Keeping (ELK)	Road Edge	Centerline	Road edge			**3.00**
		no line	no line	> -0.1 m	0.25	
		dashed	no line	> -0.1 m	0.25	
		dashed	dashed line	> -0.1 m	0.25	
		dashed	solid line	> -0.1 m	0.25	
	Solid Line	single line		>-0.3 m	0.50	
	Oncoming Vehicle	fully marked lane			1.00	
	Overtaking Vehicle	fully marked lane			0.50	

[1] Distance To Lane Edge
[2] max. HMI score limited to 0.50 points

IIHS AEB / Front Crash Prevention Test

AEB Test Protocol, V. I, Oct 2013

Approach to stationary target



Assessment:

	20 km/h Test			40 km/h Test				FCW
Speed reduction	< 8 km/h	8 - 14 km/h	≥ 15 km/h	< 8 km/h	8 - 14 km/h	15 - 34 km/h	≥ 35 km/h	
Points	0	1	2	0	1	2	3	1

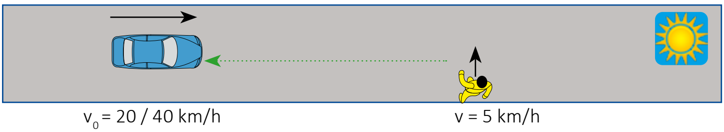
Rating Scheme:

Points	1	2 - 4	> 5
Rating	BASIC	ADVANCED	SUPERIOR

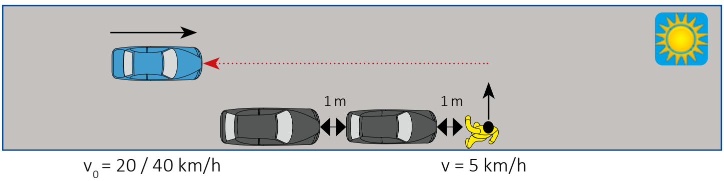
IIHS Test Scenarios for AEB Pedestrian

Pedestrian AEB Test Protocol, V. II, Feb 2019

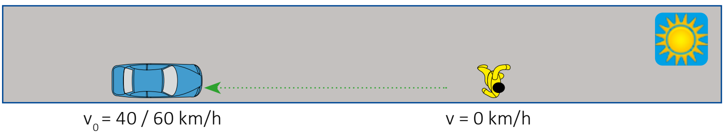
Adult, Nearside, Impact at 25 % of the Vehicle Width (CPNA-25)
day AEB



Child, Obstruction, Nearside, Impact at 50 % of the Vehicle Width (CPNC-50)
day AEB



Adult, Longitudinal, Impact at 25 % of the Vehicle Width (CPLA-25)
day AEB FCW(@ 60 km/h only)



Speed reduction [km/h]	0 ... 8	9 ... 18	19 ... 28	29 ... 38	39 ... 48	49 ... 58	59 ... 61
Points	0.0	0.5	1.0	1.5	2.0	2.5	3.0

1.0 points are awarded if a FCW is given ≥ 2.1 s time to collision in the CPLA-25$_{60\ km/h}$ scenario

Overall Score = $0.7 \cdot (\text{CPNA-25}_{20} + \text{CPNA-25}_{40} + \text{CPNC-50}_{20} + \text{CPNC-50}_{40}) + 0.3 \cdot (\text{CPLA-25}_{40} + \text{CPLA-25}_{60} + \text{FCW}_{60})$

Overall score	0	< 3	< 5	≥5
Rating	No Credit	Basic	Advanced	Superior

U.S. NCAP Crash Imminent Braking

CRASH IMMINENT BRAKE SYSTEM PERFORMANCE EVALUTION, Oct 2015

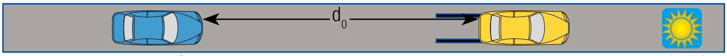
LVS (Lead Vehicle Stopped)
Approach to stationary target

v_0 = 25 mph (40.2 km/h)
v = 0 mph

LVM (Lead Vehicle Moving)
Approach to slower target

v_0 = 25 mph (40.2 km/h)
v_0 = 45 mph (72.4 km/h)
v = 10 mph (16.1 km/h)
v = 20 mph (32.2 km/h)

LVD (Lead Vehicle Decelerating)
Approach to braking target



v_0 = 35 mph (56.3 km/h) d_0 = 45.3 ft (13.8 m) ± 8 ft (2.4 m)
v_0 = 35 mph (56.3 km/h)
a = -0.3 g

False Positive Test
Approach to steel trench plate

v_0 = 25 mph (40.2 km/h)
v_0 = 45 mph (72.4 km/h)
8 ft x 12 ft x 1 in (2.4 m x 3.7 m x 25 mm)

Requirements

Scenario	LVS	LVM 25 mph	LVM 45 mph	LVD	False Positive
Requirement	Δv ≥ 9.8 mph (15.8 km/h)	no impact	Δv ≥ 9.8 mph (15.8 km/h)	Δv ≥ 10.5 mph (16.9 km/h)	deceleration ≤ 0.5 g

U.S. NCAP Forward Collision Warning

FORWARD COLLISION WARNING SYSTEM CONFIRMATION TEST, Feb 2013

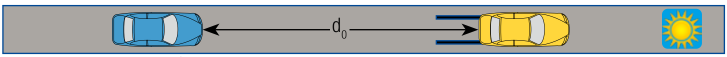
LVS (Lead Vehicle Stopped)
Approach to stationary target

v_0 = 45 mph (72.4 km/h)
v = 0 mph

LVM (Lead Vehicle Moving)
Approach to slower target

v_0 = 45 mph (72.4 km/h)
v = 20 mph (32.2 km/h)

LVD (Lead Vehicle Decelerating)
Approach to braking target



v_0 = 45 mph (72.4 km/h) d_0 = 89.4 ft (30 m) ± 8.2 ft (2.5 m)
v_0 = 45 mph (72.4 km/h).
a = -0.3 g

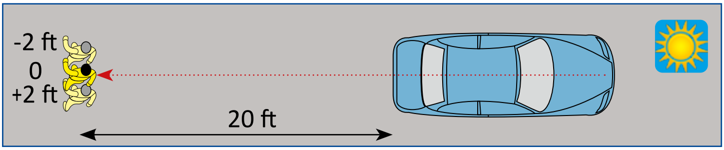
Requirements

Scenario	LVS	LVM	LVD
Requirement	Alert no later than 2.1 s TTC	Alert no later than 2.0 s TTC	Alert no later than 2.4 s TTC

U.S. NCAP Rear Automatic Braking*

Rear Automatic Braking Feature Confirmation Test Procedure (Working Draft), Dec 2015

Child, 20 ft (6.096 m) behind rearmost point of bumper @ 0/+2/-2 ft from centerline



Dummy

- 4a Euro NCAP Pedestrian - Child Dummy static

Test Procedure

- Place the direction selector in reverse while maintaining full pressure on the brake pedal.
- Release the vehicle's brake pedal and allow the vehicle to coast backward while maintaining the vehicle's centerline within +/- 1 inch of the longitudinal line marked on the ground.
- Allow the vehicle to coast until the rear automatic braking feature intervenes by automatically engaging the service brakes bring the vehicle to a stop or until the vehicle strikes the test object. Once either of these two outcomes occurs, the vehicle's brake pedal should be depressed to end the test trial. Every effort must be made to safely conduct this test. If testing indoors, proper ventilation must be provided. No personnel shall be located to the rear of a test vehicle at any time during the test trial.

Requirements

- A positive test outcome would involve the vehicle coming to a stop before it reaches the location of the test object and with no physical contact with the test object for each of the three test object locations assessed.

* Please note: The rear automatic brake test is part of the planned U.S. NCAP upgrade. The test procedure and requirements are based on "Rear Automatic Braking Feature Confirmation Test Procedure (Working Draft), December 2015". Docket NHTSA-2015-0119.

C-NCAP Active Safety Rating

Protocol 2020

AEB CCR

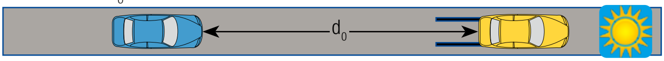
CCRs*: Approach to stationary target
AEB + FCW

AEB v_0 = 20 / 30 / 40 km/h — v = 0 km/h
FCW v_0 = 45 / 55 / 75 km/h

CCRm*: Approach to slower target
AEB + FCW

AEB v_0 = 30 / 45 / 65 km/h — v = 20 km/h
FCW v_0 = 50 / 60 / 75 km/h

CCRb*: Approach to braking target
AEB + FCW



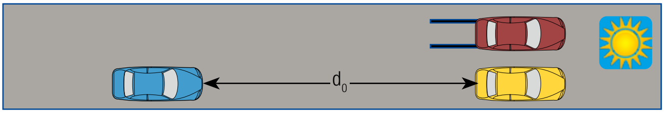
v_0 = 50 km/h — d_0 = 12 m — v_0 = 50 km/h, a = -4 m/s²
v_0 = 50 km/h — d_0 = 40 m — v_0 = 50 km/h, a = -4 m/s²

* CCR: Car-To-Car Rear; s: stationary; m: moving; b: braking

False Positive Test
Approach to steel trench plate

v_0 = 40 / 72 km/h — 2.4 m x 3.7 m x 25 mm

False Positive Test
Adjacent lane vehicle braking

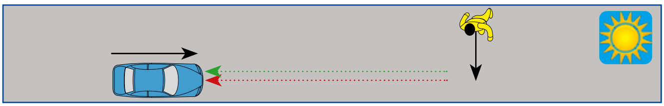


v_0 = 40 km/h — d_0 = 15 m — v_0 = 40 km/h, a = -3 m/s²

7 Points

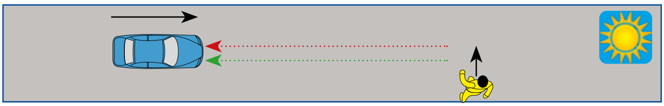
AEB VRU_Ped

Adult, Farside, Impact at 25 & 50 % of the Vehicle Width (CVFA-25/50)
AEB



v_0 = 20 km/h ... 60 km/h — v = 6.5 km/h

Adult, Nearside, Impact at 25 & 75 % of the Vehicle Width (CPNA-25/75)
AEB



v_0 = 20 km/h ... 60 km/h — v = 5 km/h

3 Points

ESC

ESC System must meet the requirements of **GB/T 30677-2014**. Performance test report issued by a qualified third party institution must be submitted to C-NCAP. Alternatively the test report can be based on **GTR 8, UN R13H (R140) or FMVSS 126** but should not be in violation of GB/T 30677-2014.

4 Points

Opt

Optional Systems: Lane Departure Warning, Speed Assistance System, Blind Spot Detection (Car-to-Car)

1 Point per system / Max. 2 Points total

Max. 15 Points total

automotive CAE GRAND CHALLENGE

September 29 – 30, 2020
Congress Park Hanau
Germany

Computer simulation has become an indispensable tool in automotive development. Tremendous progress in software and computer technology makes it possible today to assess product and process performance before physical prototypes have been built. Despite of significant progress in simulation technology and impressive results in industrial application there remains a number of challenges which prevent a "100 % digital prototyping". We at carhs.training call these Grand Challenges.

Automotive CAE Grand Challenge offers a Platform for Dialogue

The automotive CAE Grand Challenge stimulates the exchange between users, scientists and software developers in order to solve these challenges. Annually the current, critical challenges in automotive CAE are being identified through a survey among the simulation experts of the international automotive industry. In the conference one session is dedicated to each of the most critical challenges, the so-called Grand Challenges. In each session CAE experts from industry, research and software development will explain the importance of the individual Challenge for the virtual development process and talk about their efforts to solve the challenge.

Automotive CAE Grand Challenges 2020

In September 2019 we have determined the important current challenges of automotive CAE - the so-called "Grand Challenges" - through a survey among the CAE experts of the international automotive industry. These "Grand Challenges" will form the topics of the sessions of our automotive CAE Grand Challenge 2020 conference:

- **CAE General: Influence of Scatter on Simulation Results**
- **CAE Process: Evaluating Simulation and Test Results with AI + ML**
- **Crash: Modeling of Wheels for the Small Overlap Test**
- **Durability: Fatigue of Welded Connections**
- **NVH: Accuracy of Acoustic Simulations**
- **Optimization: Use of Reduced Order Modeling for Fast Optimization**
- **Safety: Use of Human Body Models in Autonomous Vehicle Safety**

Who should attend?

The conference intends bringing together industrial users, researchers and software developers to discuss these current, critical challenges of automotive CAE and to initiate collaboration between these groups to help overcoming the Grand Challenges of automotive CAE. The presentation program of the conference provides both experts and beginners valuable information for their daily work. The possibility to meet and exchange with all stakeholders of automotive CAE is a great opportunity. In the accompanying exhibition participants can receive additional information from leading companies of CAE.

DATE	29.-30. September 2020
HOMEPAGE	www.carhs.de/grandchallenge
VENUE	Congress Park Hanau, Schloßplatz 1, 63450 Hanau
LANGUAGE	Englisch
PRICE	980,- EUR till 01.09.2020, thereafter 1.180,- EUR

HUMAN MODELING AND SIMULATION
IN AUTOMOTIVE ENGINEERING

The application of numerical simulation incorporating digital human models offers exciting opportunities in automotive development. Applying human models in comfort, ergonomics and safety allows to overcome limitations imposed by the use of real humans or their mechanical surrogates and thus enables further optimization of automotive designs.

Autonomous vehicles will bring significant comfort benefits to passengers. However, safety cannot be compromised for alternative seating positions. Human Modeling and Simulation is currently the only technology that will allow assessment of occupant protection for new car interior architectures with flexible seat arrangements.

In November 2020 the 8th International Symposium Human Modeling and Simulation in Automotive Engineering will be held. The symposium intends to continue and further advance the dialog between researchers, software developers and industrial users of human models. Presentations from renowned researchers, software manufacturers and industrial users on biomechanical research, digital human models and their application in automotive development will make up a most interesting conference.

The 8th symposium is again organized in cooperation with Wayne State University‘s renowned Bioengineering Centre, which has been a pioneer and leading institution in biomechanics research for automotive safety for 75 years.

Conference Topics

- Occupant Protection for Autonomous Vehicles
- Biomechanical Research
- Development of Human Models and Simulation Software
- Industrial Applications of Human Models
- **Focus Theme:** Occupant Protection for Autonomous Vehicles

Image: Wiesbaden Congress & Marketing GmbH

Who should attend?

Engineers, researchers, software developers and managers involved in automotive or software development will benefit from participating in the symposium.

FACTS

DATE	19.-20. November 2020
HOMEPAGE	www.carhs.de/humo
VENUE	Hotel Oranien, Wiesbaden
LANGUAGE	Englisch
PRICE	1.490,- EUR till 22.10.2020, thereafter 1.750,- EUR

Model Based Head Injury Criteria within Industry

Course Description

To prevent injuries resulting from head impacts inside and outside the car, the next generation of head protection design will have to be based on improved model-based head injury criteria including virtual or coupled experimental and virtual methods. These novel approaches will consider linear and rotational head acceleration vs time and take into account a range of head injury mechanisms. By implementing recent research tools into new design methods, it will be possible in a near future, to propose protective structures and panels to be optimized against biomechanical injury criteria including the challenging aspect of mild brain injury. An analysis of how SUF-EHM is monitored within Euro NCAP will be exposed as well.

Course Objectives

The objective of this course is to provide an overview of head trauma biomechanics and existing head injury criteria. Focus will then be on the state of the art in the domain of human head FE modeling, both its limitations and its recent achievements. Special attention will be paid to real world head trauma reconstruction and the derivation of model based head injury criteria. Finally the novel head injury prediction tool SUFEHM (Strasbourg University Finite Element Head Model) will be presented, with special focus to its implementation into an industrial environment It will be shown how the assessment of head injury risk is conducted in the context of an experimental crash scenario and how new protection design is evaluated in a virtual testing environment.

Who should attend?

This seminar is especially suited for engineers and technicians who work on experimental or numerical development of vehicle interior parts or pedestrian protection, who want to prepare the next generation of head protection design based on virtual methods.

Course Contents

- Introduction
- Human head surrogates and existing head injury criteria
- Overview of head protection standards
- The state of the art in human head FE modeling
  - Overview of existing head models
  - Model validation issues
- Real world head trauma simulation
  - Head trauma database
  - Victim kinematics and head impact conditions
  - FE modeling of the head trauma
- Model-based head injury criteria
  - Methodology
  - Injury criteria for different injury mechanisms
  - Age dependent issues (elderly and children)
- Application to head protection
  - Optimization against biomechanical injury criteria
  - Focus on the implementation of the tool SUFEHM within an industrial environment (experimental and virtual testing)
- Conclusion and next steps

A Pre-Conference Seminar of

HUMAN MODELING AND SIMULATION
IN AUTOMOTIVE ENGINEERING

Instructor

Prof. Dr. Rémy Willinger (University of Strasbourg) has been leading a research group focusing on head & neck impact biomechanics at the University of Strasbourg since 1990. The research activity of this lab focuses on experimental characterization of biological tissue, head and neck FE modeling and injury mechanisms investigation via accident simulation. Development of injury criteria and protection systems modeling and optimization are also part of his skills. This group contributed to ten EU projects and conducted no less than 100 contracts with public institutions and private companies.

Date

DATE	COURSE ID	VENUE	DURATION	PRICE	LANGUAGE
18.11.2020	141/3592	Wiesbaden	1 Day	740,- EUR till 21.10.2020, thereafter 890,- EUR	

»AUTOMOBIL INDUSTRIE« LEICHTBAUGIPFEL

Lightweight Design Summit 2020: Lightweight Design is undergoing a Renaissance

On Juli 21/22, 2020 specialist lectures, sessions and live demonstrations will be used to demonstrate the key role that is played by lightweight design. The Lightweight Design Summit is accompanied by a large exhibition with numerous innovations and exhibits.

The **Parliamentary State Secretary to the German Federal Minister of Economics and Energy Elisabeth Winkelmeier-Becker** is expected as a keynote speaker.

Who should attend?

The Automobil Industrie Light Weight Design Summit is the platform for the communication between OEMs and suppliers. The summit addresses the technical management/CEO level of OEMs and suppliers, the purchasing management, heads of development and design, project engineers, innovation managers and materials specialists.

FACTS

DATE	21.-22. July 2020
HOMEPAGE	www.leichtbau-gipfel.de
VENUE	Vogel Convention Center, Würzburg
LANGUAGE	German with translation into English
PRICE	980,- EUR till 12.06.2020, thereafter 1.180,- EUR

Robust Design - Vehicle Development under Uncertainty

Course Description

The seminar addresses the current state of the art complemented by recent achievements in research and development to quantify and control uncertainties (lack-of-knowledge and variations) in vehicular development. Aspects of sensitivity and robustness analysis are discussed as well as topics in reliability, resilience, redundancy and model uncertainty. In addition, numerical methods for optimization with consideration of uncertainties and methods for Model Order Reduction (MOR) to reduce computational effort are discussed. Applications (e.g. NVH, crash) illustrate the usage of the methods and the fact that methods should be adapted to the degree of maturity of the design in the development process.

Course Objectives

The seminar is focused on methods and their theoretical background to enable the participants to realize applications directly in the industrial context. Hence, uncertainties can be characterized, quantified, and – together with sensitivity analysis – concept and structural evaluations are made possible, which consider robustness, reliability, resilience, and redundancy. Corresponding optimizations can then be realized in an efficient manner.

Who should attend?

The seminar is proposed for engineers with first experiences in numerical concept and series development of vehicles, who are interested in including robustness, reliability and other aspects of uncertainty management in their industrial designs.

Course Contents

- Mathematical methods for uncertainty quantification
- Linear and non-linear sensitivity analysis (global / local)
- Design of Experiments (DoE), Response Surface Methods (RSM)
- Methods for Model Order Reduction (MOR)
- Robustness versus reliability
- Robustness in early design stages (Set-based Design und Solution Space Approach)
- Methods for resilience, redundancy, model uncertainty
- Optimization under uncertainties
- Applications taken from acoustics and crashworthiness

Instructor

Prof. Dr.-Ing. Fabian Duddeck (Technical University of Munich) is the head of the research group on optimization and robustness at the Technical University of Munich (TUM, Chair of Computational Mechanics, www.bgu.tum.de/cm). His research is focusing on numerical methods for optimization of structures with respect of crashworthiness, NVH (noise, vibration, and harshness), durability, and other disciplines. In this framework, new methods for stochastic modeling and robustness assessments for different types of uncertainties (aleatoric and epistemic) are included. Besides standard approaches using probabilistic theory, possibilistic and special methods for early phase design are developed and applied for problems in automotive, aerospace, and civil engineering.

Date

DATE	COURSE ID	VENUE	DURATION	PRICE	LANGUAGE
13.-14.02.2020	144/3549	Alzenau	2 Days	1.340,- EUR till 16.01.2020, thereafter 1.590,- EUR	English
03.-04.09.2020	144/3550	Alzenau	2 Days	1.340,- EUR till 06.08.2020, thereafter 1.590,- EUR	German

Interior Development – Fundamentals, Materials, Design, Manufacturing

Course Description

The seminar illustrates the subject, in many parts with workshop character:

Part 1: Basics of Plastics - physics, chemistry and application technology, in industry and in the automobile. Processes for Rapid Prototyping and Rapid Tooling, as well as the processes of mass manufacturing, such as injection molding and blow molding, are discussed. Day 1 ends with a workshop in which, based on practical examples, functionality and choice of materials are treated.

Part 2: Plastics in Automotive Interiors deals with the use of plastics in automotive interiors and their properties. Interior components are subject to many requirements, ranging from the design appearance, look and touch and ergonomics to production and assembly. The second part explains what is being done at various stages of the interior development process. Using the example of the cockpit and the cockpit module, the materials and processes used are discussed. Due to the complexity of the topic a lot of real components are shown and their properties are discussed.

Course Objectives

The aim of the seminar is to provide the necessary skills for the design of vehicle interior components and modules. This includes in particular the choice of materials, the design and manufacturing processes.

Who should attend?

The seminar is aimed at engineers, technicians and managers who are planning and controlling interior development projects. The focus of the seminar is on the cockpit module.

Instructor

Timo Baumgärtner (csi entwicklungstechnik GmbH)

Date

SEMINAR ON DEMAND

You can book this seminar as an in-house seminar with a minimum of 5 participants directly at your site. Alternatively, if you are interested in the course, you can make a reservation. As soon as a sufficient number of participants has been reached, we will arrange a specific course date with the interested parties.

DURATION
2 Days

LANGUAGE

Structural Optimization in Automotive Design – Theory and Application

Course Description

In recent years numerical simulation has gained importance in all engineering disciplines. In the automotive industry the development process evolved from an experiment based to a virtual development process. Through this move towards simulation, mathematical optimization also gained importance and new opportunities for its application have been opened within the development process. Only a few years ago it would have been unthinkable to find the optimal cross section and the number and location of ribs for a cast part through mathematical optimization, which is now common practice. As there exists no single optimization method that is suited for all problems it is important to gain an overview over various optimization methods and their characteristics. In the seminar the most popular and reliable optimization methods will be presented. The focus will be on the explanation of the basic concepts and ideas rather than on the detailed mathematical derivations and formulations. Emphasis will be on practical applications. Possibilities for using optimization methods will be demonstrated through many industrial examples. The following questions will be answered in the seminar: Which optimization methods are suited for which problems and which are not? How big is the optimization effort? How can the optimization effort be minimized? Which possibilities exist for the formulation of different optimization problems? What can lead to failure of an optimization?

Course Objectives

At the end of the seminar participants will have gained an overview over different optimization disciplines and procedures, the areas of application and their individual limitations.

Who should attend?

The seminar is suited for engineers and technicians from research and development departments, users that intend to enlarge or fresh up their background knowledge and newcomers that want to get an overview of the subject.

Course Contents

- Local and global optimization methods and coupled strategies
- Approximation methods
- Lagrange function, dual method
- Optimality criteria methods
- Bionic optimization procedures (CAO, SKO, evolutionary algorithms, optimization with particle swarms)
- Coupling with FEM
- Formulation of optimization problems
- Sensitivity analysis
- Determination of important variables and variable reduction
- Sizing
- Shape optimization, use of morphing techniques, topology optimization
- Robustness optimization
- Multi disciplinary and multi objective optimization
- Numerous application examples

Instructor

Prof. Dr. Lothar Harzheim (Opel Automobile GmbH) worked in the Group of Professor Mattheck on the development of the optimization programs CAO and SKO, before joining the simulation department of Opel. At Opel he is responsible for optimization, bio engineering and robustness. In this position he not only introduced and applied optimization methods but has also developed software for topology optimization. Prof. Dr. Harzheim regularly holds seminars for applied structural optimization and teaches at the Technical University of Darmstadt. He is the author of the book "Strukturoptimierung: Grundlagen und Anwendungen".

Date

DATE	COURSE ID	VENUE	DURATION	PRICE	LANGUAGE
19.-20.02.2020	112/3547	Alzenau	2 Days	1.340,- EUR till 22.01.2020, thereafter 1.590,- EUR	
23.-24.11.2020	112/3548	Alzenau	2 Days	1.340,- EUR till 26.10.2020, thereafter 1.590,- EUR	

Improving Efficiency and Reducing Risk in CAE Driven Product Development

Course Description

To avoid mistakes and economic loss, CAE-applications require reasonable and reliable workflows. This seminar provides background information on risks of using CAE and gives recommendations of implementing best practice. Maintaining high quality of CAE applications and enhancing efficiency within the context of organizational structures and analysis tasks are the main focus of this seminar. Use of knowledge management builds a bridge between performing an analysis project and improving efficiency. Knowledge management is a basis for efficiency, quality of prognosis and reliability of CAE application. A holistic view onto knowledge management and knowledge based engineering will be given.

Who should attend?

The seminar is aimed at product developers, CAE engineers but also managers and decision makers who are responsible for risk, performance and efficiency of projects supported by numerical analyses.

Inhalte

- Motivation to use structured processes in CAE
- Which risks managers and analysis experts are facing?
- Use of CAE to minimize risks
- Structured process management in CAE as a means to focus improvements
- Duties of analysis experts and managers from liability and warranty issues
- Efficient and quality driven process management
- Specific procedural requirements for CAE environment and CAE processes
- Verification and validation
- Monitoring and documentation
- Quality driven practices and collaboration with suppliers

Instructor

Prof. Dr.-Ing. Klemens Rother (Munich University of Applied Sciences)

Date

SEMINAR ON DEMAND

You can book this seminar as an in-house seminar with a minimum of 5 participants directly at your site. Alternatively, if you are interested in the course, you can make a reservation. As soon as a sufficient number of participants has been reached, we will arrange a specific course date with the interested parties.

DURATION 1 Day

LANGUAGE

Design of Composite Structures

Course Description

Since the mass is one of the main factors influencing the fuel consumption of vehicles, increasing demands to reduce energy usage and CO_2 emissions, force the automotive industry to consider the use of alternative designs and new materials. Composite materials have proven their potential to reduce the weight of structures in many applications (e.g. aerospace and motorsports). As composites have a special set-up and behave completely different than traditional materials, engineers must learn how to employ these materials to take advantage of their special characteristics in the design of vehicle structures. In the seminar real world examples are used to create a basic understanding of designing composite structures. Then the theoretical and practical foundations of composite design are explained.

Course Objectives

After participating in the seminar participants are able to design and develop composite structures. They understand the specific requirements of composite structures and the related design concepts. In the seminar special attention is directed to the concurrent consideration of loading, design and manufacturing related requirements. Accordingly, the different designs - integral, differential, fully laminated and sandwich - are addressed. The seminar also provides knowledge about preliminary design and FE analysis based on classical laminate theory.

Who should attend?

This seminar is especially designed for engineers and technicians who work in the development departments of automotive manufacturers, suppliers and engineering service providers and deal with the design and development of composite components.

Course Contents

- Introduction
- Elastic behavior of composite materials
- Failure of composite materials
- Mechanics of composite materials and structures
- Joining technologies for composites
- Design of composite structures
- Fatigue and strength of composites

Instructor

Dr.-techn. Roland Hinterhölzl (University of Applied Sciences Upper Austria) has been heading the Professorship Composite Materials and the study degree program "Lightweight Design and Composite Materials" at the University of Applied Sciences Upper Austria since 2016. From 2010 to 2016 he was head of the numerical simulation department of the Institute for Carbon Composites at the Technical University of Munich. The focus of his work is on process simulation and structural analysis for the automotive and aviation industries. Dr. Hinterhölzl received his doctorate in 2000 at the University of Innsbruck on the simulation of the time-dependent behavior of composite materials, after he had spent several months at the Department of Aerospace Engineering and Engineering Mechanics at the University of Texas at Austin and CRREL (USA). Subsequently, he developed innovative composite components at the aerospace supplier FACC AG and headed the structural analysis department.

Date

DATE	COURSE ID	VENUE	DURATION	PRICE	LANGUAGE
31.03.-01.04.2020	135/3476	Alzenau	2 Days	1.340,- EUR till 03.03.2020, thereafter 1.590,- EUR	
22.-23.09.2020	135/3586	Alzenau	2 Days	1.340,- EUR till 25.08.2020, thereafter 1.590,- EUR	

Material Models of Composites for Crash Simulation

Course Description

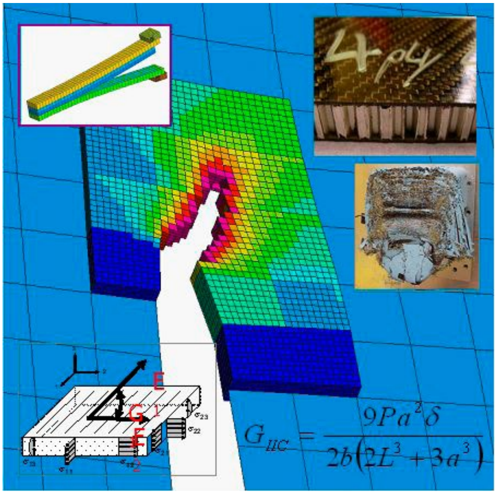
Increasing demands for weight reduction paralleled by requirements for improved crash performance and stiffness of structures have strongly pushed the development of advanced composites. The use of composite materials today is not limited to niche applications or secondary parts; they are increasingly used for important load carrying structural components in series production. In this one day seminar Prof. Thomas Karall presents the foundations of structural impact and crash analysis of composites with the Finite Element Method. At the beginning of the seminar an overview of current and upcoming industrial applications of composite materials is given. Thereafter concepts for the correct physical modeling of the complex load degradation and failure mechanisms in numerical simulation are presented. The course concentrates on the numerical simulation of the crash behavior of composites and is accompanied with demonstrations using the PAM-CRASH code.

Who should attend?

The course addresses simulation and project engineers, project managers as well as researchers involved in the analysis and design of composite parts and structures.

Course Contents

- Current and upcoming areas of application of composite materials
- Analysis of composite materials
- Available material models and their application
- Modelling methods for plies and laminates
- FEM modelling of composites
- Failure mechanisms and their representation
- PAM-CRASH ply and delamination models
- Necessary material tests
- Examples



Instructor

Prof. Dr. Thomas Karall (Hof University of Applied Sciences) studied mechanical engineering at the Technical University of Vienna and received his PhD as Assistant Professor at the University of Leoben in the field of fibre-reinforced plastics and the calculation by finite elements. From 2006 to 2010 he was head of department at the Austrian Research Institute for Chemistry and Technology in Vienna in the field of mechanical and thermal testing / fibre composites, and Secretary General of the Austrian Working Group for reinforced plastics. From 2010 to 2015 he worked as Lead Researcher for lightweight design at Virtual Vehicle Research Center in Graz. He was also a lecturer at the Technical University of Graz and lecturer at the FH Joanneum Graz. Since 2015 he has been Professor at the Engineering Department of the Hof University. His areas of work include lightweight design, fibre-reinforced composites and the finite element method.

Date

DATE	COURSE ID	VENUE	DURATION	PRICE	LANGUAGE
05.03.2020	68/3561	Alzenau	1 Day	790,- EUR till 06.02.2020, thereafter 940,- EUR	English
02.10.2020	68/3562	Alzenau	1 Day	790,- EUR till 04.09.2020, thereafter 940,- EUR	German

Material Models of Metals for Crash Simulation

Course Description

Besides an appropriate spatial discretisation of the structure and a profound knowledge of the required load cases, appropriate material modelling is a key ingredient for predictive crash simulations. The load carrying structure of a car today still mainly consists of metallic materials. The materials to be described are diverse.

The seminar deals with the following materials:

- Mild and high strength steels,
- Cold formable AHSS and UHSS steels,
- Hot formable and quenchable boron steels,
- Wrought Al and Mg alloys,
- Cast Al and Mg alloys.

The objective of this 1 day course is to give the participants an overview of material models of metals used in crash simulation. In a first step the deformation behavior and the failure mechanisms of each material class are explained based on the material structure. The influence of strain rate on material behavior is an important aspect in the context of crash simulation and will be discussed in the seminar. In a second step phenomenological material models for crash simulation are introduced. In the third step the tests needed for the characterization of materials are described and the parameter identification for the material models is discussed. Finally and using example simulations the sensitivity of simulation results regarding the identified material parameters is shown.

The seminar was extremely well received in our company! Even our colleagues, who had already worked a lot in this area, were able to learn many new things."

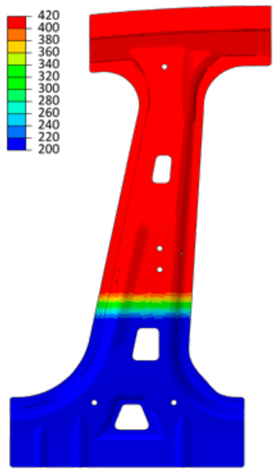
Fabian Wolf - *P+Z Engineering GmbH*

Who should attend?

The course addresses engineers working in the field of crash simulation and heads of simulation departments interested in the important topic of material modelling.

Course Contents

- Overview of metallic materials used in cars
- Influence of material structure on mechanical behavior
- Phenomenological material models for metals
- Overview of experimental methods for material characterization
- Identification of material parameters from experiments
- Discussion of the sensitivity material parameters



Instructor

Dr.-Ing. Helmut Gese (MATFEM - Partnerschaft Dr. Gese & Oberhofer)
founded the engineering consultancy MATFEM in 1993 (from 1999 the company has been named MATFEM partnership Dr. Gese & Oberhofer). MATFEM offers technical and scientific consultancy services at the intersection of material science and finite element methods. Besides performing FEM analysis projects the area of activity covers experimental and theoretical characterization of materials and the development of new material models for simulation.

Date

DATE	COURSE ID	VENUE	DURATION	PRICE	LANGUAGE
28.05.2020	70/3553	Alzenau	1 Day	790,- EUR till 30.04.2020, thereafter 940,- EUR	English (UK flag)
08.10.2020	70/3554	Alzenau	1 Day	790,- EUR till 10.09.2020, thereafter 940,- EUR	German (German flag)

Material Models of Plastics and Foams for Crash Simulation

Course Description

Numerical simulation has become a fundamental element in the development of motor vehicles. Today, many important design decisions, especially in the field of crash, are based on simulation results. During the last few years there has been an increase in the use of foams in vehicles. These are, due to their variety and structure, much more complicated regarding the characteristics of the materials than "simple" materials such as steel or aluminum, which can be modelled rather well. Characterization of foam materials is a great challenge for the simulation expert. Although by now there are different modelling approaches available in explicit FEM-programs such as LS-DYNA, PAM-CRASH or RADIOSS, these are, however, often not satisfactory. The application of these special material models requires a sound knowledge and experience.

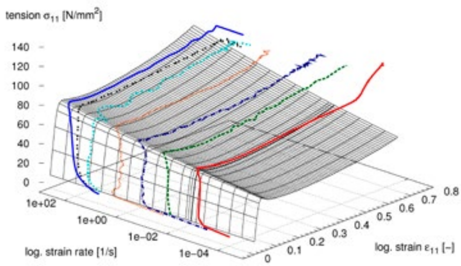
The seminar provides an overview over plastics and foam materials used in automotive engineering and their phenomenology. On the first day you obtain an introduction into the simulation of elastic and visco-elastic polymers, such as elastomers and elastic polymer foams with volume elements. You are thereby coming to understand the available material models in explicit finite element programs. On the second day the focus is on the treatment of plastics, such as thermo- and duroplastics through elasto-plasticity with isotropic hardening. Non-associated deformation is going to be discussed as well. The seminar is rounded off with the procedure for simulation of glass-fiber reinforced plastics using both isotropic and anisotropic material laws. For a demonstration you are going to see examples created with the program LS-DYNA. References to material models in LS-DYNA an PAM-CRASH are going to help you in applying what you will have learnt.

Who should attend?

The seminar addresses experienced CAE engineers and heads of CAE departments with an interest in plastic and foam materials simulation. At least 1-year of experience with FEM-programs such as LS-DYNA, PAM-CRASH or RADIOSS is suggested for participating in this course.

Course Contents

- Overview of polymer materials used in vehicle construction
- Verification and validation procedure for crash simulation
- Introduction to mechanics of materials
- Simulation of elastic and visco-elastic rubbers and foams with volume elements
- Overview of available material models in explicit finite element codes
- Simulation of elastic-plastic polymers under crash loading for validation
- Simulation of anisotropic materials with application to glass-fiber reinforced plastics



Instructor

Prof. Dr.-Ing. Stefan Kolling (TH Mittelhessen University of Applied Sciences) is Professor for Mechanics at the TH Mittelhessen University of Applied Sciences (THM). Previously he worked as a simulation engineer at the Mercedes Technology Center in Sindelfingen. He was responsible for methods development in crash simulation. In particular he was involved in the modelling of non-metal materials such as glass, polymers and plastics. Prof. Kolling graduated from the Universities of Saarbrücken and Darmstadt, from where he also received his Ph.D. He is author of numerous publications in the field of material modeling.

Date

DATE	COURSE ID	VENUE	DURATION	PRICE	LANGUAGE
22.-23.09.2020	37/3467	Alzenau	2 Days	1.340,- EUR till 25.08.2020, thereafter 1.590,- EUR	

Modeling of Joints in Crash Simulation

Course Description

For the efficient assembly of components and complete structures many different joining techniques are available. Joints have to ensure that the assembly will fulfill crashworthiness, durability and other requirements. Therefore the best joining technique has to be selected for each application. Modern lightweight design often uses a material mix. Using different materials, like various steel grades, lightweight alloys, plastics or composites for applications for which the individual material is best suited allows for weight savings. The efficient and reliable joining of different materials is even more challenging. Failure of joints can be a reason for collapse of vehicle structures during crash testing. Therefore failure of joints must be precisely predicted in numerical crash simulation applied in the virtual design process of vehicle development.

Course Objectives

The objective of this one day course is to give the participants an overview of failure modelling of different joints (punctiform, linear, planar joints) for crash simulation and also of the characterization tests and methods that are necessary for calibrating the model parameters. Also recommendation for validation tests and simulations of calibrated joint models are given. Examples of typical and used models are shown in all common crash codes.

Who should attend?

The course addresses engineers working in the field of crash simulation and heads of simulation departments interested in the important topic of modelling of joints including failure.

Course Contents

- Overview of modeling techniques for different joining techniques
- Tests and methods for characterization of joints
- Local loading conditions at joints during testing under shear, tension and bending load
- Characteristics of failure behavior
- Failure modelling of
  - Spot welded joints including spot welds in press hardened steels
  - Self-piercing riveted joints
  - Laser welded joints
  - Adhesive joints
- Calibration methods for determination of model parameters
- Validation of calibrated models through testing and simulation

Instructor

Dr.-Ing. Silke Sommer (Fraunhofer-Institut für Werkstoffmechanik) studied Physics at the RWTH Aachen University and obtained her PhD degree at the Karlsruhe Institute of Technology about modelling of the deformation and failure behaviour of spot welds. She has been working at the Fraunhofer Institute for Mechanics of Materials IWM in Freiburg since 2000 in the field of damage and failure modelling of materials and joints for crash simulation. Since 2013 she is a group leader for joining and joints.

Date

DATE	COURSE ID	VENUE	DURATION	PRICE	LANGUAGE
11.03.2020	155/3569	Alzenau	1 Day	790,- EUR till 12.02.2020, thereafter 940,- EUR	
14.09.2020	155/3570	Alzenau	1 Day	790,- EUR till 17.08.2020, thereafter 940,- EUR	

Introduction to the Python Programming Language

Course Description

Python is a modern programming language that is increasingly used in the field of Scientific Computing. Together with the environment scipy Python is an open source alternative to the commercial software MATLAB. A series of CAE software products, including the Pre-Processor ANSA, the solvers ABAQUS and PAM-CRASH and the Post-Processor META, are already using Python as an integrated scripting language. Python puts the emphasis on well-readable code, so beginners can learn the language very quickly. Nevertheless, Python is a powerful programming language and can also be used for larger projects. Further advantages of Python are the platform independence and the very extensive standard library supplied.

Course Objectives

The seminar provides a comprehensive introduction to the basics of the Python programming language. It also includes an introduction to object-oriented programming. Practical exercises, such as processing text-based files from the CAE world, will be treated. After the seminar, participants will be able to acquaint themselves with the Python interfaces of CAE software products.

Who should attend?

The seminar is aimed at newcomers to the Python language. Experience in other scripting or programming languages would be an advantage but is not a requirement.

Course Contents

- Basic concepts of the Python programming language
  - Introduction to the language
  - Data and control structures, functions
- Advanced topics
  - Processing of data
  - Important modules of the Python standard library
  - Examples from scientific computing
  - Modularization in bigger Python projects
- Practical exercises

Instructor

Dr. André Backes (TECOSIM Technische Simulation GmbH) studied Mathematics at the University of Duisburg. From 2000 to 2006 he was a researcher at the Institute for Mathematics at the Humboldt University in Berlin. His PhD studies at the chair for Numerical Mathematics introduced him to the field of CAE. Since 2006 he works at TECOSIM GmbH in Ruesselsheim and among other topics specialized in NVH. In the area of Virtual Benchmarking he helped developing the TECOSIM-owned process TEC|BENCH where also the Python language was used. In current research projects he investigates the use of Python-based methods for data analysis and machine learning in the CAE process.

Date

DATE	COURSE ID	VENUE	DURATION	PRICE	LANGUAGE
17.-18.03.2020	161/3479	Alzenau	2 Days	1.340,- EUR till 18.02.2020, thereafter 1.590,- EUR	
16.-17.11.2020	161/3574	Alzenau	2 Days	1.340,- EUR till 19.10.2020, thereafter 1.590,- EUR	

Python based Machine Learning with Automotive Applications

Further Seminars on the Topic
Machine Learning & Artificial Intelligence
➲ page 136

Course Description

The topic of Artificial Intelligence (AI) is currently becoming more and more important, in particular in areas where processes are automated and many data are processed. Especially in automotive area as well in the virtual development process as in the field of testing, numerous applications are conceivable in this context. A part of Artificial Intelligence is Machine Llearning, which is becoming increasingly important in addition to classical rule-based expert systems. This current development is due to the generation of ever-larger datasets (big data) as well as more powerful computers for their processing. Especially in the automotive environment, extensive data are generated in the context of simulation or testing, for which an automated analysis is often sought. In addition to the classical interpretation of individual simulation or testing results, the methods of Machine Learning allow a new view at models and results. Based on the analysis of numerous results (big data), e.g. from parameter studies, it is possible to derive Artificial Intelligence using methods of Machine Learning, which is then used to evaluate further simulations or tests. Python is currently the most popular programming language for data analysis and Machine Learning. The freely available Python library Scikit-Learn provides a user-friendly entry to the relevant procedures. Especially the application of artificial neural networks (Deep Learning) has become very popular lately. The software TensorFlow developed by Google and the Python library Keras based on it provide a beginner-friendly access.

Course Objectives

The seminar gives an introduction to Machine Learning based on the programming language Python. This includes, as a start, topics of data analysis, preparation and visualization. In the second step, methods of machine learning are studied using the Python packages Scikit-Learn and Keras or TensorFlow. Practical exercises will deepen the topics discussed and discuss possible applications in CAE or testing. An important aspect of data analysis is the extraction of features from CAE or testing data for the use in Machine Learning. After the seminar participants will be able to tackle the implementation of their own tasks. This also includes evaluating various methods of machine learning regarding their applicability to one's own tasks and to deepen the methods based on the discussed Python packages.

Who should attend?

The seminar addresses participants coming from CAE or testing field who want to take the first steps in Machine Learning based on their Python knowledge. It is assumed that basic Python knowledge - e.g. as it is conveyed in the carhs.training seminar Introduction to the Python Programming Language of the same trainer - exists.

Course Contents

- Basics of data analysis with Python
  - Data structures
  - Concepts of data preparation
  - Extraction of features for Machine Learning methods
  - Data visualization
  - The Python packages Numpy, Scipy, Pandas, Matplotlib
- Machine Learning with Python
  - Methods for classification and regression analysis
  - The Python Package Scikit-Learn
  - Deep Learning and Neural Networks with Keras, TensorFlow
- Applications motivated by CAE or testing background
  - Introductory examples
  - Discussion of possible deeper applications
  - Procedure for implementing your own ideas

Instructor

Dr. André Backes (TECOSIM Technische Simulation GmbH) studied Mathematics at the University of Duisburg. From 2000 to 2006 he was a researcher at the Institute for Mathematics at the Humboldt University in Berlin. His PhD studies at the chair for Numerical Mathematics introduced him to the field of CAE. Since 2006 he works at TECOSIM GmbH in Ruesselsheim and among other topics specialized in NVH. In the area of Virtual Benchmarking he helped developing the TECOSIM-owned process TEC|BENCH where also the Python language was used. In current research projects he investigates the use of Python-based methods for data analysis and machine learning in the CAE process.

Date

DATE	COURSE ID	VENUE	DURATION	PRICE	LANGUAGE
05.-06.05.2020	185/3481	Alzenau	2 Days	1.340,- EUR till 07.04.2020, thereafter 1.590,- EUR	
02.-03.12.2020	185/3575	Alzenau	2 Days	1.340,- EUR till 04.11.2020, thereafter 1.590,- EUR	

Important Abbreviations

A

AAA	American / Australian Automobile Association
AAAM	Association for the Advancement of Automotive Medicine
AAM	Alliance of Auto Manufacturers
aBAS	Advanced Brake Assist System
ACC	Adaptive Cruise Control
ACEA	Association of European Automobile Manufacturers
ACL	Anterior cruciate ligament
ACN	Automatic Collision Notification
ACSF	Automatically Commanded Steering Function
ACU	Airbag Control Unit
AD	Automated Driving
ADAC	Allgemeiner Deutscher Automobil Club (German Automobile Association)
ADAS	Advanced Driver Assistance Systems
ADL	Automatic Door Locking
ADOD	Average Depth of Deformation
ADR	Australian Design Rules
AE-MDB	Advanced European Mobile Deformable Barrier
AEB	Autonomous Emergency Braking
AEBS	Autonomous Emergency Brake System
AHB	Auto High Beam
AHOD	Average Height of Deformation
AHOF	Average Height of Force
AHR	Active Head Rest
AIS (1)	Abbreviated Injury Scale
AIS (2)	Automotive Industry Standards (India)
AISC	Automotive Industry Standards Committee
ANCAP	Australasian New Car Assessment Program
AOP	Adult Occupant Protection (Euro NCAP)
APF	Abdominal Peak Force
APROSYS	Advanced PROtection SYStems
APSS	Active Pedestrian Safety System
ARAI	Automotive Research Association of India
ARV	Advanced Rear Visualization
ASCC	Adaptive Speed Cruise Control
ASIC	Application-Specific Integrated Circuit
ASIL	Automotive Safety Integrity Level (Functional Safety)
ASIS	Adavanced Side Impact System
ATD	Anthropomorphic Test Device
AZT	Allianz Zentrum Technik

B

BAS	Brake Assist
BASt	Germany's Federal Highway Research Institute
BDA	Bonnet Deployment Actuator
BEV	Battery Electric Vehicle
BIS	Bureau of Indian Standards
BLE	Bonnet Leading Edge
BMVI	German Federal Ministry of Transport and Digital Infrastructure
BoD	Board of Directors (Euro NCAP)
BOS	Beginning of Steer
BRIC	Brain Injury Criterion
BSD	Blind Spot Detection
BST	Blind Spot Technology
BTA	Bumper Test Area

C

C-IASI	China Insurance Automotive Safety Index
C-NCAP	China New Car Assessment Programme
C2C	Car-to-Car
CA	Crash Avoidance
CAE	Computer Aided Engineering
CAN	Controller Area Network
CAT	Computer Aided Testing
CATARC	China Automotive Technology and Research Center
CCD	Charge Coupled Device
CCR	Car to Car-Rear
CDC	Collision Deformation Classification
CEA	Comité Européen des Assurances
CFD	Computational Fluid Dynamics
CFR	Code of Federal Regulations (USA)
CFRP	Carbon Fiber Reinforced Plastic
CIB	Crash Imminent Braking
CLEPA	Comité de liaison européen des fabricants d'equipements et de pièces automobiles
CMM	Coordinate Measuring Machine
CMOS	Complementary Metal Oxide Semiconductor
CMVR	Central Motor Vehicle Rules
CMVSS	Canadian Motor Vehicle Safety Standards
COG	Center of Gravity
CONTRAN	Conselho Nacional de Trânsito
COP (1)	Carry over Parts
COP (2)	Child Occupant Protection (Euro NCAP)
COPD	Child Occupant Presence Detection
COS	Completion of Steer
CP	Contact Point
CPD	Child Presence Detection
CRABI	Child Restraint Airbag Interaction (Child Dummy)
CRS	Child Restraint System
CSMA/CA	Carrier Sense Multiple Access / Collision Avoidance
CSMA/CD	Carrier Sense Multiple Access / Collision Detection
CV	Closing Velocity
CVFA	Car to Vulnerable road user Farside Adult
CVNA	Car to Vulnerable road user Nearside Adult
CVNC	Car to Vulnerable road user Nearside Child

D

DAS	Data Acquisition System
DBS	Dynamic Brake Support
DCU	Domain Control Unit
DGPS	Differential Global Positioning System
DLO	Daylight Opening
DPPS	Deployable Pedestrian Protection Systems
DSM	Driver Status Monitoring
DT	Deployment Time

E

EBA	Emergency Brake Assist
EBA	Effective Braking & Avoidance (ASEAN NCAP)
EBD	Electronic Brake Force Distribution
EBT	Euro NCAP Bicyclist Target
ECE	Economic Commision for Europe (United Nations)
ECOSOC	United Nations Economic and Social Council
EDM	Engineering Data Management
EES	Energy Equivalent Speed
EEVC	European Enhanced Vehicle-Safety Committee
EIF	Entry Into Force
ELK	Emergency Lane Keeping
ELSA	ELectric SAfety (UNECE/ WP.29 Working Group)
EMC	Electromagnetic Compatibility
EOU	Ease of Use
EPB	Electrical Protection Barrier
EPT	Euro NCAP Pedestrian Target
ERG	Emergency Response Guide
ES-2 re	Euro SID 2 Rib Extension
ESC	Electronic Stability Control

Important Abbreviations

ESV	Enhanced Experimental Vehicles Safety Program / Enhanced Safety of Vehicles Program
ETC	European Test Consortium
ETSC	European Transport Safety Council
Euro NCAP	European New Car Assessment Programme
EVPC	Electric Vehicles Post Crash
EVS	Electric Vehicle Safety
EVT	Euro NCAP Vehicle Target

F

FARS	Fatality Analysis Reporting System
FCEV	Fuel Cell Electric Vehicle
FCW	Forward Collision Warning
FCWS	Forward Collision Warning System
FEM	Finite Element Method
FFC	Femur Force Criterion
FIWG	Frontal Impact Working Group (Euro NCAP)
Flex PLI	Flexible Pedestrian Legform Impactor
FMH	Free Motion Headform (FMVSS 201)
FMVSS	Federal Motor Vehicle Safety Standards
FPS	Frontal Protection System
FPSLE	Frontal Protection System Leading Edge
FRG	Floating Rib Guide
FRP	Fiber Reinforced Plastic
FRS	Fitment Rating System (ASEAN NCAP)
FSI	Fluid-Structure-Interaction
FTDMA	Flexible Time Division Multiple Access
FW	Full Width
FWDB	Full Width Deformable Barrier
FWRB	Full Width Rigid Barrier

G

G.S.R.	General Statutory Rules
GAMBIT	Generalized Acceleration Model for Brain Injury Threshold
GCS	Glasgow Coma Scale
GIDAS	German in-Depth Accident Study
GRSG	Groupe de Rapporteurs sur la Sécurité Générale (WP.29 - General Safety Provisions)
GRSP	Groupe de Rapporteurs sur la Sécurité Passive (WP.29 - Passive Safety)
GSR	General Safety Regulation
GTR	Global Technical Regulation
GVM	Gross Vehicle Mass
GVT	Global Vehicle Target
GVWR	Gross Vehicle Weight Rating

H

HAD	Highly Automated Driving
HAV	Highly Automated Vehicle
HBM	Human Body Model
HGV	Heavy Goods Vehicle
HIC	Head Injury Criterion
HIT	Head Impact Time
HITS	Harmonisation Interlab Test Series
HLDI	Highway Loss Data Institute
HLLC	High Level Liaison Committee
HMI	Human Machine Interface
HNI	Head Neck Impactor
HOF	Height of Force
HPC	Head Performance Criterion
HPM	H-Point Manikin
HPS	Head Protection System
HPT	Head Protection Technology
HRC	Time to Head Restraint first Contact
HRMD	Head Restraint Measuring Device
HRV	Head Rebound Velocity
HTD	Hardest to detect
HV	High Voltage

I

IARV	Injury Assessment Reference Value
IBRL	Internal Bumper Reference Line
ICPL	Injury Criteria Protection Level
ICRT	International Consumer Research and Testing
IG	Informal Group
IHC	Intelligent Headlight Control
IHRA	International Harmonized Research Activities
IIHS	Insurance Institute for Highway Safety
IIWPG	International Insurance Whiplash Prevention Group
INRETS	Institut National de Recherche sur les Transports et leur Sécurité
INSIA	Instituto Universitario de Investigación del Automóvil
IP	Intersection Point
IRC	Injury Risk Curve
IRCOBI	International Research Council on the Biomechanics of Impact
IRF	Injury Risk Function
ISA	Intelligent Speed Assistance
ISM	Intelligent Speed Management
ISO	International Organization for Standardization
ISS	Injury Severity Score
ITC	Inland Transport Committee (UNECE)
IWVTA	International Whole Vehicle Type Approval

J

J-MLIT	Japan: Ministry of Land, Infrastructure and Transport
JA	Junction Assist
JAMA	Japan Automotive Manufacturers Association
JARI	Japan Automobile Research Institute
JASIC	Japan Automobile Standards Internationalization Center
JNCAP	Japan New Car Assessment Program

K

KMVSS	Korean Motor Vehicle Safety Standards
KNCAP	Korean New Car Assessment Program
KTH	Knee - Thigh - Hip

L

LDWS	Lane Departure Warning System
LHD	Left Hand Drive
LIDAR	Light Detection and Ranging
LIN	Local Interconnect Network
LINCAP	Lateral Impact New Car Assessment Program (U.S. NCAP)
LKAS	Lane Keeping Assist System
LKD	Lane Keeping Device
LKS	Lane Keeping System
LL	Lower Leg
LNL	Lower Neck Load
LSS	Lane Support System
LTR	Land Transport Rules (New Zeeland)

M

MAIS	Maximum AIS (Abbreviated Injury Scale)
MCB	Multi Collision Brake
MCL	Medial Collateral Ligament
MDB	Mobile Deformable Barrier
MoD	Motor own Damage (Insurance)
MOST	Media Oriented Systems Transport
MPDB	Moving Progressive Deformable Barrier
MSA	Manual Speed Assist
MST	Motorcyclist Safety Technology
MTBI	Mild Traumatic Brain Injury
MVWG	Motor Vehicle Working Group (EU)

N

NASS	National Automotive Sampling System
NASS CDS	NASS Crashworthiness Data System

Important Abbreviations

NASS GES	NASS General Estimates System
NASVA	National Agency for Automotive Safety & Victims' Aid (Japan)
NCAP	New Car Assessment Program
NCSA	National Center for Statistics and Analysis (an Office of NHTSA)
NHTSA	National Highway Traffic Safety Administration (USA)
NIC	Neck Injury Criterion
NISS	New Injury Severity Score
NNT	Number Needed to Treat
NPACS	New Programme for the Assessment of Child-restraint Systems
NPRM	Notice of Proposed Rule Making (USA)
NTSEL	National Traffic Safety and Environment Laboratory (Japan)

O

OC	Occipital Condyles
ODB	Offset Deformable Barrier
OICA	Organisation Internationale des Constructeurs d'Automobiles
OLC	Occupant Load Criterion
OMDB	Oblique Moving Deformable Barrier
OoP	Out of Position
OSM	Occupant Status Monitoring

P

PADI	Procedures for the assembly disassembly and inspection
PAEB	Pedestrian Automatic Emergency Braking
PCL	Posterior Cruciate Ligament
PDB (1)	Partnership for Dummytechnology and Biomechanics
PDB (2)	Progressive Deformable Barrier
PDC	Park Distance Control
PDI	Pedestrian Detection Impactor
PEAS	Primary Energy Absorbing Structure
PLI	Pedestrian Legform Impactor
PMA	Parking and Maneuvering Assistant
PMD	Photonic Mixer Device
PMHS	Post Mortem Human Subjects
PMTO	Post Mortal Test Object
PNCAP	Primary New Car Assessment Programme
PoC	Point of Collision
PP	Pedestrian Protection
PPA	Pedestrian Protection Airbag
PPAD	Partner Protection Assessment Deformation
PSPF	Pubic Symphysis Peak Force
PTS	Poly Trauma Score
PTW	Powered Two Wheeler

R

Radar	Radio Detection and Ranging
RCAR	Research Council for Automobile Repairs
RCTA	Rear Cross Traffic Alert
REX	Range Extender
RFCRS	Rearward Facing Child Restraint System
RHD	Right Hand Drive
RID	Rear Impact Dummy
RR	Repeatability & Reproducibility

S

S.O	Statutory Order
SA	Safety Assist (Euro NCAP)
SAE	Society of Automotive Engineers
SAS	Speed Assistance System
SAT	Safety Assist Technology
SB	Seat Back
SBR	Seat Belt Reminder
SD	Standard Deviation
SEAS	Secondary Energy Absorbing Structure
SgRP	Seating Reference Point
SID	Side Impact Dummy
SLD	Speed Limitation Device
SLIF	Speed Limit Information Function
SOB	Small Overlap Barrier (IIHS)
SRA	Swedish Road Administration
SRP	Seat Reference Point
SRS	Supplementary Restraint System
SSF	Static Stability Factor (U.S. NCAP, KNCAP)
SSR	Speed Sign Recognition
ST	Sensing Time
STNI	Soft Tissue Neck Injury
SUFEHM	Strasbourg University Finite Element Head Model
SUV	Sports Utility Vehicle
SWR	Strength-to-weight Ratio (Roof Crush)

T

TA	Type Approval
TCMV	Technical Committee - Motor Vehicles (EU)
TEG	Technical Evaluation Group
TF BTA	Task Force Bumper Test Area
ThCC	Thoracic Compression Criterion, also TCC
THOR	Test Device for Human Occupant Restraint
THUMS	Total Human Model for Safety
TIPT	Thorax Injury Prediction Tool
ToPI	Time of Pedestrian Identification
TOR	Takeover Request
TPL	Third Party Liability (Insurance)
TREAD	Transportation Recall, Enhancement, Accountability and Documentation
TRL	Transport Research Laboratory (UK)
TRT	Total Reaction/Response Time
TSP	Top Safety Pick (IIHS)
TT	Top Tether
TTB	Time to Brake
TTC	Time to Collision
TTD	Time to Decision
TTI	Thoracic Trauma Index
TTS	Time to Steer

U

U.S. NCAP	United States New Car Assessment Program
UBM	Upper Body Mass
UL	Upper Leg
UMTRI	University of Michigan Transportation Research Institute
UN	United Nations
USCAR	The United States Council for Automotive Research
UUT	Unit Under Test

V

VAN	Vehicle Area Network
VC	Viscous Criterion
VDC	Vehicle Dynamics Control
VERPS	Vehicle Related Pedestrian Safety
VR	Virtual Reality
VRTC	Vehicle Research & Test Center (NHTSA)
VRU	Vulnerable Road User
VSS	Vehicle Safety Score (U.S. NCAP)

W

WAD (1)	Wrap Around Distance
WAD (2)	Whiplash Associated Disorders
WG	Working Group
WP	Working Party
WS	World SID
WS5F	World SID 5th%ile Female Dummy
WSTC	Wayne State University Tolerance Curve
WSU	Wayne State University

Registration

You can register for seminars directly via our webpage www.carhs.de or send us the completed and signed registration form by mail or fax.
By signing the registration or by transmitting the e-mail/internet-registration the participant accepts the terms of participation. Your registration data are saved for internal purposes.

Confirmation of registration/invoice

Immediately after receipt of the registration you obtain a written confirmation of registration and an invoice. Invoices need to be paid within 30 days from the issuing date of the invoice, however, not later than 7 days before the beginning of the seminar, without deductions. We reserve the right to exclude participants who have not paid in time from the participation in the seminar.

Participation fee

The participation fee for one seminar is in Euro per person plus VAT and includes training material, participation certificate, drinks during breaks and lunch.
Since the place of provision of seminars held in Germany is inland, participants from abroad have to pay VAT too (it may however be possible to apply for a refunding of the purchase tax at the Federal Tax Office). A partial participation in our seminars does not entitle to a reduction in the participation fee.

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Universities and public research institutions receive a 40 % discount on seminar fees.

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Cancellation

The cancellation of the registration is possible free of charge until 4 weeks before the beginning of the seminar. In the case of a cancellation until 2 weeks before the beginning of the seminar we have to charge a fixed charge of EUR 100. In the case of a later cancellation or if the participant does not attend the seminar, the full amount has to be paid. For conferences and seminars listed in the category 'Events' the following terms apply for cancellations: The cancellation of the registration is possible free of charge until 4 weeks before the beginning of the seminar. In the case of a cancellation until 2 weeks before the beginning of the seminar we charge 50 % of the seminar fee. In the case of a later cancellation or if the participant does not attend the seminar, the full amount has to be paid.

Replacement participant

It is possible at any point to register a substitute participant for the registered participant. The same terms of participation as for the registered participant apply for him or her.

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carhs Empowering Engineers

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Alzenau · Hanau · Landsberg a. Lech · Gaimersheim · Bergisch-Gladbach

Seminar Calendar 2020

carhs Empowering Engineers

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6 Mo		6 Th		6 Su	
7 Tu		7 Fr		7 Mo	
8 We	Side Impact- Requirements and	8 Sa		8 Tu	Crashworthy and Lightweight
9 Th	Development Strategies p. 92	9 Su		9 We	Car Body Design p. 75
10 Fr		10 Mo		10 Th	
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14 Tu		14 Fr		14 Mo	Modeling of Joints in Crash Simulation p.176
15 We		15 Sa		15 Tu	SafetyUpDate Graz 2020
16 Th	Automotive Safety Summit	16 Su		16 We	Whiplash p. 108 — www
17 Fr	Shanghai 2020 www	17 Mo		17 Th	NVH- Background, Practice and
18 Sa		18 Tu		18 Fr	Simulation Methodology www
19 Su		19 We		19 Sa	
20 Mo		20 Th		20 Su	
21 Tu	Lightweight Design Summit 2020	21 Fr		21 Mo	
22 We	p. 166	22 Sa		22 Tu	Material Models of Plastics
23 Th		23 Su		23 We	and Foams p. 175
24 Fr		24 Mo		24 Th	Practical Seminar PRIMUS Dummy p. 117
25 Sa		25 Tu		25 Fr	
26 Su		26 We		26 Sa	
27 Mo		27 Th		27 Su	
28 Tu		28 Fr		28 Mo	Crash-Sensing Systems p.87
29 We	SafetyWeek 2020 p. 14	29 Sa		29 Tu	automotive CAE Grand Challenge 2020
30 Th		30 Su		30 We	p. 162
31 Fr		31 Mo			

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2 Fr	Material Models of Composites p. 173	2 Mo		2 We	Python based Machine Learning
3 Sa	German National Holiday	3 Tu		3 Th	with Automotive Applications p. 178
4 Su		4 We	Static Vehicle Safety Tests in Dev. p. 74	4 Fr	
5 Mo	Pedestrian Protection - Dev. Strategies p. 104	5 Th	Crash Safety of Hybrid and — Frontal Restraint	5 Sa	
6 Tu		6 Fr	Electric Vehicles p. 22 — Systems p. 79	6 Su	
7 We		7 Sa		7 Mo	Crashworthy and Lightweight
8 Th	Material Models of Metals p. 174	8 Su		8 Tu	Car Body Design p. 75
9 Fr		9 Mo	Introduction to Active Safety of Vehicles p. 127	9 We	
10 Sa		10 Tu	International Safety and — Scenario-, Simulation- and	10 Th	
11 Su		11 We	Crash-Test Regul. p. 18 — Data-based Dev. p. 137	11 Fr	
12 Mo	Design Maturity of Restraint System Comp. p. 82	12 Th		12 Sa	
13 Tu	Vehicle Safety under Self-Certification	13 Fr		13 Su	
14 We	p. 26	14 Sa		14 Mo	
15 Th	Worldwide Automated Vehicle Policies p. 134	15 Su		15 Tu	Euro NCAP UpDate 2020
16 Fr	Head Impact FMVSS 201 & UN R21 p. 97	16 Mo	Introduction to the Python	16 We	p. 27
17 Sa		17 Tu	Programming Language p.177	17 Th	
18 Su		18 We	Passive Safety — Head Injury Criteria p. 165	18 Fr	
19 Mo		19 Th	p. 16 — Human Modeling	19 Sa	
20 Tu	Safety of Commercial Vehicles p. 17	20 Fr	and Simulation in Automotive Engineering p. 164	20 Su	
21 We		21 Sa		21 Mo	
22 Th		22 Su		22 Tu	
23 Fr		23 Mo	Structural Optimization in Automotive Design	23 We	
24 Sa		24 Tu	– Theory and Application p. 170	24 Th	Christmas Eve
25 Su		25 We	Rear Seat p. 86 — ISO 26262 www	25 Fr	Christmas
26 Mo		26 Th		26 Sa	Christmas
27 Tu	AI & Machine Learning- p. 136 — Side Impact	27 Fr		27 Su	
28 We	Automated Driving — p. 92	28 Sa		28 Mo	
29 Th		29 Su		29 Tu	
30 Fr		30 Mo	Design f. Durability www — NCAP p. 30	30 We	
31 Sa				31 Th	New Year´s Eve

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