



Left & Right Oblique Restraints Countermeasures

SAE Government Industry Meeting
January 24-26, 2018



Project Acknowledgement

This project is a collaboration between ZF and UMTRI. It is being funded and directed by NHTSA under contract DTNH2215R-00079



Presented at the 2018 SAE Government & Industry in Washington DC



Agenda

Project Definition

Countermeasures

Driver Side

Passenger Side

Summary



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Passenger Side

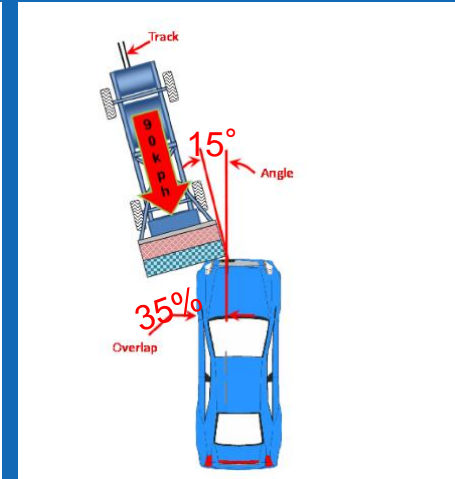
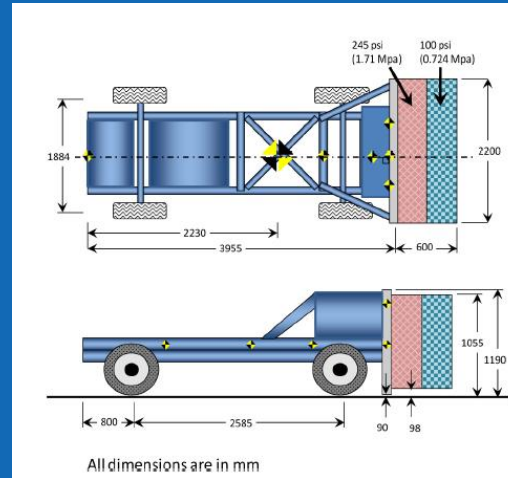
Summary



Project Definition

Load Case Definition

- Movable Deformable Barrier (~2490 kg / 90 km/h)
- Impact angle 15° - Overlap 35%
- THOR dummy on driver and passenger side
- IAVs like BrIC, Multiple chest deflection measurements





Evaluate vehicles that meet the following requirements

- Small and midsize cars
- Good or acceptable small overlap structural rating
- FMVSS 226 Capable Curtain Air Bag

Seven vehicles met the requirements

- Nissan Versa
- Dodge Dart
- Honda Accord
- Mazda 3
- Honda Civic
- Honda Fit
- Volvo S60



Baseline Vehicle and Sled Tests

- B-Segment interior and restraints with 18° sled angle
- Occupant kinematics, contact points, and injury measures in the sled tests matched the general trends in the full vehicle O MDB tests
 - Driver near (left) side:
head rolls off bag, door contact, high BrIC and chestD
 - Driver far (right) side:
belt rollout, IP contact, high BrIC and chestD
 - Passenger near (right) side:
head rolls off bag, high BrIC and chestD
 - Passenger far (left) side:
belt rollout, IP contact, high BrIC and chestD



Agenda

Project Definition









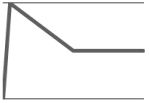
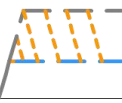

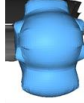
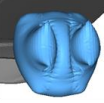
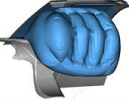

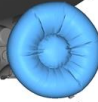
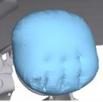
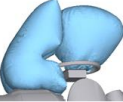

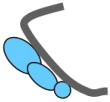
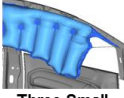
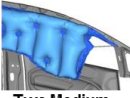
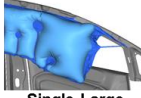
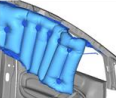

Countermeasures

Driver Side

Passenger Side

Summary

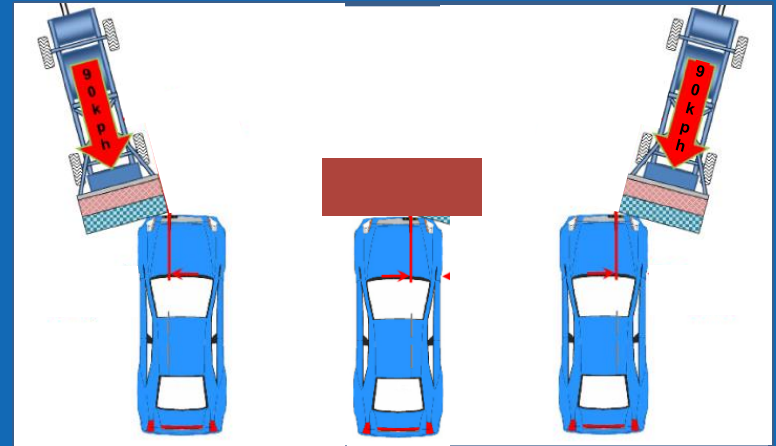
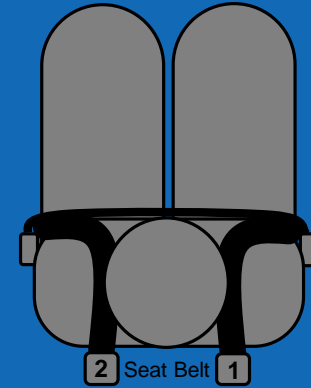
Countermeasures Investigated

Seat Belts	 3-Pt Belt	 'X-type' 4-Pt Belt	 Suspender 4-Pt Belt	 Rerouted 3-Pt Belt	 Relocated Retractor
Seat Belts Pre-tensioner (PT) Load Limiter (LL)	 DLT	 Buckle PT	 Anchor PT	 Digressive LL	 Switchable LL
Passenger Air Bags	 V64 PAB	 V13 PAB	 Clapper PAB	 Parallel Cell PAB	 Kickstand PAB
Driver/Knee/Side Air Bags	 Cone DAB	 SQS DAB	 Support Bag	 Inboard SAB	 Passenger KnAB
Curtain Air Bags	 Three Small Chamber CAB	 Two Medium Chamber CAB	 Single Large Chamber CAB	 Buckle CAB	



Driver 4-Pt Belt Option

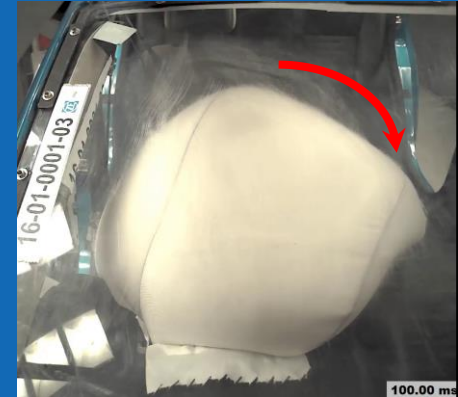
- In a left side oblique collision, seat belt retractor #2 would have a larger load limiting force than retractor #1.
- In a frontal collision, both seat belt retractors (#1 & #2) would have the same load limiting force.
- In a right side oblique collision, seat belt retractor #1 would have a larger load limiting force than retractor #2.





Passenger Kickstand Bag

- In the oblique crash condition, the passenger bag tends to tip over because the occupant pushes the bag over.
- The kickstand bag works like a kickstand on a bike. It gives lateral support so the bag doesn't have the tendency to tip over.





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Countermeasures

Driver Side

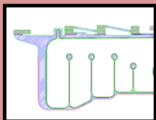
Passenger Side

Summary

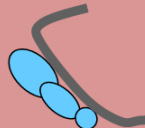
Driver Advanced System

Baseline

Baseline DAB

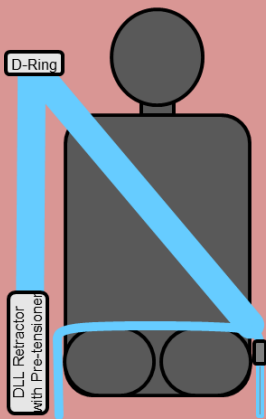


Three Small Chamber CAB



Baseline KnAB

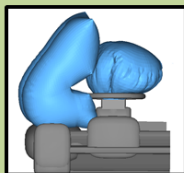
D-Ring



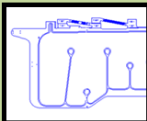
DLT Retractor with Pre-tensioner

3-Point System

Baseline DAB

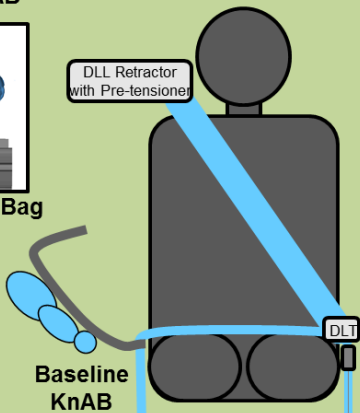


Driver Support Bag



Two Medium Chamber CAB

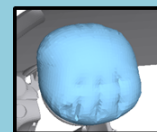
DLT Retractor with Pre-tensioner



DLT

Baseline KnAB

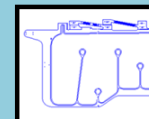
4-Point System



SQS DAB

Baseline KnAB

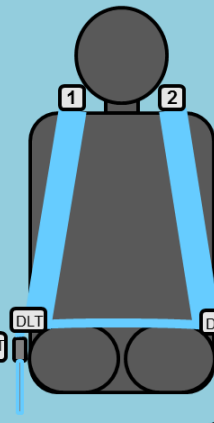
TB-1: 8.0mm
TB-2: 10.5mm



Two Medium Chamber Curtain

1 2

Buckle PT



DLT

Buckle PT



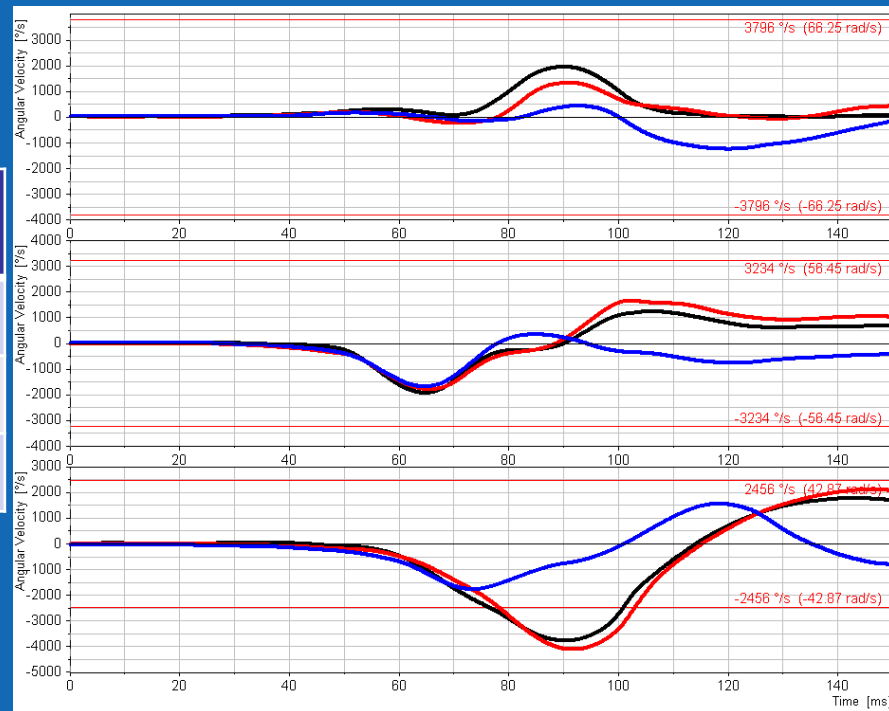
Driver Far Side

Test No.	Technology	Head		Neck	Chest	Abd.	Acet.	Femur	Pjoint
		HIC	BrIC	Nij	Rmax	Dmax	Fmax	Comp	
16-01-0001-08	Baseline	496	1.73	0.58	45	75	2476	3354	0.980
17-04-0136-21	3-Pt System	500	0.94	0.43	37	40	2565	3750	0.603
17-02-0070-15	4-Pt System	405	0.70	0.65	33	62	1731	3152	0.411



Driver Far Side (Driver Support Bag)

DAB	Support Bag	Seat Belt	KnAB	BrIC
Baseline	No	Baseline	Baseline	1.73
Baseline	No	Relocated	Baseline	1.80
Baseline	Yes	Relocated	Baseline	0.94



Driver Far Side



Baseline



3-Point System



4-Point System



Driver Near Side

Test No.	Technology	Head		Neck	Chest	Abd.	Acet.	Femur	Pjoint
		HIC	BrIC	Nij	Rmax	Dmax	Fmax	Comp	
16-01-0001-07	Baseline	448	1.04	0.56	51	76	2065	3916	0.809
17-02-0070-32	3-Pt System	402	0.72	0.36	40	51	2121	2774	0.426
17-04-0136-08	4-Pt System	448	0.75	0.53	20	37	1934	3192	0.267

Driver Near Side



Baseline



3-Point System



4-Point System

Driver Near Side



Baseline (CAB: 34 ms)



3-Pt System (CAB: 14 ms)



4-Pt System (CAB: 14 ms)



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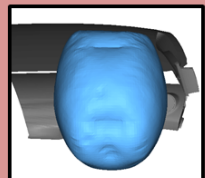
Driver Side

Passenger Side

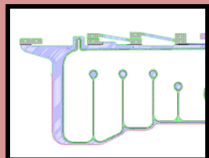
Summary

Passenger Advanced Systems

Baseline



Baseline PAB

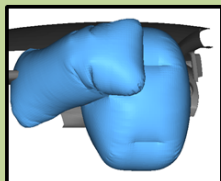


Three Small Chamber Curtain

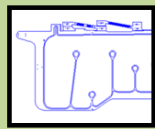
D-Ring

SLL Retractor with Pre-tensioner

3-Point System



Kickstand PAB



Two Medium Chamber Curtain

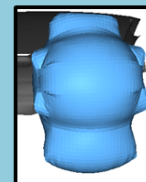


KnAB

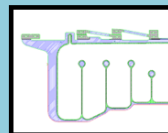
DLL Retractor with Pre-tensioner

DLT

4-Point System



V13 PAB



Three Small Chamber Curtain

TB-1: 8.0mm
TB-2: 9.0mm

1 2

DLT

DLT

Buckle PT



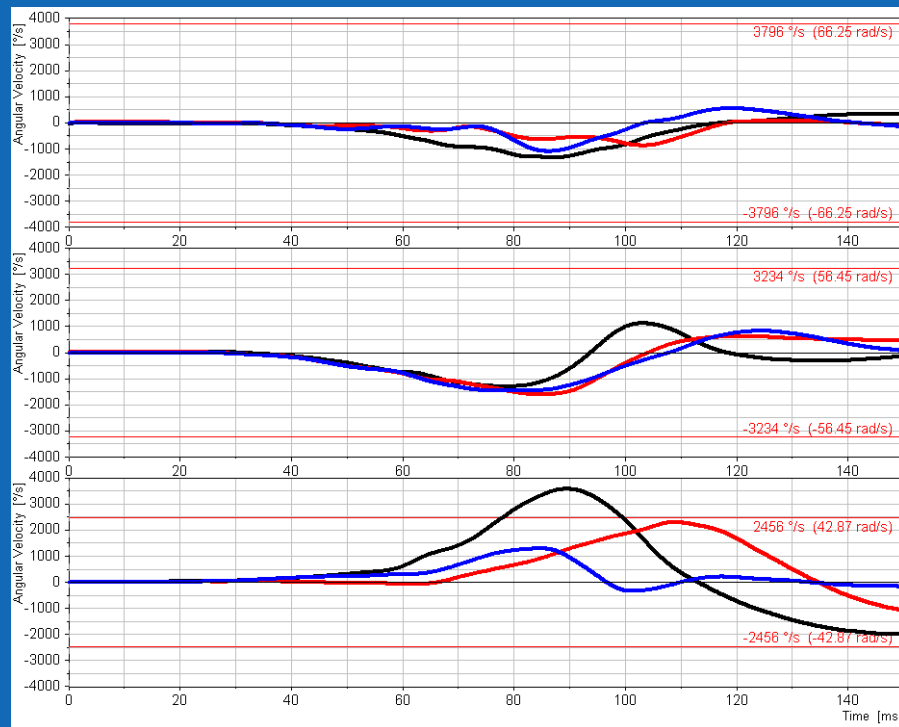
Passenger Far Side

Test No.	Technology	Head		Neck	Chest	Abd.	Acet.	Femur	Pjoint
		HIC	BrIC	Nij	Rmax	Dmax	Fmax	Comp	
16-01-0001-03	Baseline	332	1.55	0.47	50	82	4430	3010	0.995
17-04-0136-03	3-Pt System	372	0.75	0.44	38	42	2231	3850	0.427
17-04-0136-02	4-Pt System	543	0.53	0.58	38	39	2450	3550	0.438



Passenger Far Side (Kickstand Bag)

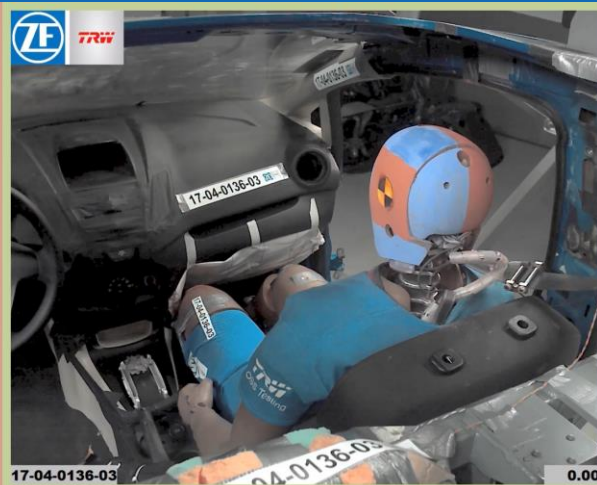
PAB	Seat Belt	KnAB	BrIC
Baseline	Baseline	No	1.54
Baseline	Relocated	Yes	1.08
Kickstand	Relocated	Yes	0.75



Passenger Far Side



Baseline



3-Point System



4-Point System



Passenger Near Side

Test No.	Technology	Head		Neck	Chest	Abd.	Acet.	Femur	Pjoint
		HIC	BrIC	Nij	Rmax	Dmax	Fmax	Comp	
16-01-0001-10	Baseline	773	0.97	0.71	59	78	2840	2095	0.883
17-04-0136-19	3-Pt System	489	0.69	0.45	45	45	2861	4504	0.589
17-04-0136-18	4-Pt System	476	0.83	0.49	26	44	2411	4074	0.423

Passenger Near Side



Baseline



3-Point System



4-Point System



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Driver Side

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Summary



Summary

- Far Side Impacts
 - Driver Support Bag and Passenger Kickstand Bag supported the head and reduced the BrIC and Nij, and eliminated head contact to the instrument panel.
 - The relocated belt (closer to shoulder) and a digressive load limiter reduced shoulder roll out of the belt and the chest compression.
 - The knee air bag on the passenger side reduced the acetabulum loads.
 - The 4-Point belt system reduced the chest compression, BrIC, and acetabulum loads (passenger side) while eliminating head contact to the instrument panel and shoulder roll out of the belt.



Summary

- Near Side Impacts
 - A thicker curtain air bag fired earlier reduced the BrIC.
 - The relocated belt (closer to shoulder) and a digressive load limiter reduced the chest compression.
 - The 4-Point belt system reduced the chest compression while eliminating the head contact to the door.

NHTSA



THANK YOU

