



Cost Analysis: Current and Improved Truck and Trailer Underrun Protection

VC-Compat Workshop
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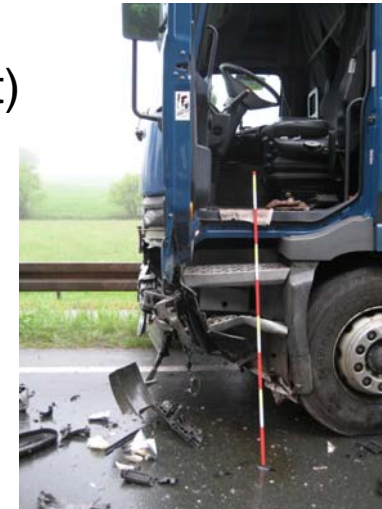
October 18, 2006

Overview

- Cost of current and improved underrun protection
- Determination of front underrun protection equipment rates in trucks
- Considerations on current legislation regarding underrun protection

Need for Effective Front and Rear Underrun Protection on Heavy Vehicles

No front underrun protection (FUP) regulation until end of 2003 (Directive 2000/40/EC going into effect)



Source: Brilon
Volunteer F.D.



Rear underrun protection (RUP) regulation (Direct. 70/221/EEC) from early 70's

Estimated Costs of Front Underrun Protection

- Data from truck manufacturers among VC-Compat partners
- Cost data per vehicle from three manufacturers ,
for development and production preparation from two manufacturers
- Development and preparation cost estimations apply to one truck-model
line, each (e.g., light, medium and heavy duty class)

type of FUPD or improvem. measure	min. cost per vehicle	max. cost per vehicle	min. developm. & prep. cost	max. developm. & prep. cost	remarks
"rigid" FUPD	120 ... 200 €	250 ... 300 €	1.0 mill. €	3.0 mill. €	costs per vehic. are variable costs only
cost in addition to "rigid" design					
energy-absorbing FUPD	+100 €	+100 ... +200 €	+1.0...+2.0 mill. €	+3.0 mill. €	costs per vehic. are variable costs only

Costs of Rear Underrun Protection

Two manufacturers of truck bodywork interviewed

Manufacturer #1 (F.X. Meiller, Germany)

- primarily vehicles for construction logistics
- ca. 10,000 tipper bodies annually
- market share of ca. 70 % in Germany
- production of roll-off tippers and skip handlers



Manufacturer #2

- primarily transport logistics vehicles
- ca. 21,000 „rolling units“
incl. (semi-) trailers annually
- 2nd largest German (23 % market share) and European manufacturer

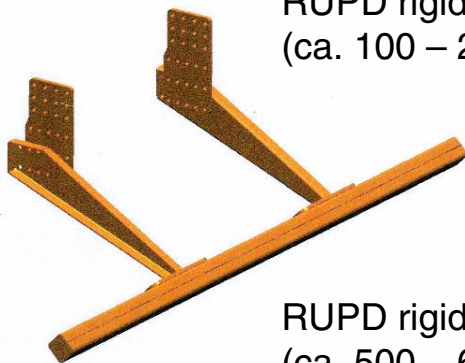


Costs of Rear Underrun Protection

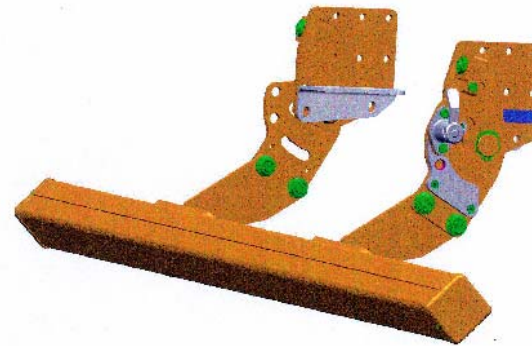
- Cost information from truck manufacturers among VC-Compat partners and bodywork/trailer manufacturers (e.g., spare part prices)
- Large spread of costs due to variety of designs for different purposes



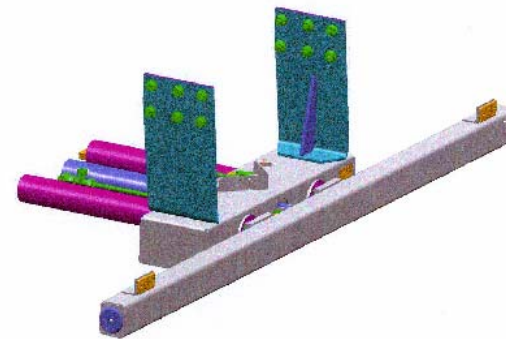
RUPD rigid type
(ca. 100 – 200 €)



RUPD rigid type
(ca. 500 – 600 €)



RUPD folding type
(ca. 800 – 1600 €)



RUPD sliding type
(ca. 1900 – 4600 €)

Costs of Improved Rear Underrun Protection

Special questionnaire for bodywork / trailer manufacturers on influence of raised requirements or RUPD improvement measures, respectively:

- Improve resistance (200 kN in two points, each)
- Improve resistance under angled impact (ca. 10°)
- Increase size of cross member profile (to a height of 200 mm)
- Reduce distance to rear of vehicle (flush with rear contour)
- Reduce ground clearance (to 400 mm from road surface)

With key descriptors:

- Add-on cost
- Additional weight
- Others like feasibility, variety of variants, ...

Costs of Improved Rear Underrun Protection

Example of questionnaire

Improve resistance (200 kN in two points, each)

influence on ...	cost per vehicle	mass	feasibility / constr. effort	variety of variants	obstruction of other functions
larger profile, material of higher strength					
remarks					

more than +100 €; more than +30 kg

↑ presumably strong influence

+21 to +100 €; +11 to +30 kg

→ presumably slight influence

0 to +20 €; 0 to +10 kg

— presumably no influence

Costs of Improved Rear Underrun Protection

M#1 = Bodywork/trailer manufacturer for construction logistics

M#2 = Bodywork/trailer manufacturer for transport logistics

Constructive Improvement	Added cost	Added mass	Feasibility, constr. effort	Obstruction for other functions
Improve impact resistance	M#1 → M#2 ↑	M#1 → M#2 ↑	M#1 ↑ M#2 ↑	40 daN max. operat. force for folding RUP
Improve under angled impact	M#1 → M#2 →	M#1 → M#2 →	M#1 ↑ M#2 →	Interferes w. rear-mnt. parts on constr. vehic.
Higher cross member	M#1 n.p. M#2 →	M#1 n.p. M#2 →	M#1 n.p. M#2 →	Interferes in folded-up position w. tipper body
Reduce distance to rear	M#1 n.p. M#2 —	M#1 n.p. M#2 —	M#1 n.p. M#2 —	Interferes in folded-up position w. tipper body
Reduce ground clearance	M#1 → M#2 →	M#1 → M#2 →	M#1 ↑ M#2 →	Limits off-road capab., may require fold. RUP

— = probably no influence, added cost +0 to +20 €, added mass +0 to +10 kg

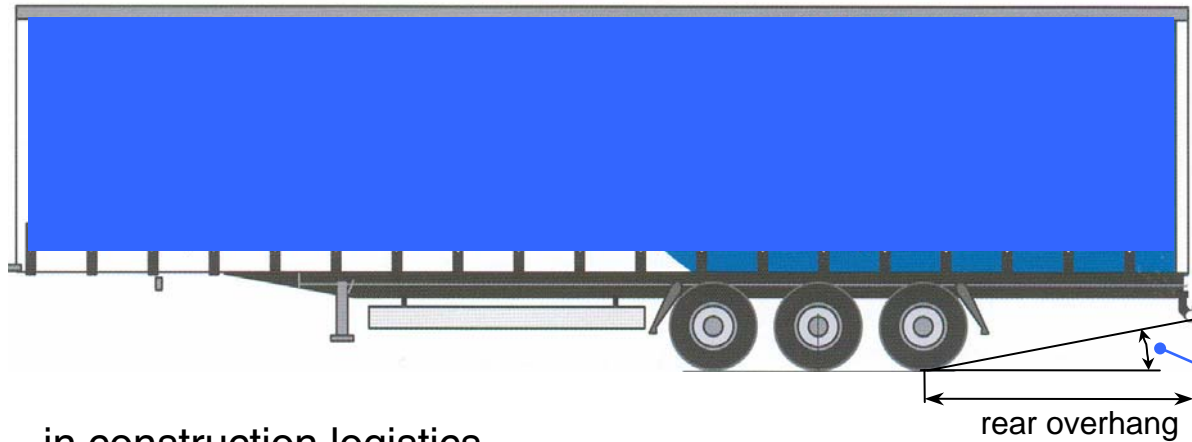
→ = probably slight influence, added cost +21 to +100 €, added mass +11 to +30 kg

↑ = probably strong influence, added cost > +100 €, added mass > +30 kg

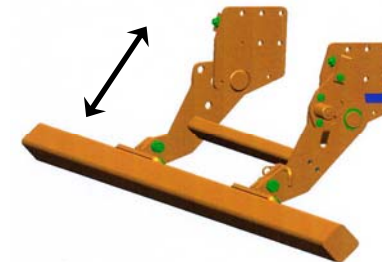
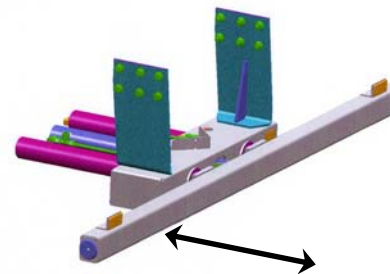
n.p. = not possible to realize

Folding and Extending RUPS

in transport logistics (e.g., Ro/Ro traffic)



in construction logistics



Source: F.X. Meiller

Summary of Cost of Improved Underrun Protect.

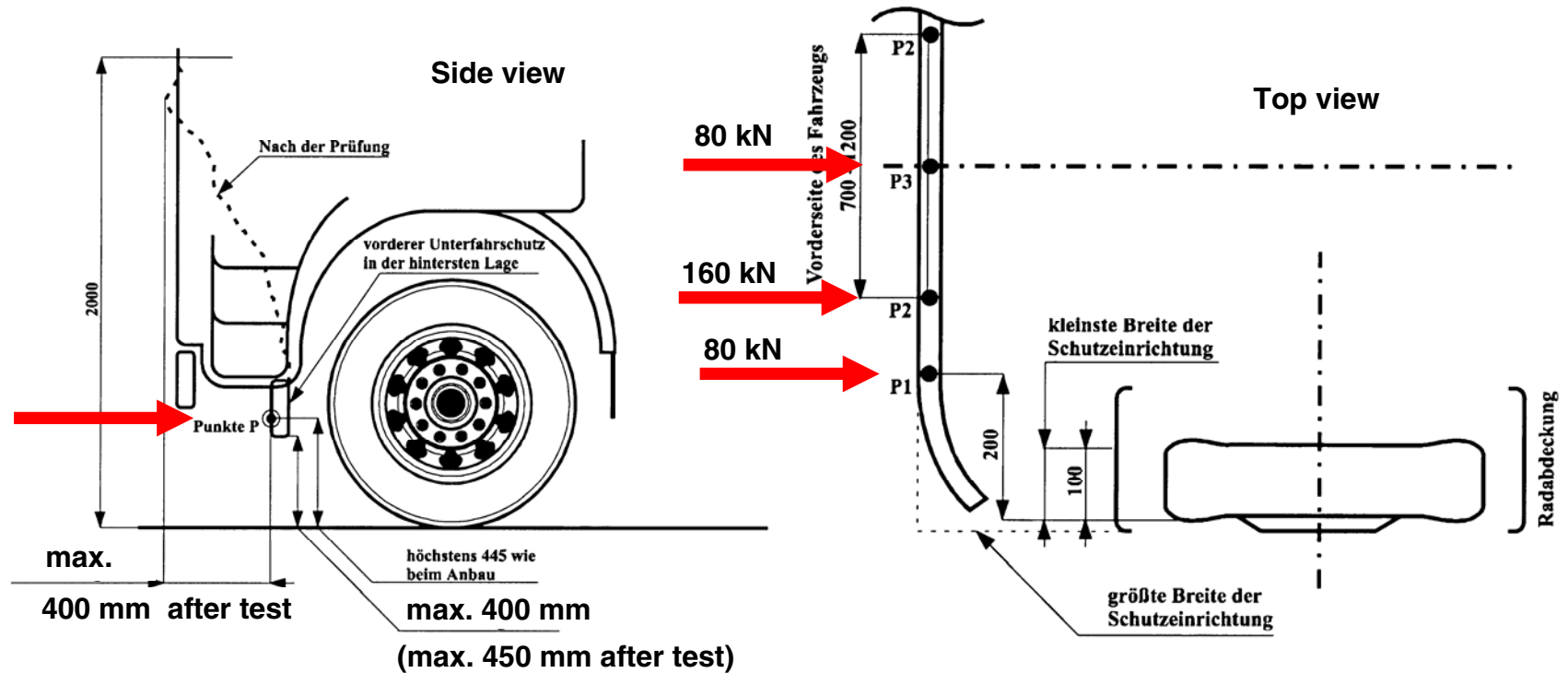
Cost of energy-absorbing front underrun protection

- Energy-absorbing FUPD adds ca. +100 to +200 € to cost of “rigid” FUPD (120 to 300 €) (cost per vehicle)
- Development of e.a. FUPD adds ca. +1.0 million to +3.0 million € to costs for “rigid” FUPD (one-time cost per model line)

Cost of improved rear underrun protection

- Generally, improvements for better RUPD performance feasible, but some difficult, esp. on construction vehicles with folding RUPD (higher cross member, reduced distance to rear)
- Higher RUPD strength, also for angled impact, possible at moderate cost and mass increase (mostly for less than +100 € and +30 kg)
- Reduced RUPD ground clearance also possible, but may require folding device also for road transport (semi-) trailers (ca. +250 €)

Front Underrun Protect. Acc. to Dir. 2000/40/EC



Static test loads in points, seperately applied:

P1, P3: 80 kN or 50% of permissible mass (GVW)

P2: 160 kN or 100% of permissible mass (GVW)

FUP Requirements and Exemptions

FUP fitment is required for:

- N₂ vehicles with a GVW > 3.5 t and ≤ 7.5 t
(only FUPS ground clearance ≤ 400 mm required, no strength requirem.)
- N₂ vehicles with a GVW > 7.5 t
- N₃ vehicles (i.e., with a GVW > 12 t)

FUP fitment is not required for:

- “Vehicles, such that their use is incompatible with the provisions of front underrun protection”
- N₂ and N₃ vehicles that qualify as „off-road vehicles“ (N₂G and N₃G)
acc. to Directive 70/156/EEC

FUP Fitment Exemptions

N₂ vehicles qualify as „off-road“ (N₂G) acc. to Directive 70/156/EEC if:

- all wheels can be driven simultaneously *or*
- at least half the wheels are driven *and*
- at least one differential locking mechanism or similar *and*
- can climb 25 % gradient (solo vehicle)

FUP Fitment Exemptions

N₃ vehicles qualify as „off-road“ (N₃G) acc. to Directive 70/156/EEC if:

- all wheels can be driven simultaneously *or*
- at least half the wheels are driven *and*
- at least one differential locking mechanism or similar *and*
- can climb 25 % gradient (solo vehicle) *and*

at least four of the following six requirements are satisfied:

- approach, ramp and departure angle $\geq 25^\circ$
- ground clearance under front and rear axle ≥ 250 mm
- ground clearance between the axles ≥ 300 mm

Determination of FUP Equipment Rate in EU

- Collect 2004 truck sales figures from 7 major European manufact.

Sales figures

Example

2004 truck sales	region	trucks ≤ 12 tons GVW with FUPS	trucks ≤ 12 tons GVW w/o. FUPS	trucks > 12 tons GVW with FUPS	trucks > 12 tons GVW w/o. FUPS
Volvo	Germany				
	all EU*				

* if „all EU“ figures not available, please provide „all Europe“ figures

- For selected European countries: Determine 2004 truck registration figures and market share of truck makes

Trucks over 16.0 tons GVW, 2004 new registrations

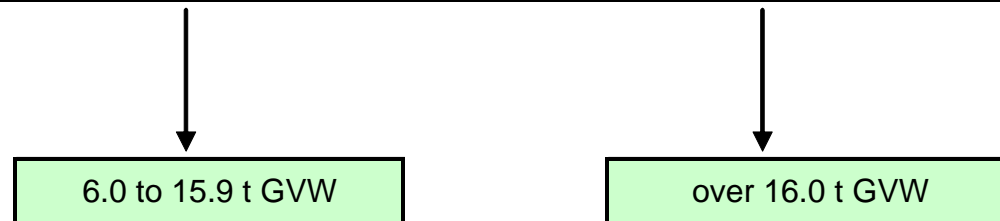
Example

„Whole“ market

	DAF	Iveco	MAN	D/C	Renault	Scania	Volvo	others	Total Europ. OEMs
Belgium	19,7	3,7	15,3	11,9	8,5	15,2	24,6	1,1	98,9
Denmark	9,5	4,5	17,0	10,8	2,8	26,3	29,1	0,0	100,0
Germany	8,1	6,9	28,4	39,2	1,8	7,1	8,5	0,0	100,0
France	12,5	8,9	6,8	14,6	35,6	8,8	12,3	0,5	99,5
UK	23,0	5,7	7,5	16,6	4,8	17,2	16,4	8,8	91,2
Ireland	24,7	4,6	4,4	6,8	2,6	21,5	22,0	13,4	86,6
Italy	7,7	35,5	8,3	13,3	8,8	12,9	10,4	3,1	96,9
Netherlands	33,0	2,1	9,9	10,8	3,0	19,2	19,3	2,7	97,3
Austria	10,2	7,3	40,0	14,4	3,3	12,0	12,8	0,0	100,0
Poland	14,6	3,9	17,6	14,4	13,2	16,7	18,8	0,8	99,2
Sweden	1,2	0,0	1,6	5,7	0,0	45,2	46,2	0,1	99,9
Switzerland	4,1	9,5	16,2	26,6	4,4	16,1	20,0	3,1	96,9
Spain	9,8	18,1	13,3	14,5	17,5	11,0	14,8	1,0	99,0

Determination of FUP Equipment Rate in EU

(1)	Calculation of sales figures for "whole market", which consist of pre-selected European countries \Rightarrow share of individual countries of "whole market" (in %)
(2)	Share of manufacturers of market for each individual country, multiplied by share of respective country of "whole market" (in %) \Rightarrow Share of manufacturer of "whole market" (in %)
(3)	Application of figures for EU/Europe/EU25 with respect to number of trucks "with FUPS" and w./o FUPS", applied for each individual manufacturer (in %)
(4)	Multiplication of share for "with FUPS" and "w./o FUPS" (applied for each manufacturer) with respective share of "whole market", also for each manufacturer (in %)



Determination of FUP Equipment Rate in EU

Results:

- for category 6 – 15.9 t GVW *
 - trucks equipped with FUPS = 60.7 %
 - trucks without FUPS = 33.4 %
- for category ≥ 16 t GVW
 - trucks equipped with FUPS = 83.6 %
 - trucks without FUPS = 14.1 %

Note:

* segment of trucks 6 – 7.5 t GVW (no FUPS strength requirement) included no information for remaining 5.9 % and 2.3 %, respectively, due to share of other manufacturers without available data

Determination of FUP Equipment Rate in EU

New registrations for trucks with
7.001 – 7.5 t GVW in 2004
(no FUP strength requirement):

in UK: 12511 trucks*

in Germany: 15082 trucks**

in Austria: 199 trucks (7.0 – 8.0 t GVW)***



Example of 7.5 t truck w/ FUPS

⇒ trucks in the 7.0 – 7.5 t GVW represent a large market segment in
some EU countries (typical distribution service truck)

* source: Department for Transport, UK

** source: Kraftfahrtbundesamt, Germany

*** source: Bundesanstalt Statistik Oesterreich

Costs For Traffic-Related Injuries

Overview of socio-economic cost of casualties for selected EU countries (HEATCO = EU project 2004 - 2006, "Developing Harmonised Europ. Approaches for Transp. Costing and Project Assessment")

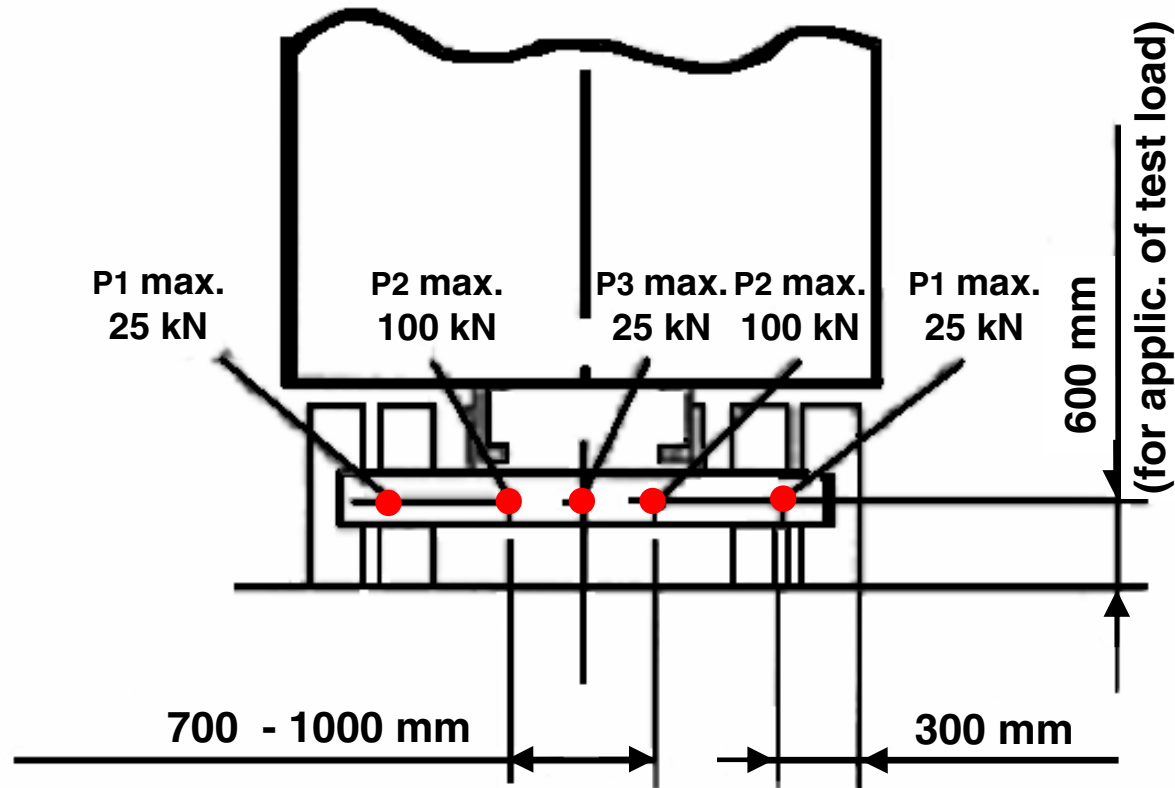
Costs	2003	2003	2003	1999	1997
	UK (in brit. Pounds)	D (in Euros)	F (in Euros)	S (in SEK)	NL (in Euros)
Fatal	1,312,600	1,164,119	1,100,000	14,300,000	1,338,000
Severe	147,460	83,972	166,600	2,600,000	179,000
Slight	11,370	3,755	23,800	150,000	1,000
acc. to HEATCO	2002	1998	2000	2001	1998
Fatal	1,447,490	1,176,000	1,000,000	16,269,000	1,500,000
Severe	168,260	81,800	50,000	2,503,000	200,000
Slight	16,750	3,579	22,000	113,000	30,000
Assessment Method	willingness to pay	human capital		willingness to pay	
Remarks			definition for slight and severe injuries different from other countries		

Revised Benefit Estimations E.A. vs. Rigid FUP

Minimum benefit of e.a. over rigid FUPS (old pass. car fleet assumed):

Fatalities		-148 to -159 (saved)	⇒	-162.8 to -174.9 mill. € (saved)
Severely injured		-1168 (saved)	+148 to +159 (produced)	⇒ -98.1 mill. € (saved) +12.4 to +13.4 mill. € (produced)
Slightly injured		+1168 (produced)	⇒	+4.4 mill. € (produced)
Σ Savings =		Fatalities -148 to -159 Severely inj. -1009 to -1020		244.1 mill. € to 255.2 mill. € 500 mill. € when highest monetary values are applied

Rear Underrun Protect. Acc. to Dir. 70/221/EEC



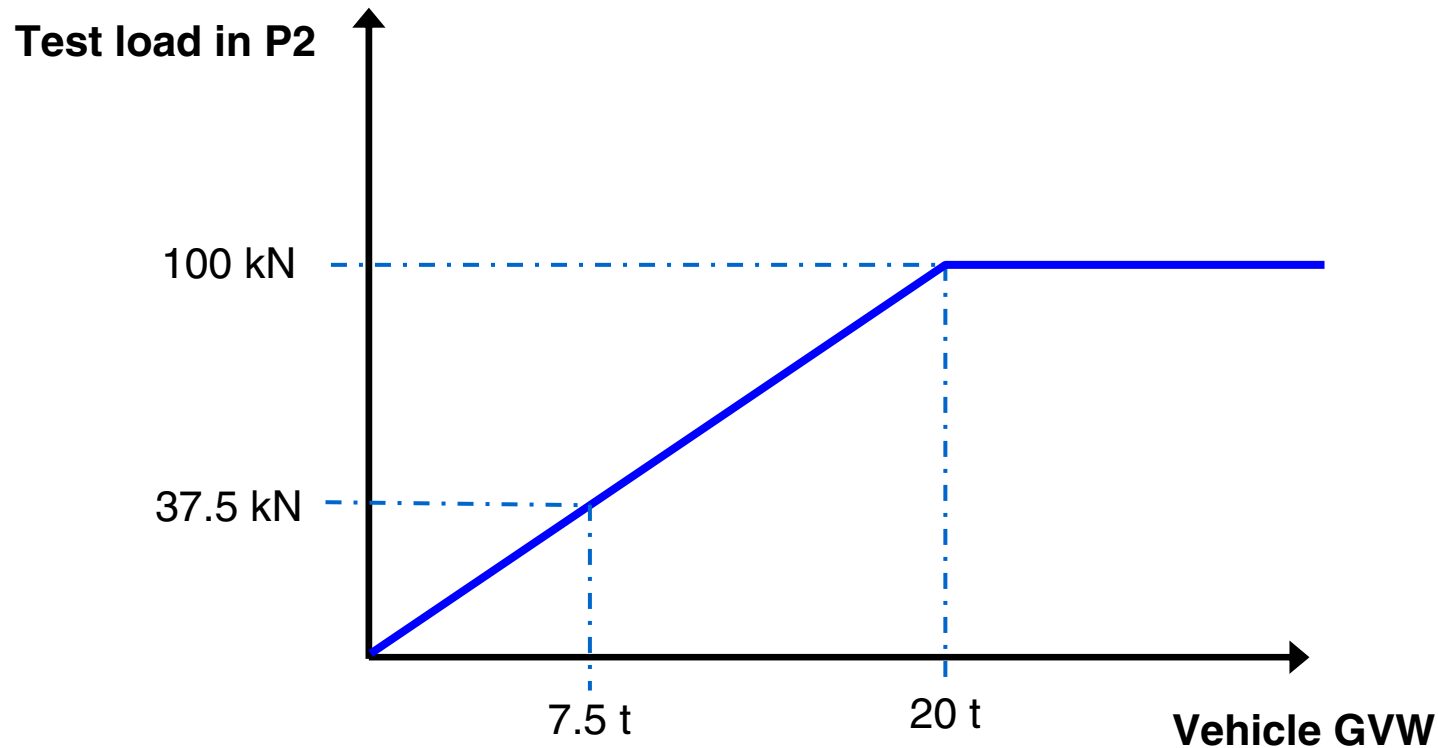
Static test loads in points, seperately applied:

P1, P3: 25 kN or 12.5% of permissible mass (GVW)

P2: 100 kN or 50% of permissible mass (GVW).

Maximum Test Loads Acc. to Dir. 70/221/EEC

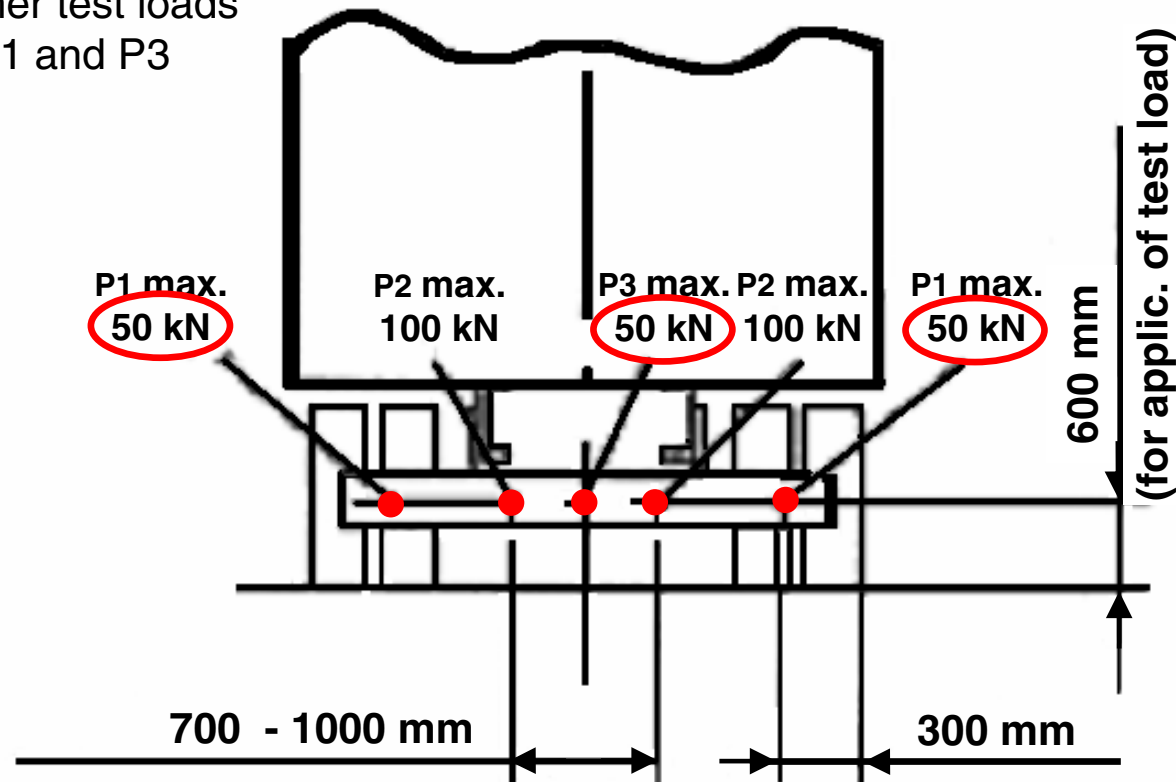
- Test load in P1, P3 max. 25 kN or 12.5% of vehicle permissible mass (GVW), whichever is lower
- Test load in P2 max. 100 kN or 50% of vehicle permissible mass (GVW), whichever is lower



Rear Underrun Protect. Acc. to Dir. 2006/20/EC

amending Annex II of Directive 70/221/EEC, in effect by March 2007

- higher test loads in P1 and P3



- vehicles with air, hydraulic suspension etc. in normal driving position (height) for testing
- explicit permission of RUP with divided cross member if required by hydraulic loading platforms

Divided RUP Devices

Divided RUP cross members appear to be the rule already although products with undivided cross members are available



FUP And RUP Real-World Performance

Front underrun protection (FUP) acc. to Directive 2000/40/EC improves protection of accident opponent



Source: Landsberg a. Lech
Volunteer F.D.

Rear underrun protection with significant deficits

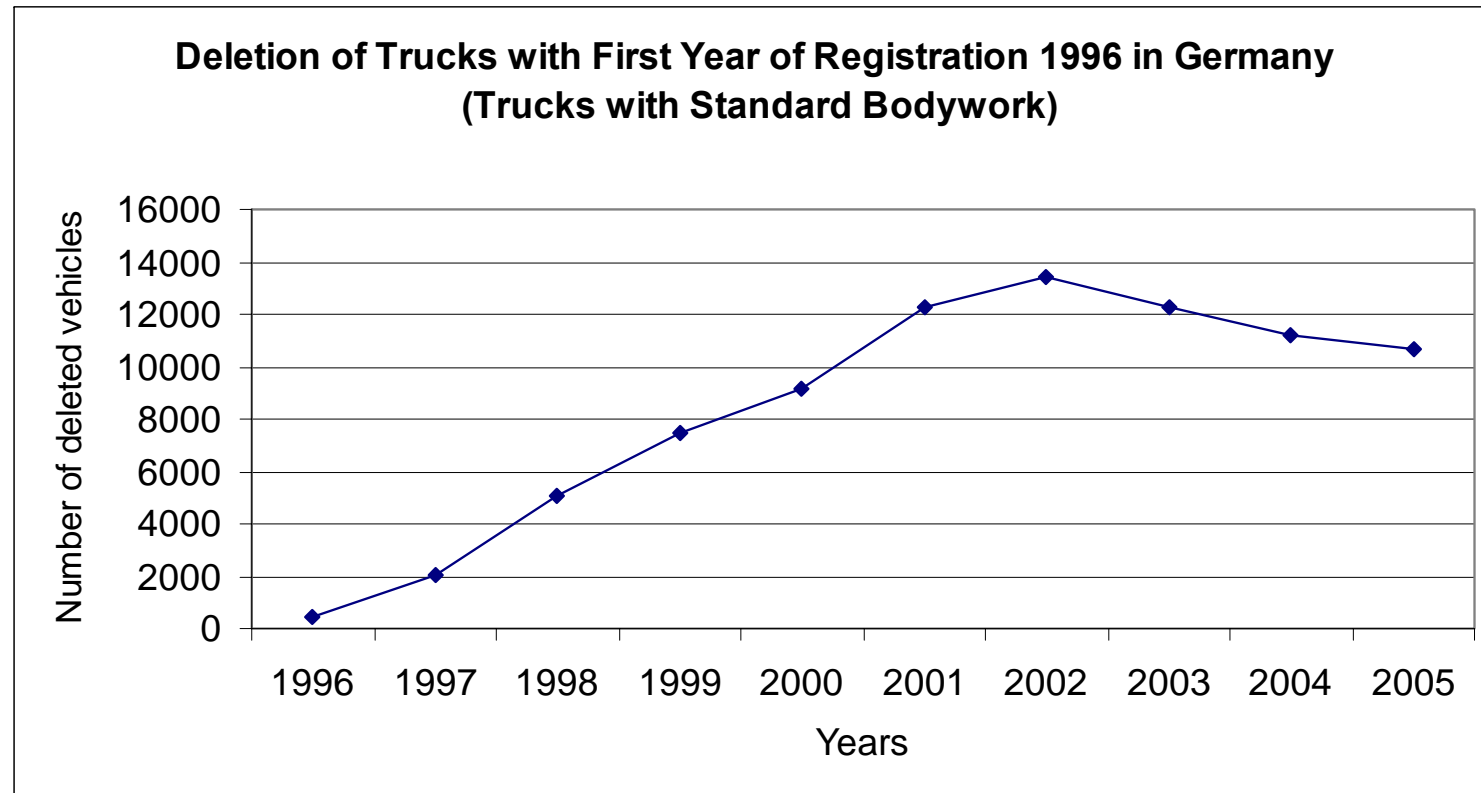


Source: Friedberg
Volunteer F.D.

Penetration of Truck Fleet With FUP

Time until approx. 50% of truck fleet (of one registration year) taken out of service determined from German registration statistics

⇒ It takes until 2012 that 50% of 2003 model year (last year without legal FUP requirement) is replaced by new trucks, complying with 2000/40/EC



Conclusions

Cost of improved underrun protection

- Energy-absorption feature adds 50 – 100% to cost of rigid FUPD
- Improved rear underrun protection possible, esp. for on-road trucks and trailers, with acceptable additional cost and mass

FUPS equipment rate on trucks in EU

- Potential – and need – for extension of FUP fitment requirement to vehicles (“off-road” acc. to current definition) that are currently exempt

Current underrun legislation in EU

- Consider inclusion of trucks ≤ 7.5 tons GVW in strength requirement for FUP
- Raise strength requirements for RUP of trucks ≤ 20 tons GVW to better reflect real-world situation

Thank you for your attention!

Appreciation is extended to the truck manufacturers DaimlerChrysler, DAF, Iveco, MAN, Renault Trucks, Scania, Volvo Trucks who provided sales figures and F.X. Meiller and other trailer manufacturers who provided cost estimations on underrun protection equipment