Equal Effectiveness Study on Pedestrian Protection

Objective

Demonstration that effectiveness of combined primary and secondary safety solutions is at least as effective as EU Directive 2003/102/EC current phase 2 in reducing pedestrian injuries and fatalities when hit by passenger cars!

Steps

Analysis of upper legform to bonnet leading edge test regarding relevance for current car fleet

Review and assessment of previous effectiveness studies, to find the most appropriate study as basis for equal effectiveness

Determination of savings in seriously and fatally injured pedestrians with implementation of EU Directive 2003/102/EC current phase 2 in comparison to the implementation of EU Directive 2003/102/EC phase 1 and Brake Assist System

EES - Step 1

Analysis of Upper legform to bonnet leading edge test regarding relevance for current car fleet

from EEVC WG17 report

AIS 2+ upper leg and pelvis injuries caused by the BLE (MUH 1985-1995)	<1990 car model	>= 1990 car model
<=40 km/h	8%	0%
>40 km/h	17%	24%
All speeds	11%	7%

reference:

EEVC WG 17 report
page 10, table 2
Kalliske Bast 1998,
“Comparison of the evaluations of pedestrian injuries caused by the bonnet leading edge looking on AIS1+ and AIS2+ injuries”

update with data of GIDAS and MUH since 1995

AIS 2+ injuries of upper leg/pelvis caused by BLE (GIDAS+MHH 1985-2003)	<1990 car model	>= 1990 car model
<=40 km/h	26 injuries by 471 injured pedestrians → **6%**	0 injuries by 189 injured pedestrians → **0%**
>40 km/h	23 injuries by 178 injured pedestrians → **13%**	4 injuries by 58 injured pedestrians → **7%**
All speeds	49 injuries by 649 injured pedestrians → **8%**	4 injuries by 247 injured pedestrians → **2%**

conclusions:

Decrease from 8% (pre 1990) to 2% (post 1990) of AIS2+ upper leg and pelvis injuries caused by BLE

No injuries up to 40 km/h for post 1990 car model

No injuries for post 1996 car model

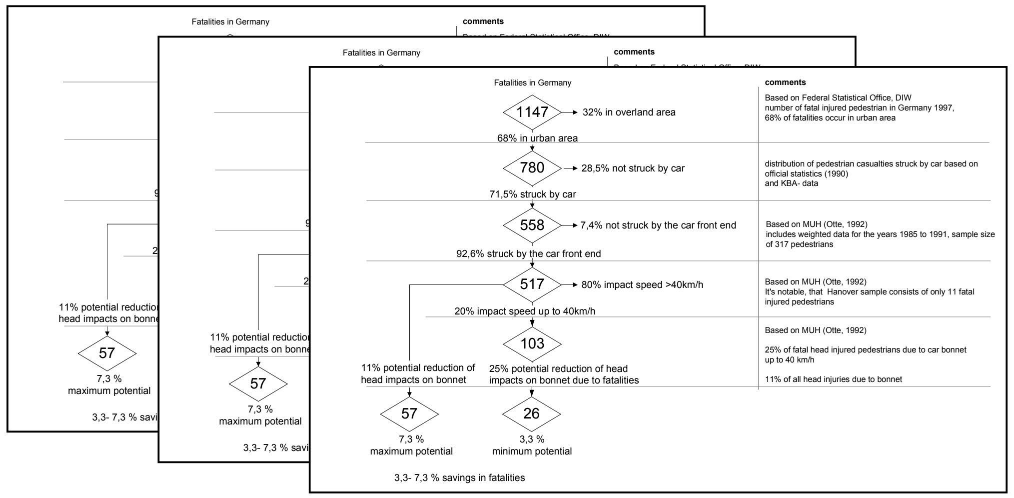
EES - Step 2

Review and assessment of previous effectiveness studies, to find the most appropriate study as basis for equal effectiveness

method

review of previous effectiveness studies and used data sources

description of calculation methods, assumptions and effectiveness for all studies with consistent and comprehensible flow charts



assessment of each study in terms of 3 criteria

- calculation method
- data source
- up-to-dateness

definition of an overall assessment score (1 to 5, 1 as the most appropriate one)

EES - Step 2

results

Association	datasources	benefit calculation: method	benefit for fatalities		benefit for seriously injured		overall assessment score
			EU Directive 2003/102/EC phase 1	EU Directive 2003/102/EC current phase 2	EU Directive 2003/102/EC phase 1	EU Directive 2003/102/EC current phase 2	
TRL 1993 (Lawrence, Hardy, Lowne)	**STATS19** (1987-1991), **Hanover data** (1985-1991), **Ashton sample** (1980)	uninjured up to equivalent car speed-method	_	7%	_	21%	**4,0**
TRL 2002 (Lawrence)	**STATS19** (1987-1991), **IHRA data** (1985-1998) **Ashton sample** (1980)	speed shift method	10%	18%	7%	13%	**3,3**
		uninjured up to equivalent car speed method	3%	10%	13%	20%	**4,0**
ACEA 1995 (LAB)	**police reports france** (1990), **LAB** (1994-1995)	uninjured up to equivalent car speed-method	_	4 - 5%	_	20 - 25%	**2,7**
MIRA 199 (Davies, Clemo)	**STATS19** (1987-1991), **Hanover data** (1985-1991, **Ashton sample** (1980)	speed shift method	_	3 - 30%	_	5 - 18%	**3,3**
DEKRA 2002 (Berg, Egelhaaf)	**Hanover data** (1985-1991) **GIDAS data** (1999- 2001) **IHRA data** (1985- 1995)	estimation with injury-causing car-parts	0,5- 1,8%	0,5 - 1,9%	7,2- 9,9%	8,8 - 13,4%	**2,3**
BASt 1994 (Bamberg, Zellmer)	**Hanover data** (1985- 1991)	method of injury shift	_	3,3 - 7,3%	_	6,7 - 7,9%	**2,3**

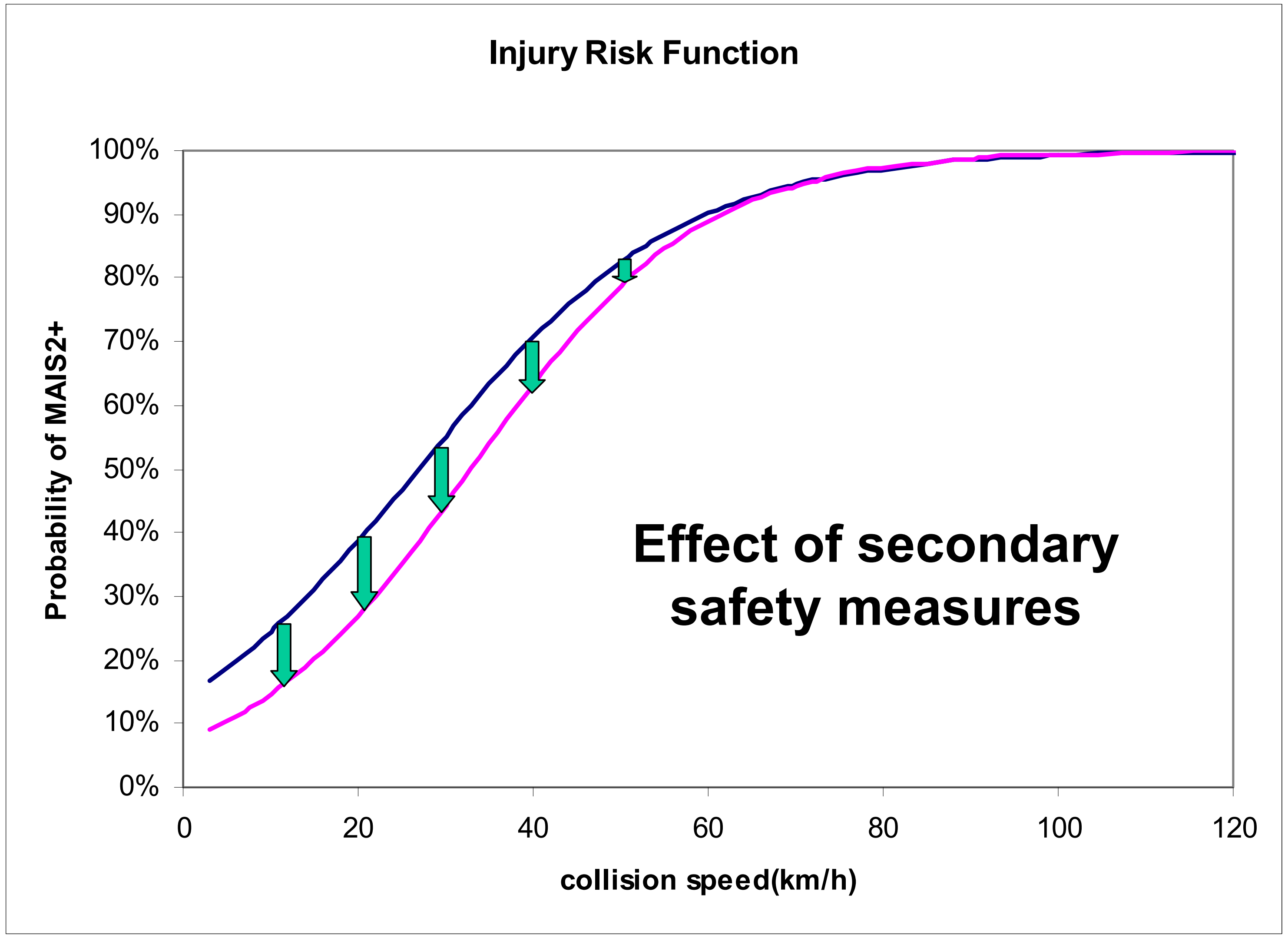
BASt study of 1994 is the most appropriate study as basis for Equal Effectiveness

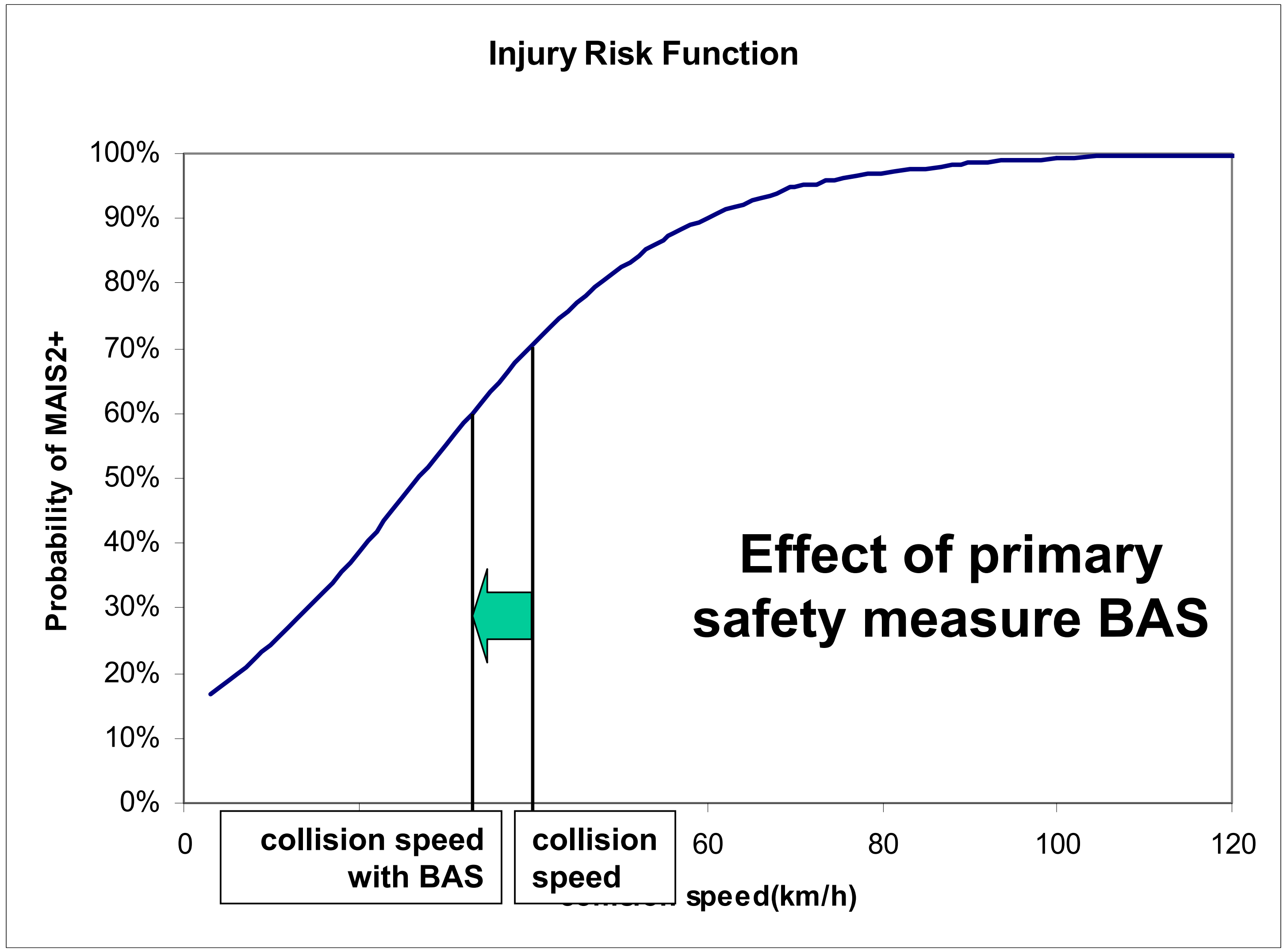
EES - Step 3

Determination of savings in seriously and fatally injured pedestrians with implementation of EU Directive 2003/102/EC current phase 2 in opposite to the implementation of EU Directive 2003/102/EC phase 1 and Brake Assist System

method

automated case by case analysis with utilization of Injury Risk Functions (IRF) based on the same dataset

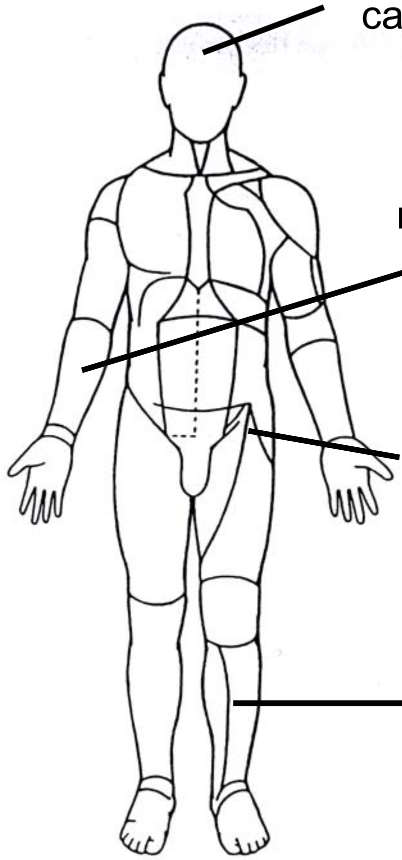




EES - Step 3

representation of effects of secondary safety measures – case-by-case method

current situation



craniocerebral injury (CCI) 1st degree
caused by 3rd third of the bonnet

AIS=2

multiple abrasions of forearm
caused by ground impact

AIS=1

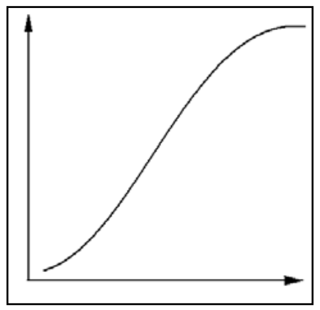
contusion of pelvis caused
by bonnet leading edge

AIS=1

fracture of tibia
caused by bumper

AIS=2

MAIS=2



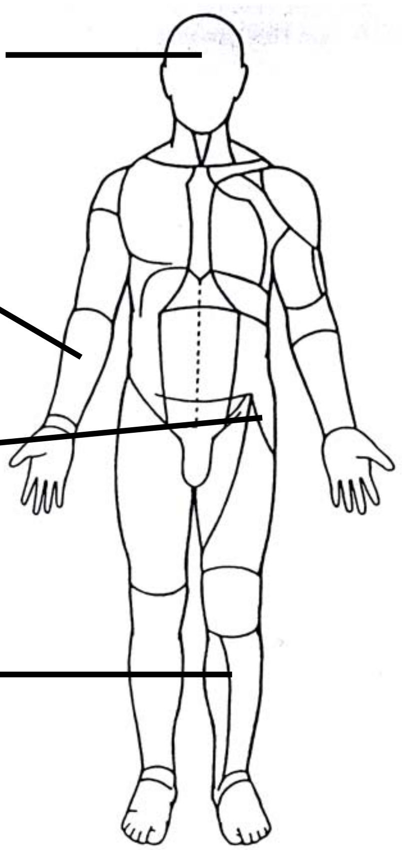
Injury Risk Function
for current situation

assumption on injury level

All injuries due to tested areas will be shifted down by one AIS level

determination of IRF over all pedestrian casualties

situation after implementation of EU Directive 2003/102/EC phase 1



craniocerebral injury (CCI) 1st degree
caused by 3rd third of the bonnet

tested area → **AIS*=1**

multiple abrasions of left forearm
caused by ground impact

non tested area → **AIS=1**

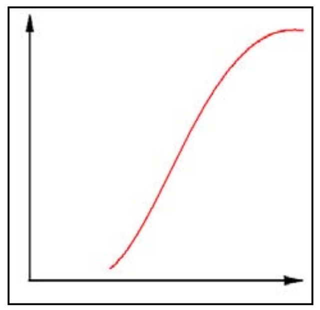
contusion of pelvis caused
by bonnet leading edge

non tested area → **AIS=1**

fracture of tibia
caused by bumper

tested area → **AIS*=1**

MAIS*=1

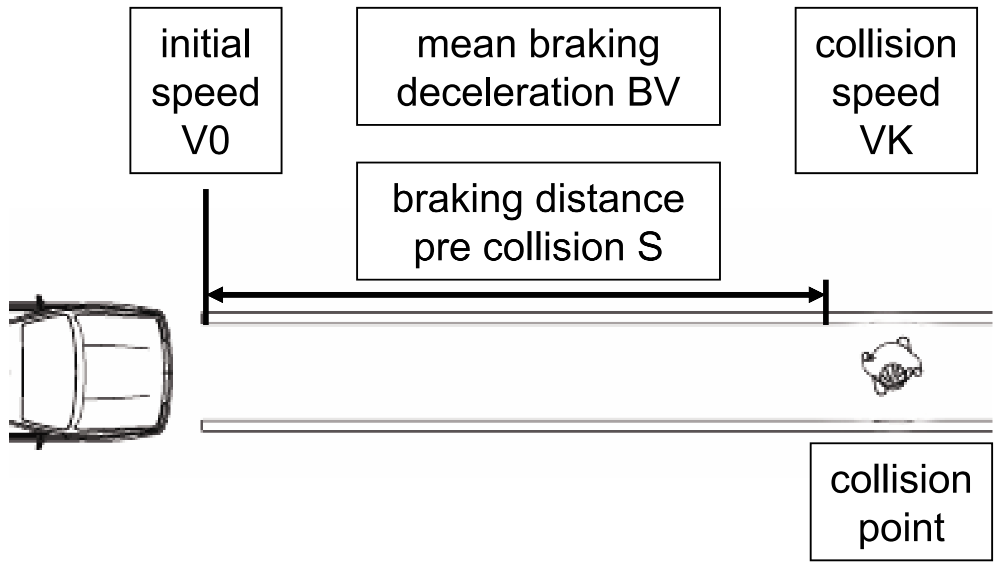


Injury Risk Function
with influence of secondary
safety measures EU Directive
2003/102/EC phase 1

EES - Step 3

representation of effect of primary safety measure BAS – case-by-case method

current situation without BAS



GIDAS dataset

- dry asphalt

$$V0 = 46 \pm 5 \frac{km}{h}$$

$$S = 7{,}4m$$

$$BV = 7{,}8 \frac{m}{s^2}$$

$$VK = 25 \pm 5 \frac{km}{h}$$

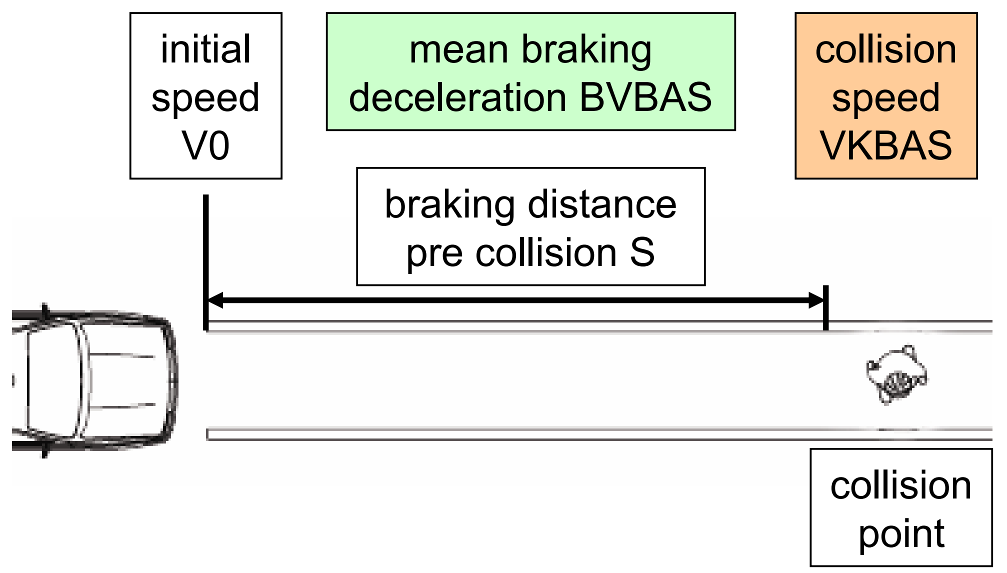
All cases in GIDAS are reconstructed.

mean braking deceleration based on forensic literature (e.g. Danner and Halm → 7,0-8,8 m/s² for dry asphalt) and were assessed or measured by reconstruction experts at the accident research units (e.g. 7,8 m/s²)

Therefore : $$VK = \sqrt{V0^2 - 2 \cdot BV \cdot S}$$

activation of BAS if mean braking deceleration BV >= 6 m/s² → 47% of all cases

predicted situation with BAS



GIDAS dataset

$$V0 = 46 \pm 5 \frac{km}{h}$$

$$S = 7{,}4m$$

determined value

- dry asphalt

$$BVBAS = 8{,}8 \frac{m}{s^2}$$

calculated value

$$VKBAS = 21 \pm 5 \frac{km}{h}$$

BAS activated:

recalculation of collision speed using the ceiling of mean deceleration based on forensic literature (e.g. Danner and Halm 8,8 m/s² for dry asphalt)

Therefore: $$VKBAS = \sqrt{V0^2 - 2 \cdot BVBAS \cdot S}$$

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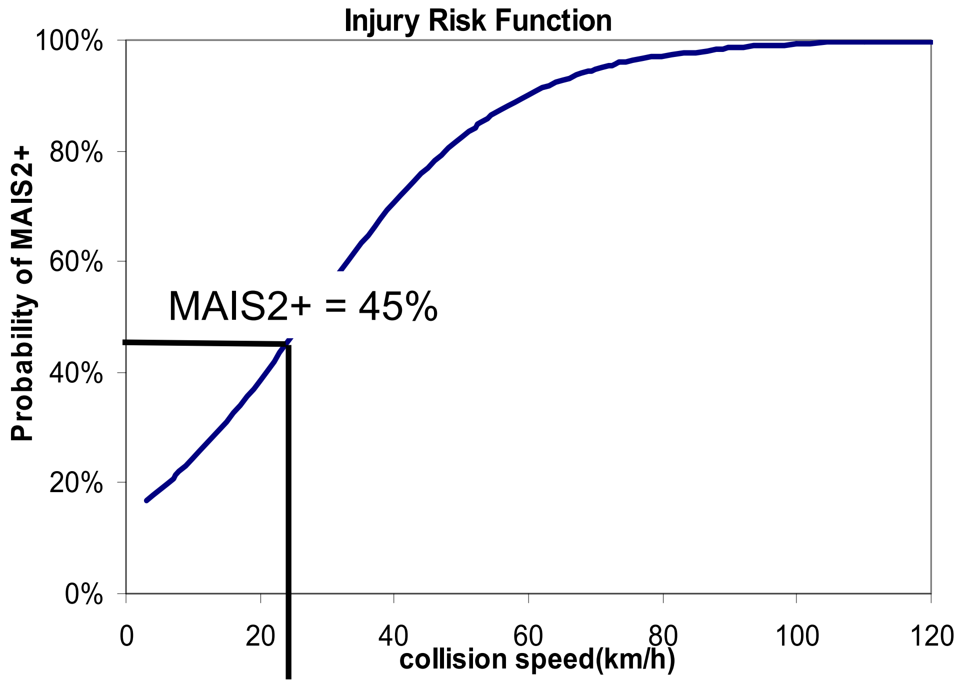
EES - Step 3

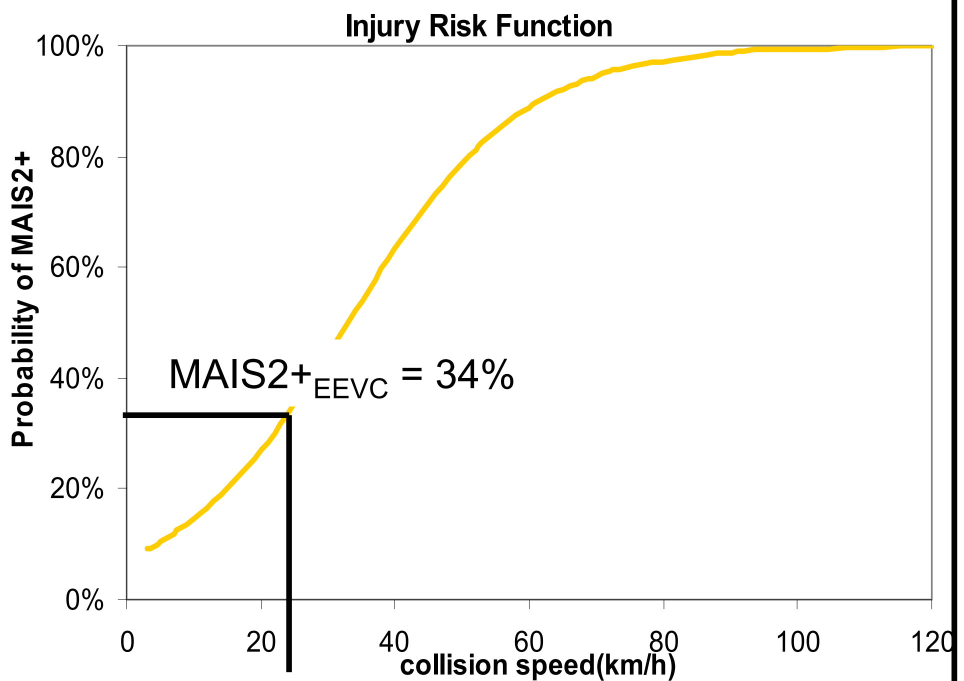
Savings in seriously and fatally injured pedestrians with implementation of EU Directive 2003/102/EC current phase 2 in comparison to the implementation of EU Directive 2003/102/EC phase 1 and Brake Assist System

current situation



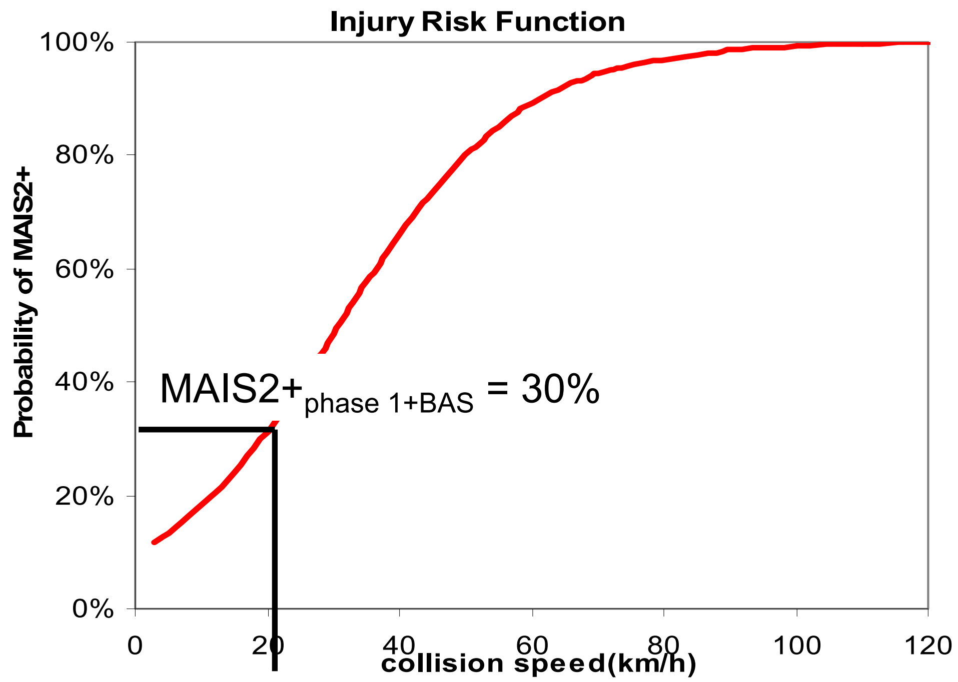
VK = 25 km/h

EU Directive 2003/102/EC phase 2



VK = 25 km/h

EU Directive 2003/102/EC phase 1 + BAS



VKBAS = 21 km/h

In sum over all 712 casualties, this method predict the number of at least serious injured pedestrians!

$$\sum_{1}^{712} MAIS2+ = 377$$

$$\sum_{1}^{712} MAIS2+_{phase2} = 307$$

Saving of 70 at least seriously injured pedestrians!

$$\sum_{1}^{712} MAIS2+_{phase1+BAS} = 296$$

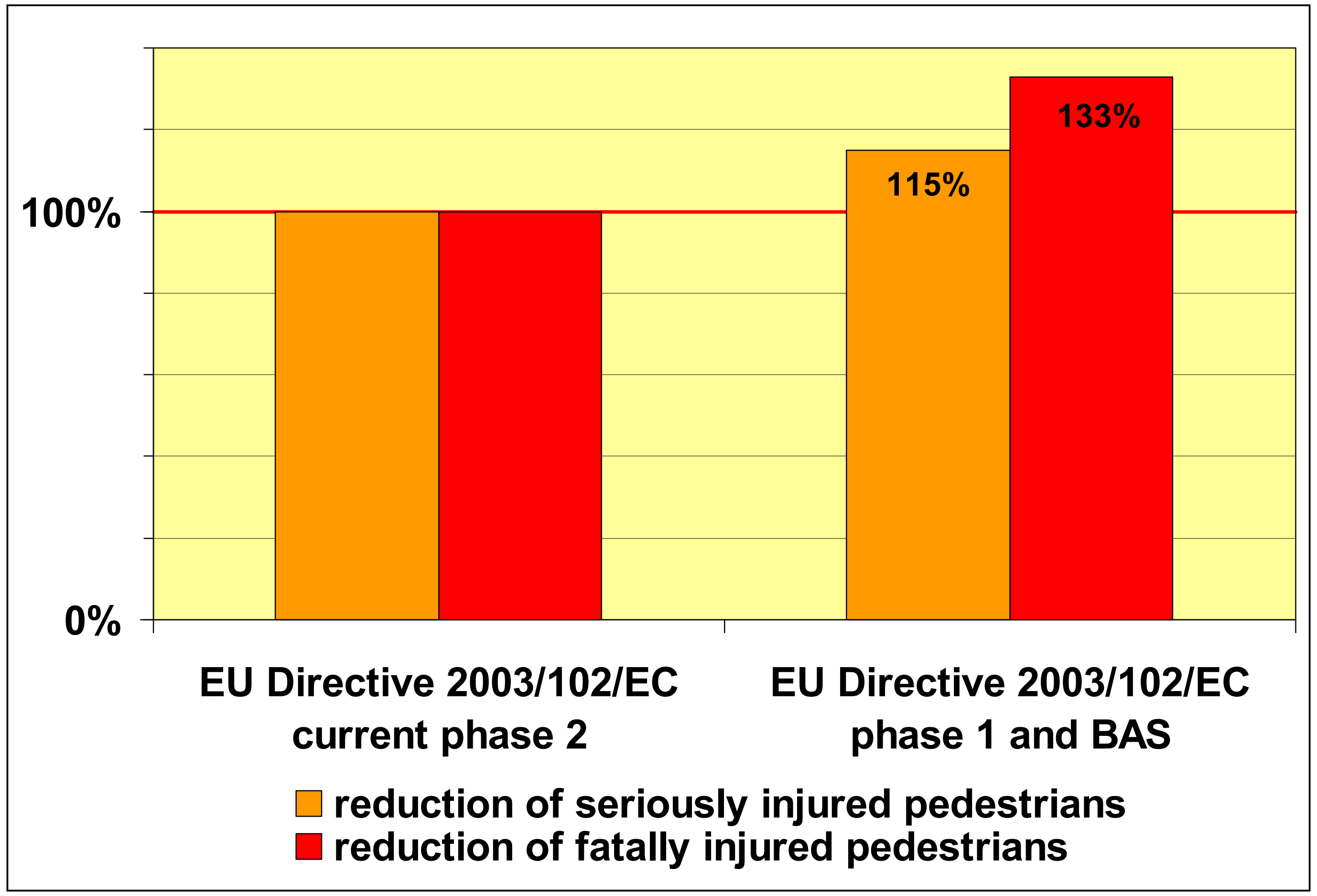
Saving of 81 at least seriously injured pedestrians

56 impacts were completely prevented (VKBAS = 0 km/h)

Summary Equal Effectiveness Study

Overall results of Equal Effectiveness Study On Pedestrian Protection

MAIS1+ n=1153	Benefit of EU Directive 2003/102/EC current phase 2	Benefit of EU Directive 2003/102/EC phase 1 + BAS
Seriously injured (n=531)	12.4%	14.3%
Fatalities (n=48)	8.3%	11.1%
Number of collisions avoided in regarded accidents (n=712)	0	56



Conclusions:

It is shown that the combination of EU Directive 2003/102/EC phase 1 and primary safety measure BAS is at least as effective as implementation of EU Directive 2003/102/EC current phase 2 in reducing pedestrian injuries and fatalities when hit by passenger cars.

Even 56 impacts could completely be prevented with implementation of BAS.

In addition there is enhanced protection for other pedestrian impacts than adressed by EU Directive 2003/102/EC current phase 2 test proposals (e.g. side impacts, overrun) and beyond it, there are positive effects for all real world crashes where BAS was activated.