Evaluation of the Equivalent Chest Deflection Criteria (DEQ) using Hybrid III models and sled tests

(DEQ LIN Version 2012-07-25)

Cecilia Sunnevång
Jan 30, 2013

Autoliv

Method - Parameter Variation

Num	Occupant Model	Pulse	Airbag Type	Belt Load Limiter [kN]	Belt Type
1	Hybrid III or THUMS	ODB64	Non-sym	Const 3.3	3-Point
2	Hybrid III or THUMS	ODB64	Non-sym	Degr 6.0-2.2	3-Point
3	Hybrid III or THUMS	ODB64	Sym	Const 3.3	3-Point
4	Hybrid III or THUMS	ODB64	Sym	Degr 6.0-2.2	3-Point
5	Hybrid III or THUMS	FF40	Non-sym	Const 3.3	3-Point
6	Hybrid III or THUMS	FF40	Non-sym	Degr 6.0-2.2	3-Point
7	Hybrid III or THUMS	FF40	Sym	Const 3.3	3-Point
8	Hybrid III or THUMS	FF40	Sym	Degr 6.0-2.2	3-Point
9	Hybrid III or THUMS	FF56	Non-sym	Const 3.3	3-Point
10	Hybrid III or THUMS	FF56	Non-sym	Degr 6.0-2.2	3-Point
11	Hybrid III or THUMS	FF56	Sym	Const 3.3	3-Point
12	Hybrid III or THUMS	FF56	Sym	Degr 6.0-2.2	3-Point

↓ 3 pulses

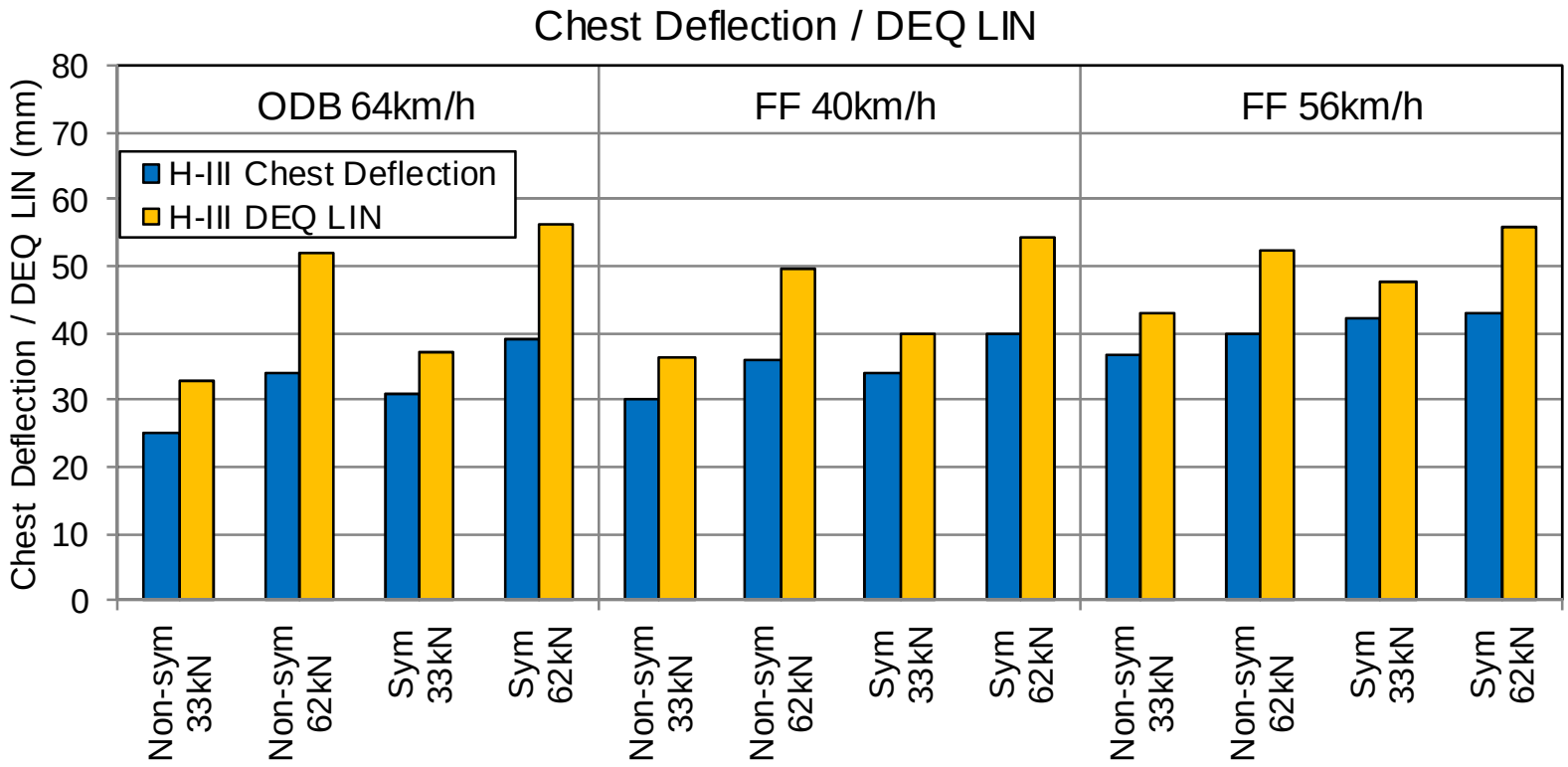
↓ 2 airbag types

↓ 2 load limiters

cecilia.sunnevang@autoliv.com

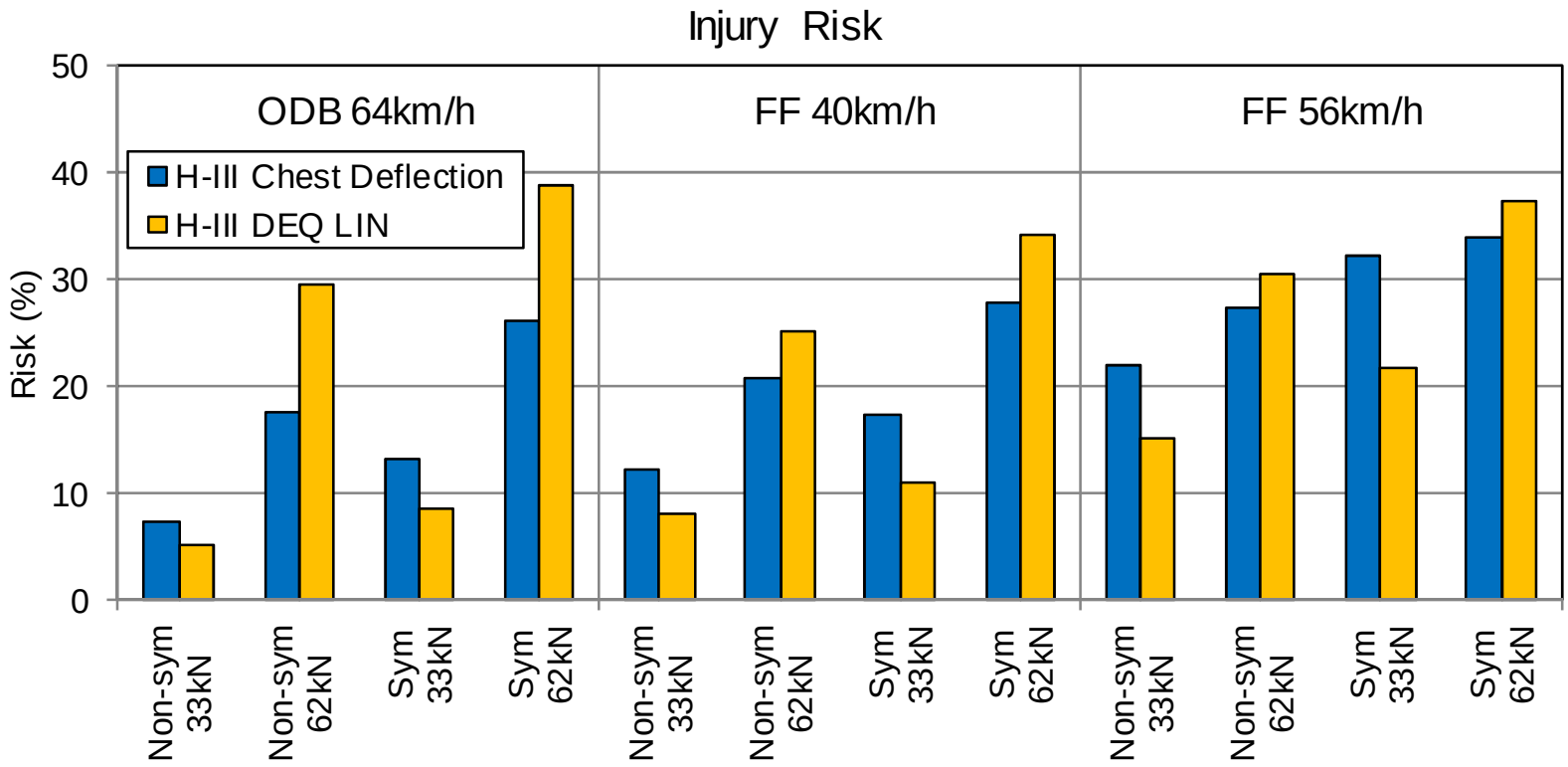
Autoliv

Simulation - Chest Deflection and DEQ LIN (Hybrid III)



> DEQ LIN values higher than chest deflection values for all cases

Simulation - Injury Risk Values based on Chest Deflection and DEQ LIN (Hybrid III)

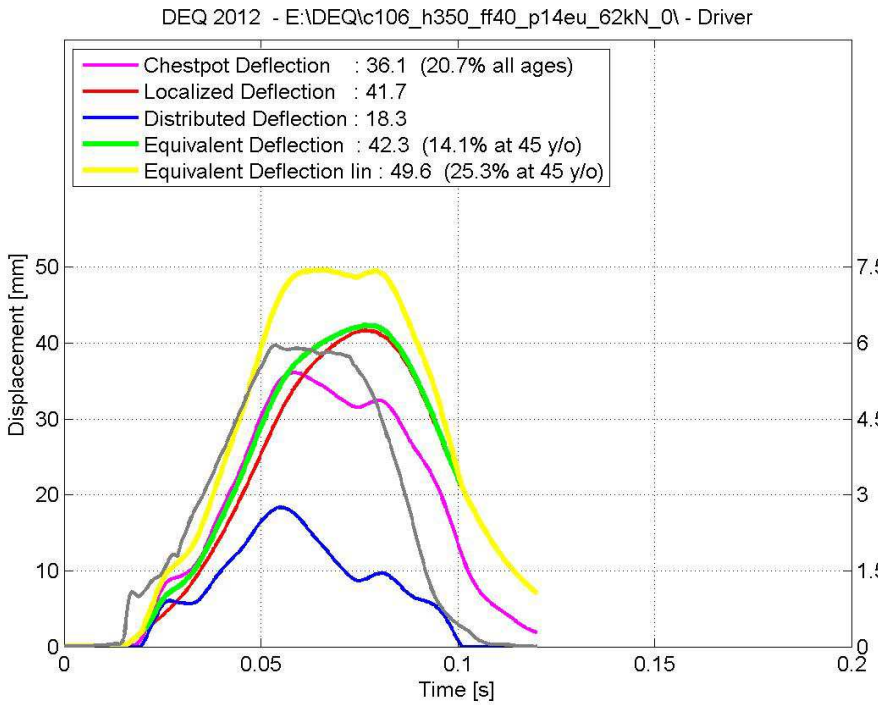


cecilia.sunnevang@autoliv.com

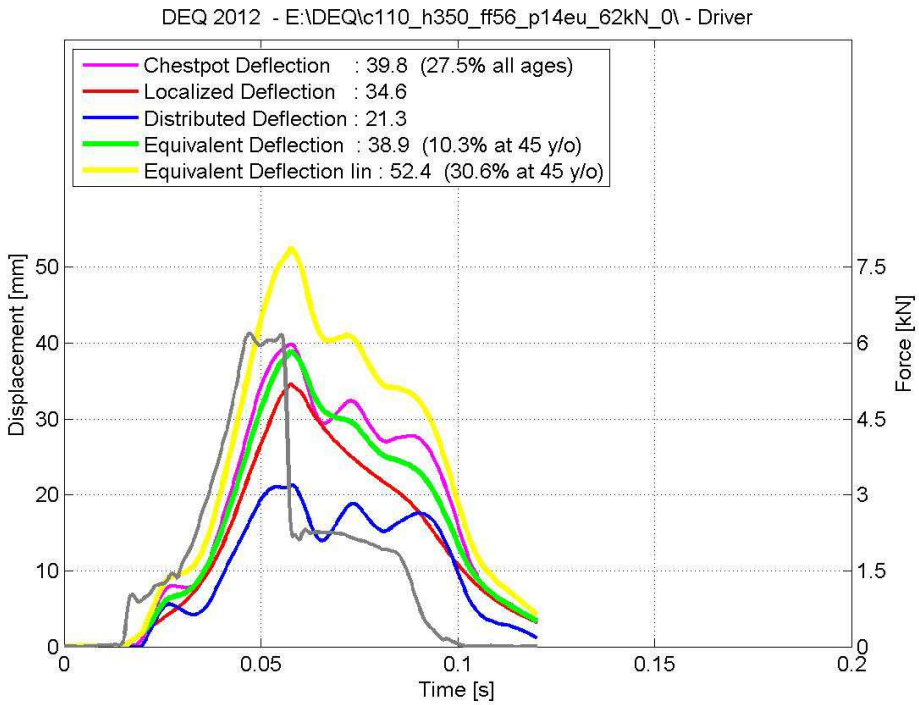
Autoliv

Simulation - CD and DEQ over time

Full-Frontal 40km/h – Non-Sym, Degressive (6,2) LL



Full-Frontal 56 km/h – Non-Sym, Degressive (6,2) LL

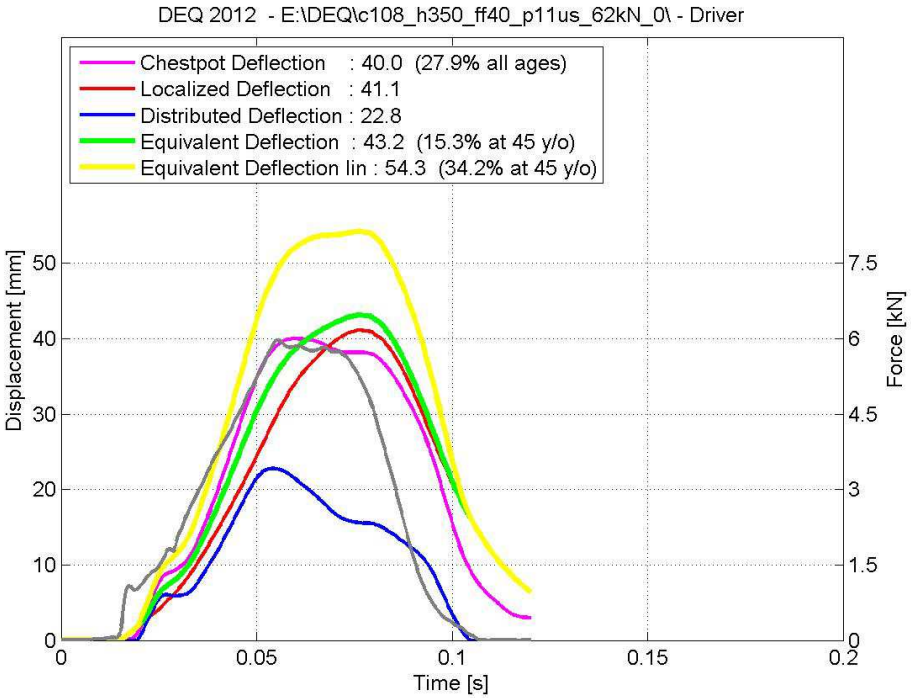


cecilia.sunnevang@autoliv.com

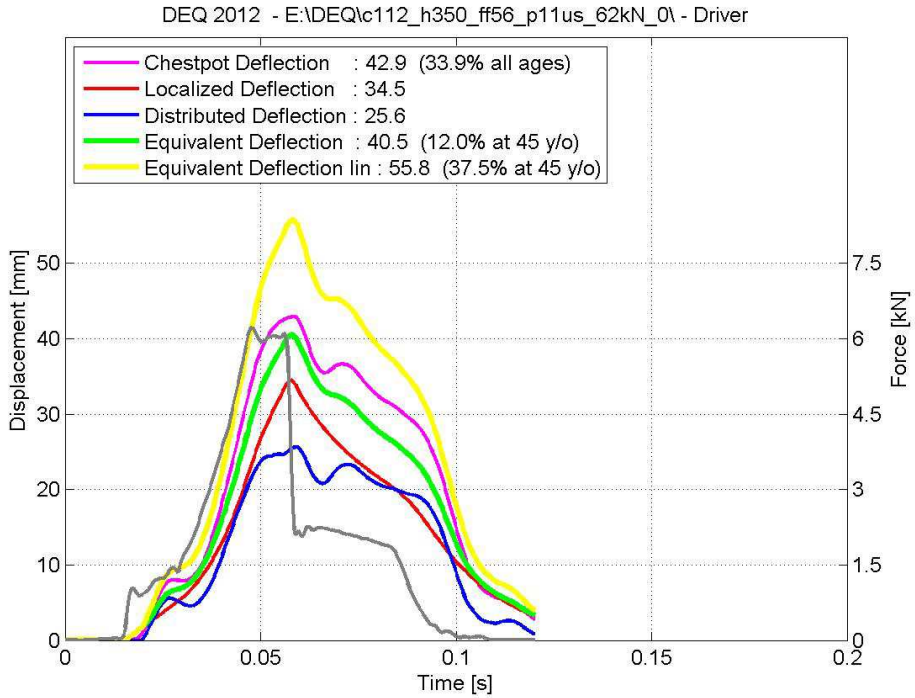
Autoliv

Simulation - CD and DEQ over time

Full-Frontal 40km/h – Sym, Degressive (6,2) LL



Full-Frontal 56 km/h –Sym, Degressive (6,2) LL



cecilia.sunnevang@autoliv.com

Autoliv

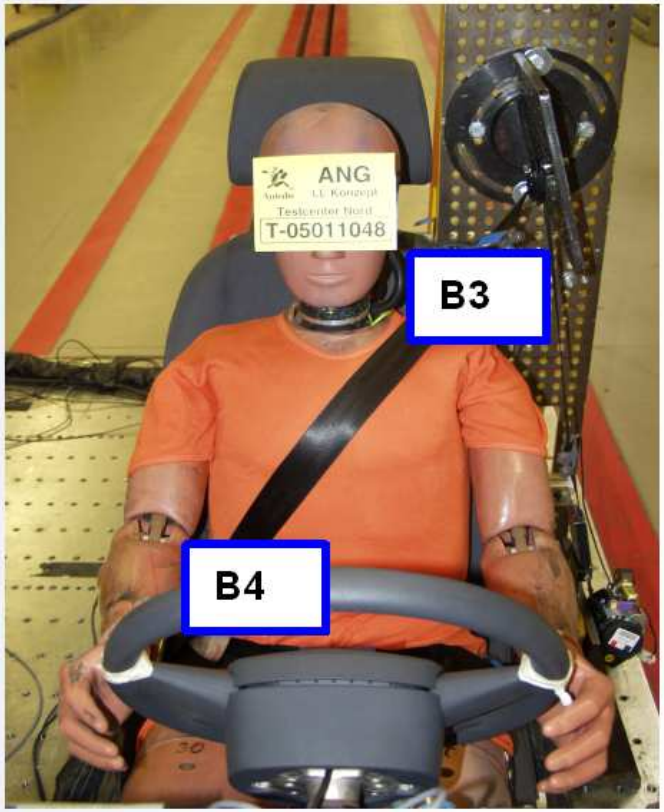
Sled tests - Crash Locking Tongue Study

The predominant force on the thorax is the belt force;

Belt induced chest deflection is caused by the resultant force on the sternum.

This force depends on:

- **the magnitude of the forces FB3 (shoulder belt) and FB4 (diagonal inner belt),**
- **the geometry of the belt system.**



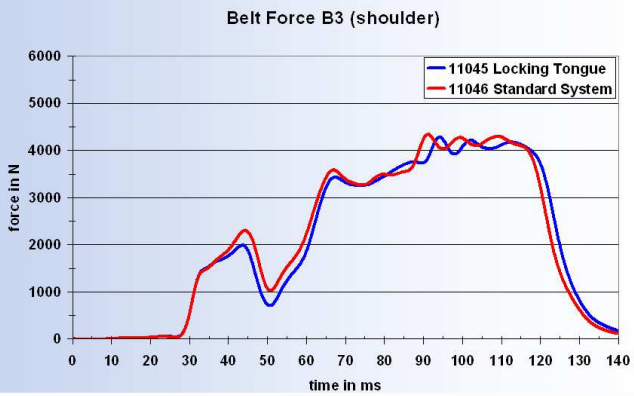
cecilia.sunnevang@autoliv.com

Autoliv

Sled tests - Crash Locking Tongue Study

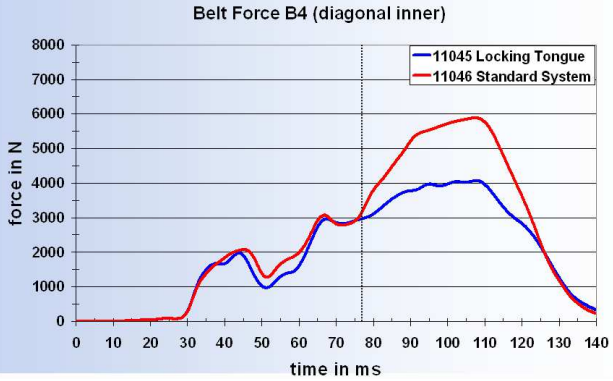
Belt force FB3 (shoulder):

Comparable curve progression



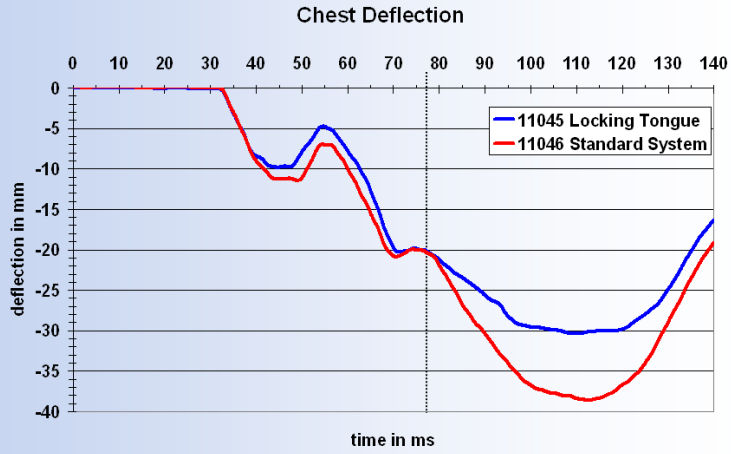
Belt force FB4 (diagonal inner):

A reduction of belt load with the locked tongue of about 2 kN is noticeable.



Chest deflection:

An reduction in the chest deflection with a locked tongue can be noticed.



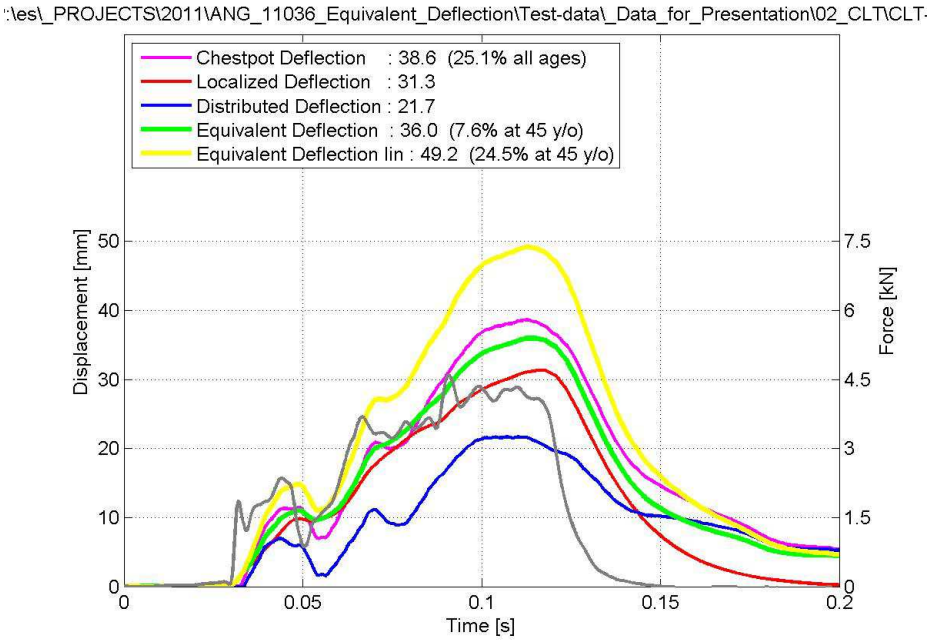
Benefit about 20% !

cecilia.sunnevang@autoliv.com

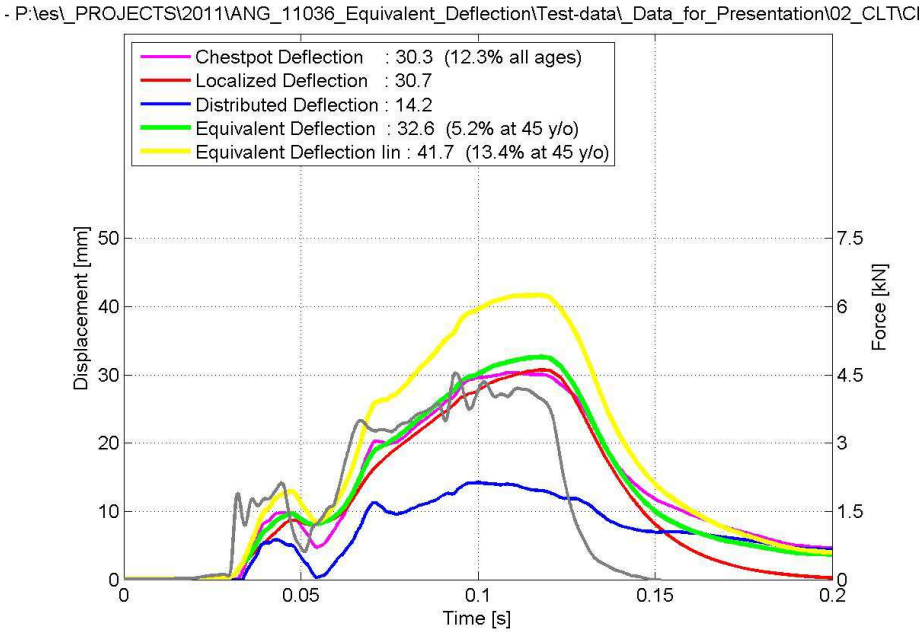
Autoliv

Sled tests - Crash Locking Tongue Study

Normal Tongue



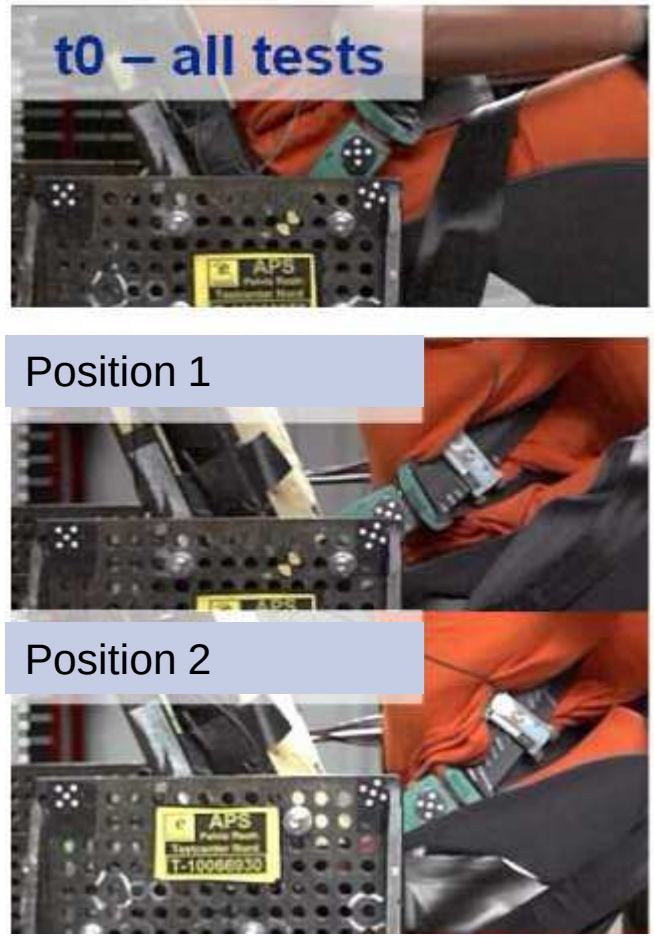
Locking Tongue



cecilia.sunnevang@autoliv.com

Autoliv

Sled tests - Buckle Motion Study



Varied buckle motions (two positions) to check influence of belt geometry

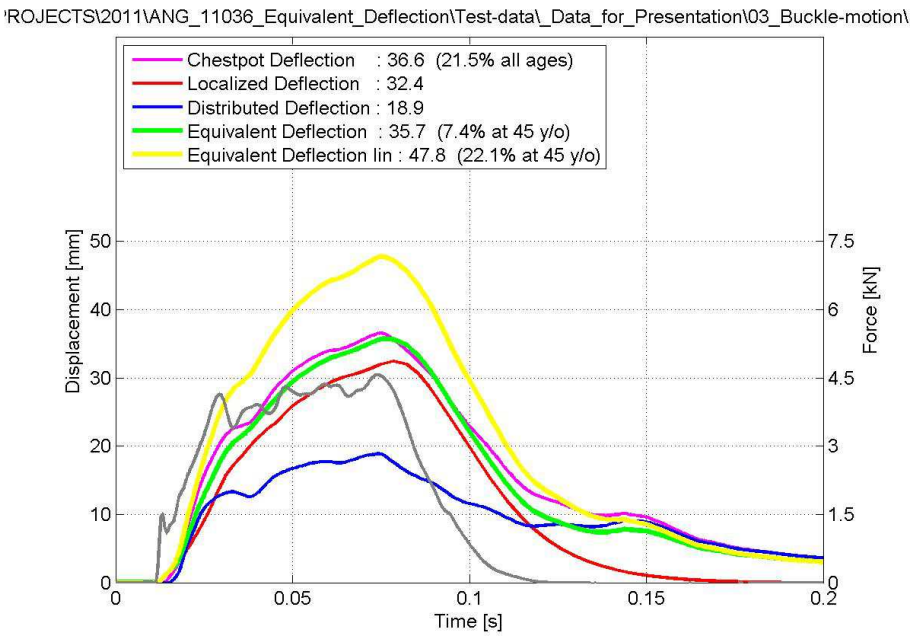
Position 2 resulted in less chest deflection

cecilia.sunnevang@autoliv.com

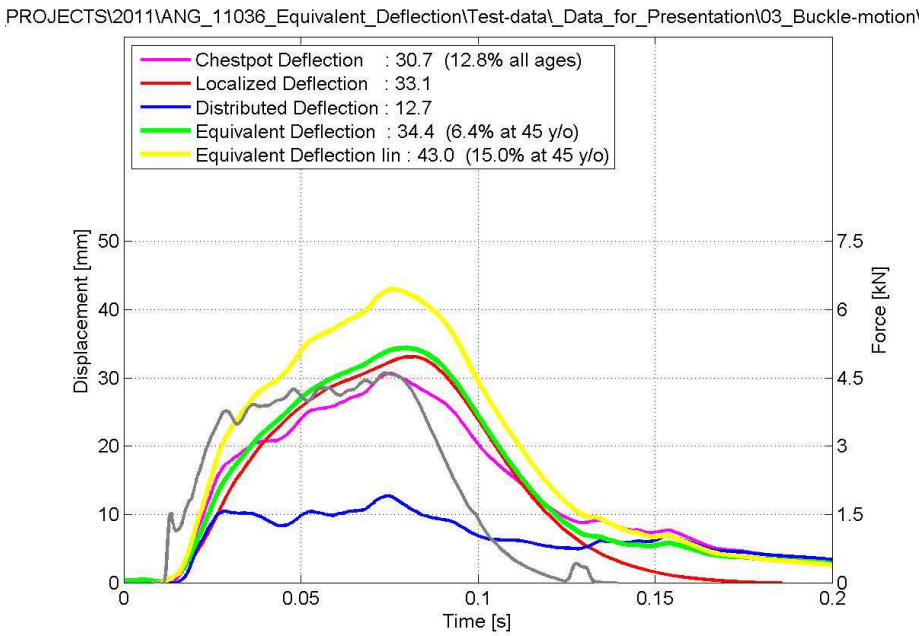
Autoliv

Sled tests - Buckle Motion Study

Buckle in position 1



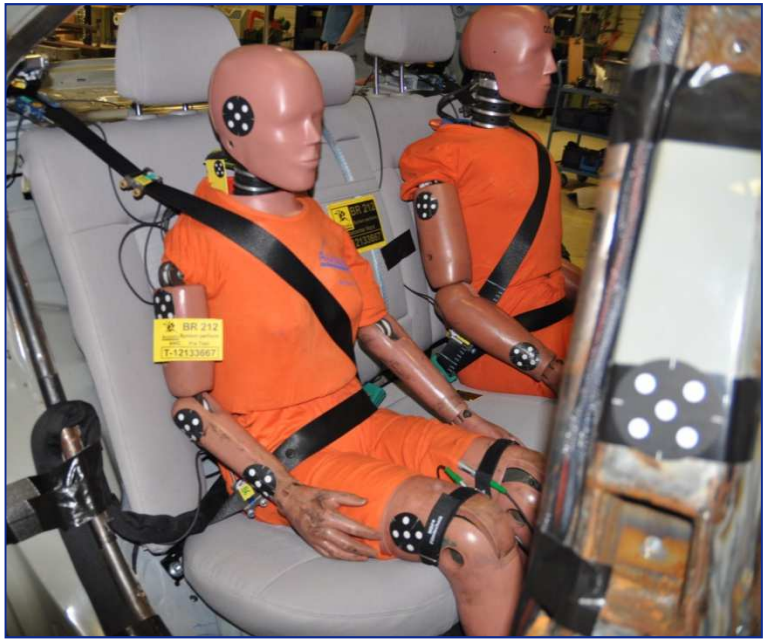
Buckle in position 2



cecilia.sunnevang@autoliv.com

Autoliv

Sled tests - Rear Seat Safety



- Test series with HIII-5% female on rear seat
- Only the anchor plate position was changed
- Differences in chest deflection although the load limiters and therefore the belt force was the same

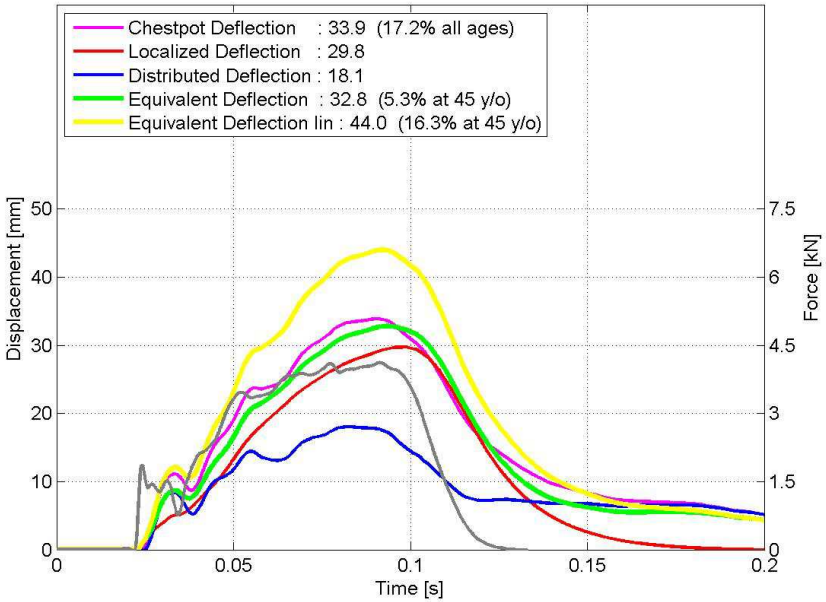
cecilia.sunnevang@autoliv.com

Autoliv

Rear Seat Study

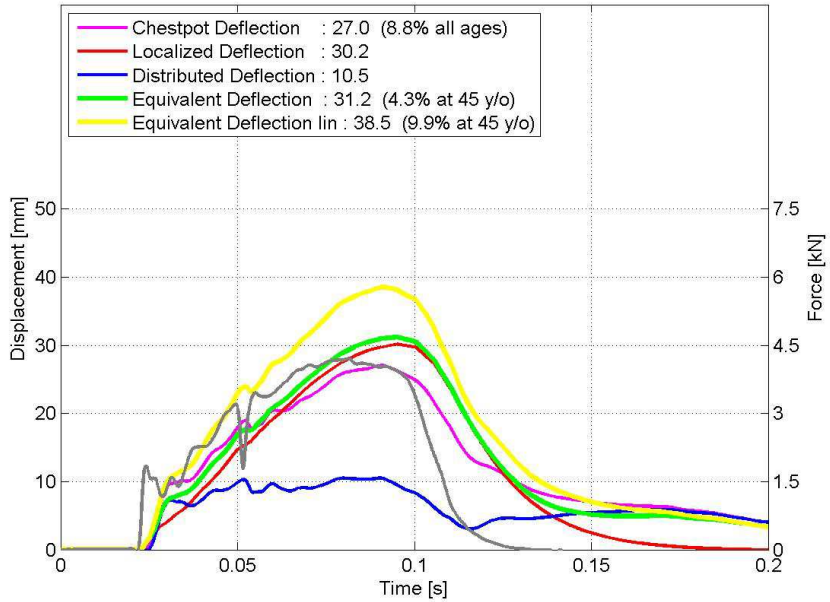
original environment

s_PROJECTS\2011\ANG_11036_Equivalent_Deflection\Test-data_Data_for_Presentation\05_Rear-Seat\



changed anchor plate

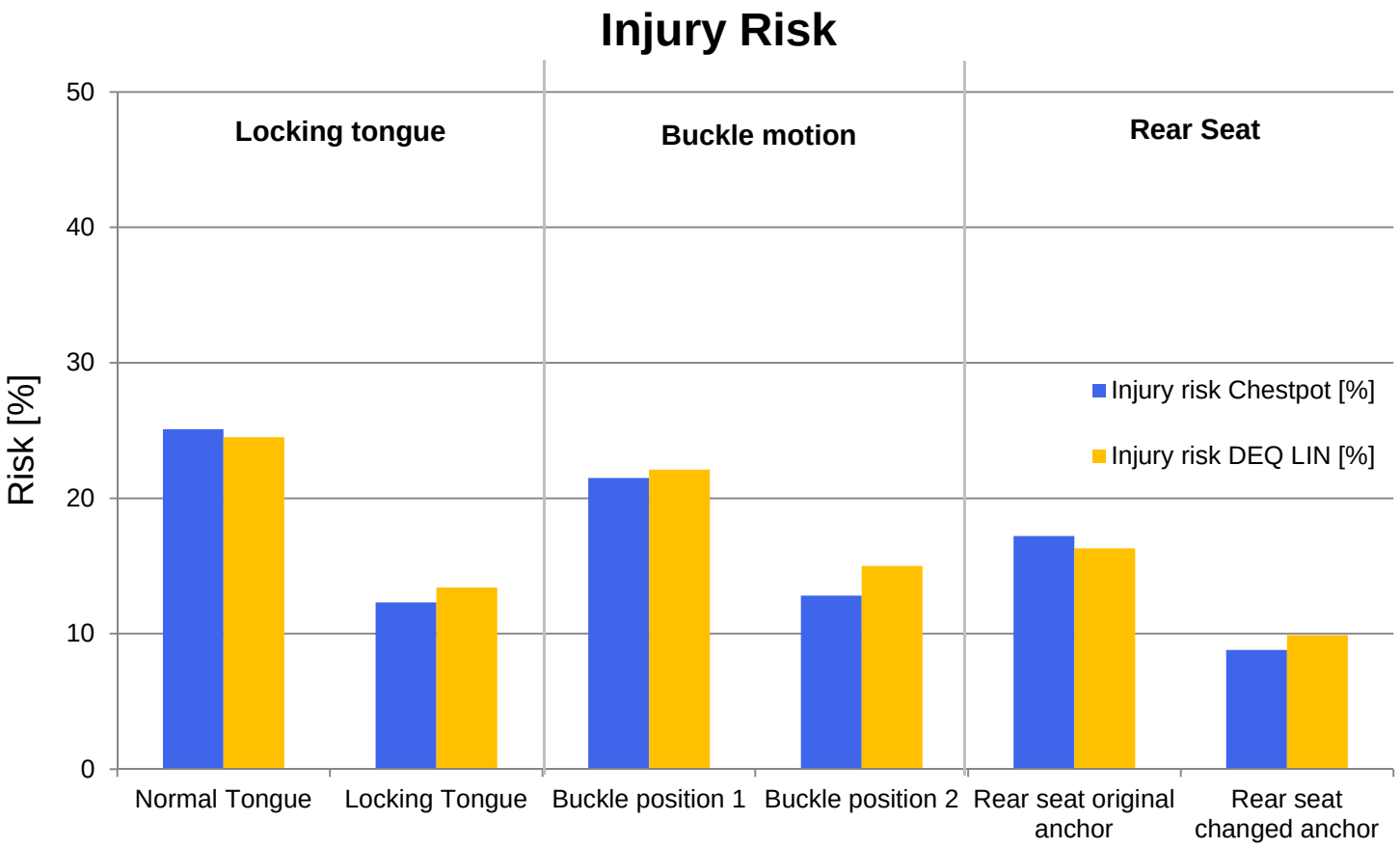
s_PROJECTS\2011\ANG_11036_Equivalent_Deflection\Test-data_Data_for_Presentation\05_Rear-Seat\n



cecilia.sunnevang@autoliv.com

Autoliv

Sled tests - Injury Risk Values based on Chest Deflection and DEQ LIN (Hybrid III)



cecilia.sunnevang@autoliv.com

Autoliv

	Normal Tongue	Locking Tongue	Buckle position 1	Buckle position 2	Rear seat original anchor	Rear seat changed anchor
B3 max [kN]	4,5	4,5	4,5	4,5	4	4
Chest deflection [mm]	38,6	30,3	36,6	30,7	33,9	27
DEQ LIN [mm]	49,2	41,7	47,8	43	44	38,5
Localized deflection [mm]	31,3	30,7	23,4	33,1	29,8	30,2
Distributed deflection [mm]	21,7	14,2	18,9	12,7	18,1	10,5
Injury risk Chestpot [%]	25,1	12,3	21,5	12,8	17,2	8,8
Injury risk DEQ LIN [%]	24,5	13,4	22,1	15	16,3	9,9

cecilia.sunnevang@autoliv.com

Autoliv

Conclusions

- DEQ LIN show effect of pelvic restraint
- DEQ LIN result in similar injury risks as the Chest Deflection
- Further evaluation within EU-THORAX

cecilia.sunnevang@autoliv.com

Autoliv

THORAX Test matrix - Driver

Driver Test no.	Goal	Dummy		Pulse			Seat Belt			Airbag	
		H III	THOR	EuroNCAP ODB	USNCAP FF	Oblique	Crash locking tounge	Single level LL	Adaptive LL	Baseline	Alter-native shape
1	Reference system		X	9*				EU		X	
2		X		10*				EU		X	
3			X		1*			EU		X	
4		X			2*			EU		X	
5			X			17*		EU		X	
6		X				18*		EU		X	
7	Influence of airbag shape (differential thorax loading)		X	11*				EU			X
8		X		12*				EU			X
9			X		3*			EU			X
10		X			4*			EU			X
11			x			19*		EU			X
12		x				20*		EU			X
13	Influence on thorax response from two levels of LL		X	13*					EU	X	
14		X		14*					EU	X	
15			X		5*				EU	X	
16		X			6*				EU	X	
17			X			21*			EU	X	
18		X				22*			EU	X	
19	Influence on thorax response from CLT (optimal point)		X	15*			X	EU			X
20		X		16*			X	EU			X
21			X		7*		X	EU			X
22		X			8*		X	EU			X
23			X			23*	X	EU			X
24		X				24*	X	EU			X
25	Influence on thorax response from high LL (6kN) level and no airbag vs normal LL (4kN) and airbag		X	25*				X(6kN)			
26		X		26*				X(6kN)			
27			X	27*				X(4kN)		X	
28		X		28*				X(4kN)		X	

cecilia.sunnevang@autoliv.com

Autoliv

THORAX Test matrix - Passenger

Passenger Test no.	Goal	Dummy		Pulse			Seat Belt			Airbag	
		H III	THOR	EuroNCAP ODB	USNCAP FF	Oblique	Crash locking tounge	Single level LL	Adaptive LL	Baseline	Altern-ative shape
1	HIII vs THOR in standard EU restraint system	X		9*				EU			X
2			X	10*				EU			X
3		X			1*			EU			X
4			X		2*			EU			X
5		X				17*		EU			X
6			X			18*		EU			X
7	HIII vs THOR in standard US restraint system	X		11*					US	US	
8			X	12*					US	US	
9		X			3*				US	US	
10			X		4*				US	US	
11		X				19*			US	US	
12			X			20*			US	US	
13	THOR 1 repeatability x3, THOR 1 (x3) vs THOR 2 (x2) repeatability		No 2	13*				EU			X
14			No 1	14*				EU			X
15			No 2		5*			EU			X
16			No 1		6*			EU			X
17			No 2			21*		EU			X
18			No 1			22*		EU			X
19	THOR 1 repeatability x3, THOR 1 (x3)vs THOR 2 (x2) repeatability		No 2	15*				EU			X
20			No 1	16*				EU			X
21			No 2		7*			EU			X
22			No 1		8*			EU			X
23			No 2			23*		EU			X
24			No 1			24*		EU			X

cecilia.sunnevang@autoliv.com

Autoliv