



# IIHS Small Overlap Program Protocol and Rating Guidelines

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August 1, 2012

# Overview

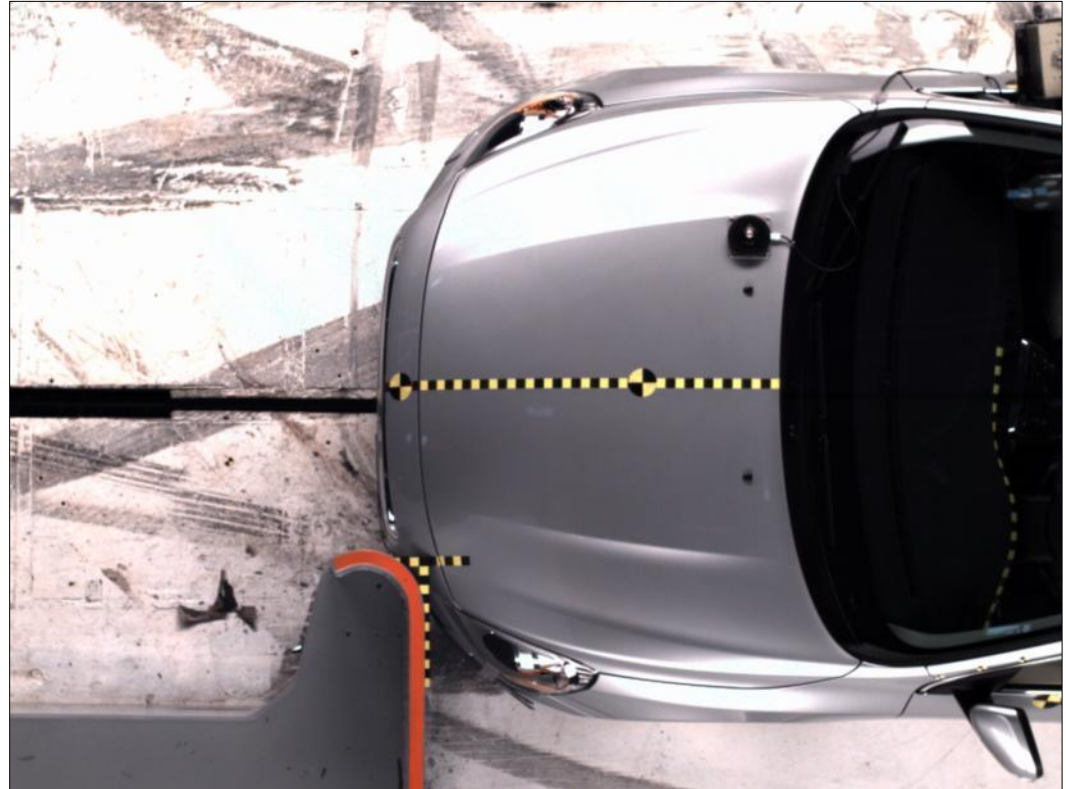
- Today's meeting
  - Protocol
    - Focus on changes/differences with moderate overlap (40% offset test)
  - Rating Guidelines
  - Slides from today's meeting on website
  - Protocol and Rating Guideline documents available by end of week
- Planned release date – August 14
  - Embargoed version likely distributed on August 9



# Protocol

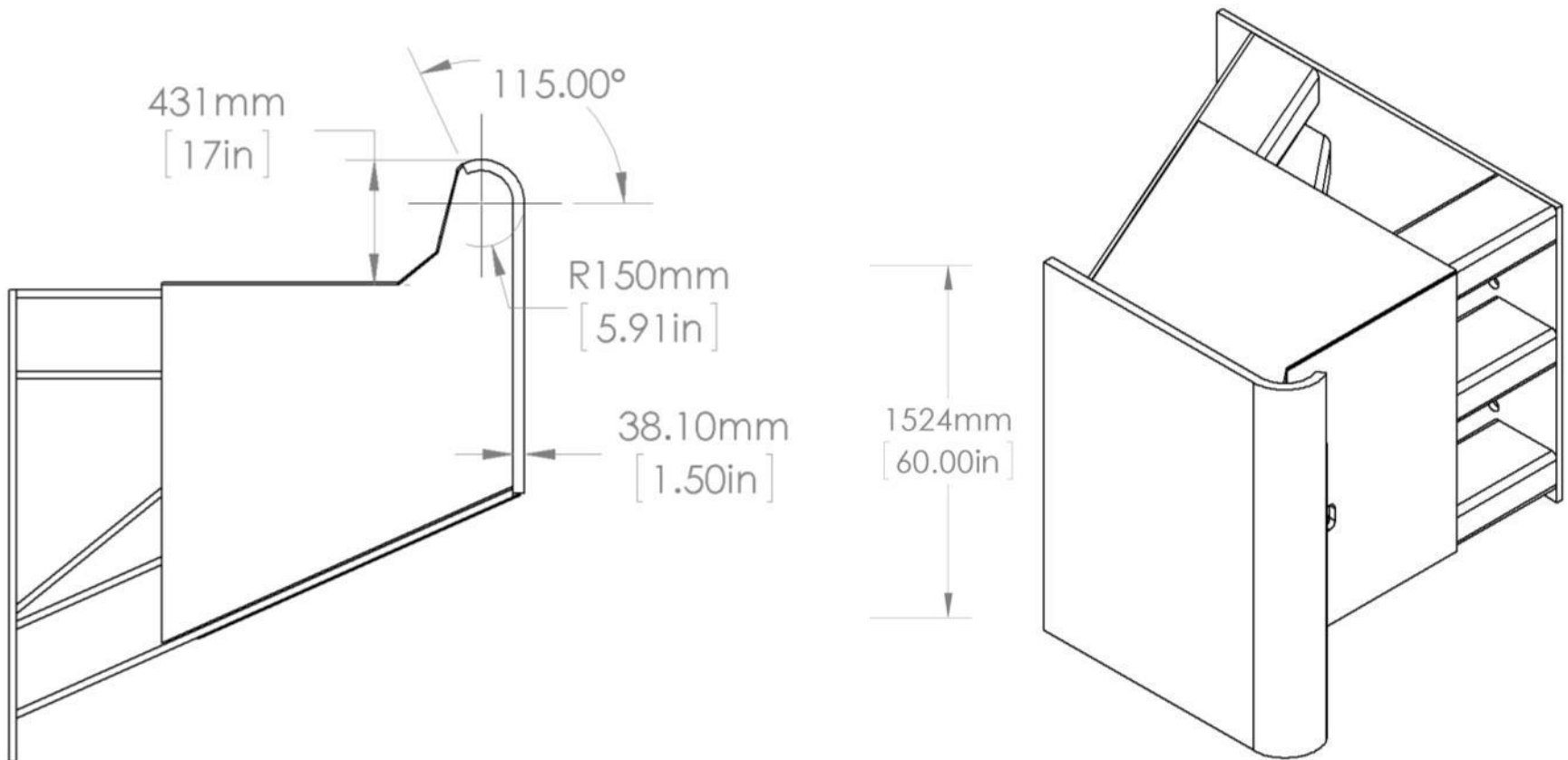
# Impact speed and overlap

- 64.4 km/h (40 mph)
- 25% overlap



# Barrier

- Drawing package on IIHS website



# Vehicle preparation

- Onboard video cameras
  - Behind driver
  - Oblique view, rear right pass seat
  - Pass side A-pillar
- Driver seat head restraint removed
- Test weight 125-175 kg greater than measured curb weight

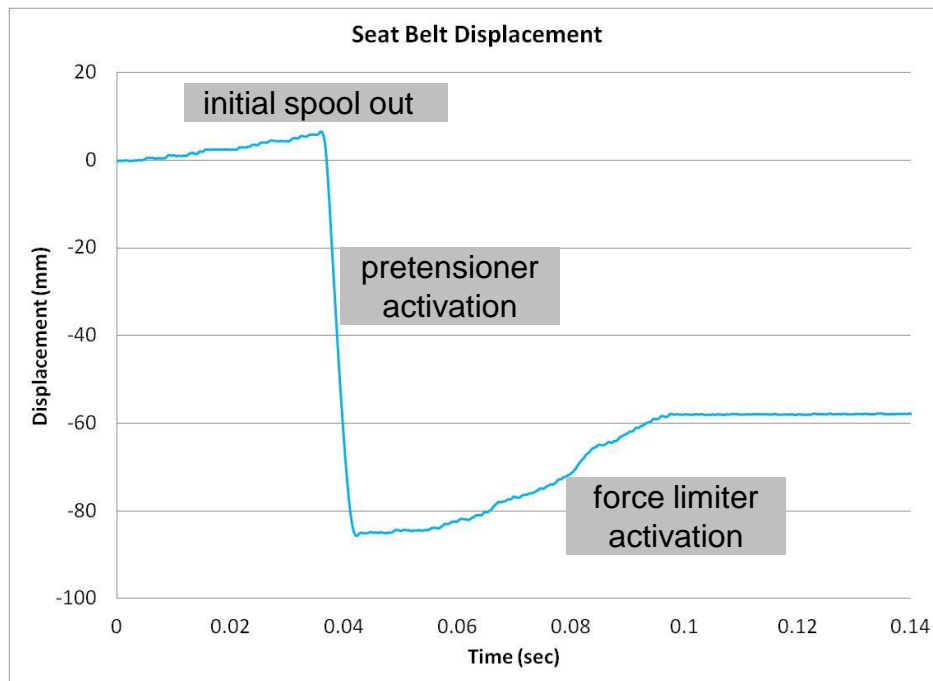


# Crash test dummy

- Hybrid III 50<sup>th</sup> percentile male dummy
  - Head angular rate sensors
  - L-M shear force

# Seat belt spool out sensor

- IES-2098 (humaneticsatd.com)
- Mounted along B-pillar near retractor





# Intrusion measurements

- Coordinate system
  - X – positive toward rear of vehicle
  - Y – positive toward passenger side
  - Z – positive upward
  - origin – face of striker
- Recovery points (post-crash)
  - left rear passenger seat pan
  - right rear passenger seat pan (backup)

# Intrusion measurements

- 18 points necessary for rating (additional research points)

steering column	parking brake pedal
left lower IP	seat bolts (2, rear)
brake pedal	upper dash
left footrest	upper hinge pillar (3)
left toepan	lower hinge pillar (3)
	rocker panel (3)

# Intrusion measurements

## Upper dash

- 25 cm outboard of steering column center
- Rearward most point on this plane
- At least 30 cm above brake pedal reference

## Parking brake pedal

- Geometric center of pedal
- Not measured if hand brake or electronic brake

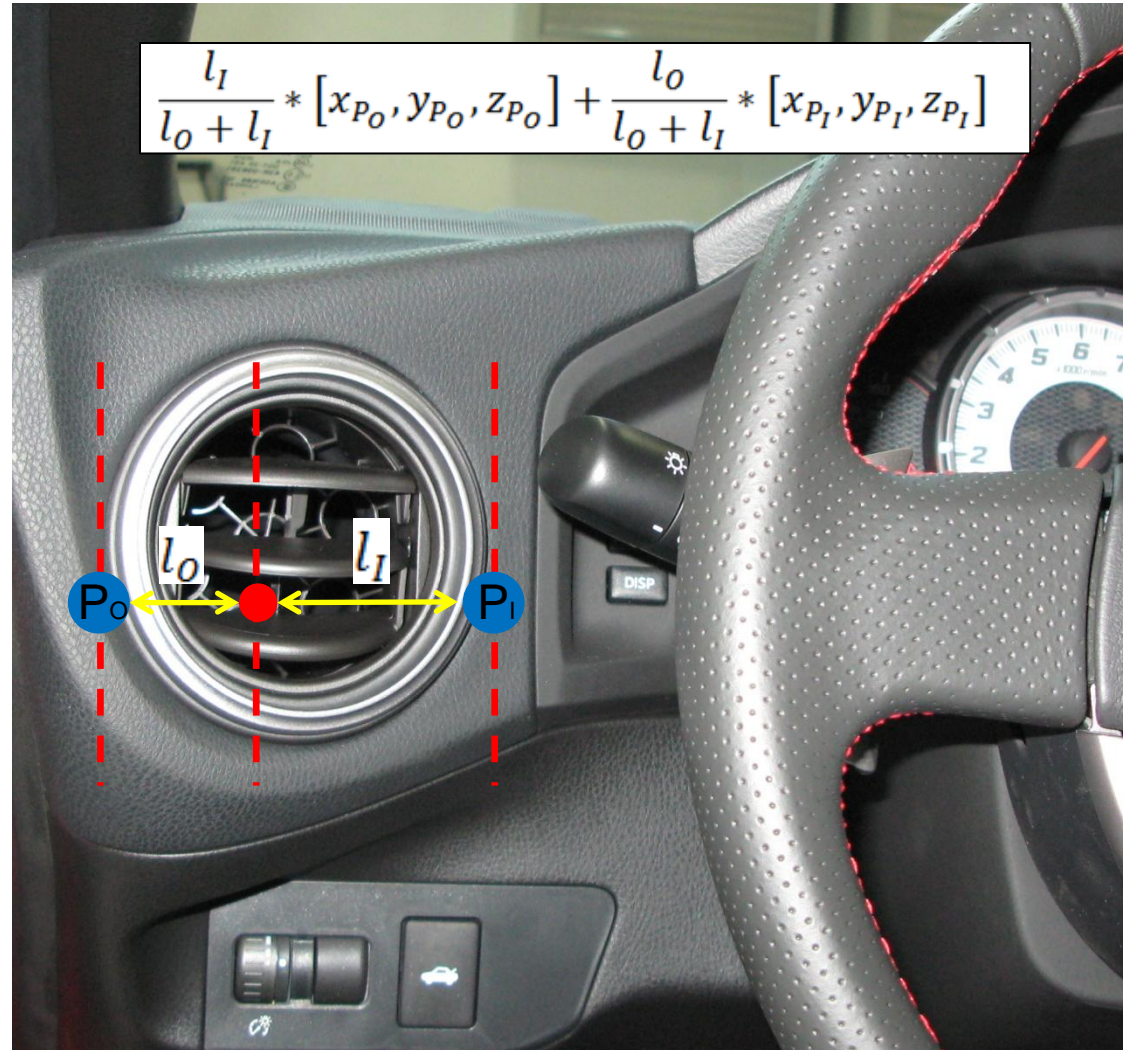


# Intrusion measurements

## Upper dash point on a “soft component”

Move inboard and outboard, with the same Z value, to the first points which are no longer on the soft component

The weighted average of these two points is used to represent the location of the original point (25 cm outboard of SW)



# Intrusion measurements

## Upper hinge pillar

3 points

45 / 52.5 / 60 cm above brake pedal

Inner most surface of door opening

## Lower hinge pillar

3 points

0 / 7.5 / 15 cm above brake pedal

Inner most surface of door opening

## Rocker panel

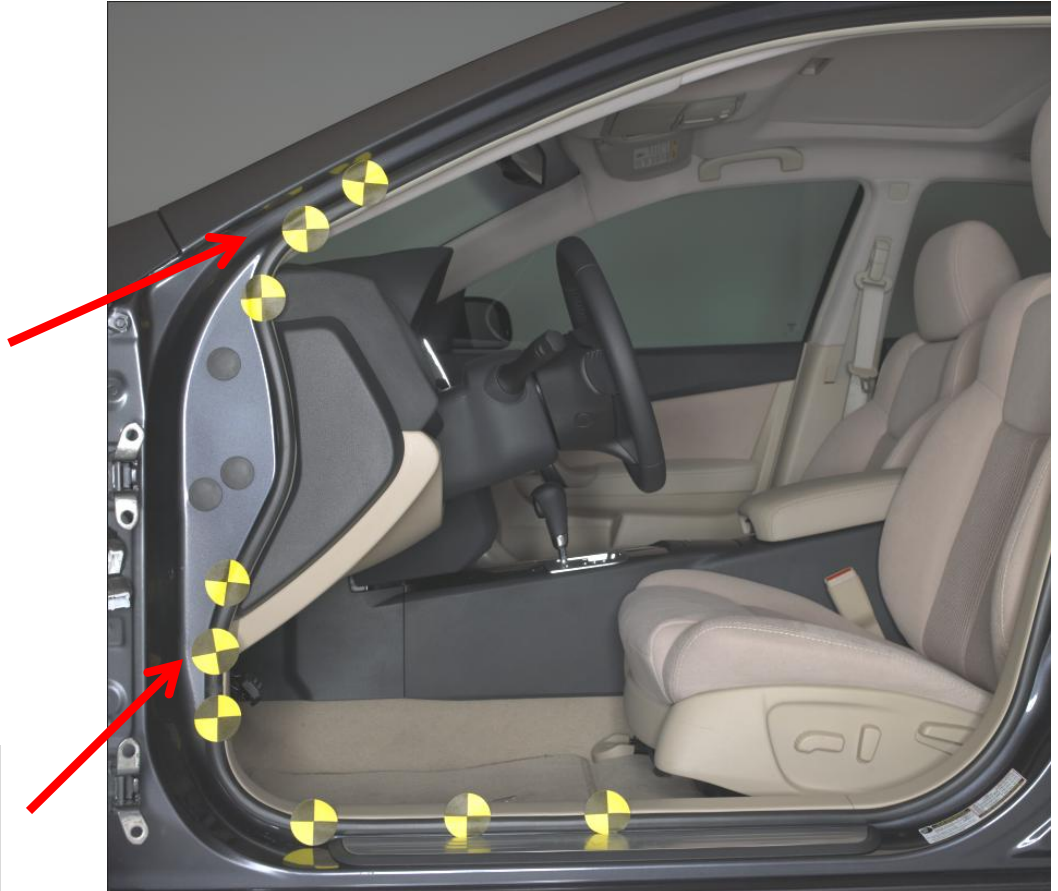
3 points

20 / 35 / 50 cm rearward of brake pedal

Inner most surface of door opening

If 20 cm point forward of door opening

Locate 5 cm rearward of lowest hinge pillar point



# Rating Guidelines

Structure

Injury

Restraints & Dummy Kinematics

Overall

**INSURANCE INSTITUTE  
FOR HIGHWAY SAFETY****Offset Frontal Crashworthiness  
Evaluation Overall Rating Calculator**

Injury	{	Structure:	Good
		Head/Neck:	Acceptable
		Chest:	Good
		Left Leg:	Marginal
		Right Leg:	Good
Restraints and Kinematics:		Marginal	
<b>Overall Evaluation:</b>		<b>ACCEPTABLE</b>	
		Reset	Quit

Rating



GOOD	ACCEPTABLE	MARGINAL	POOR
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# Structure

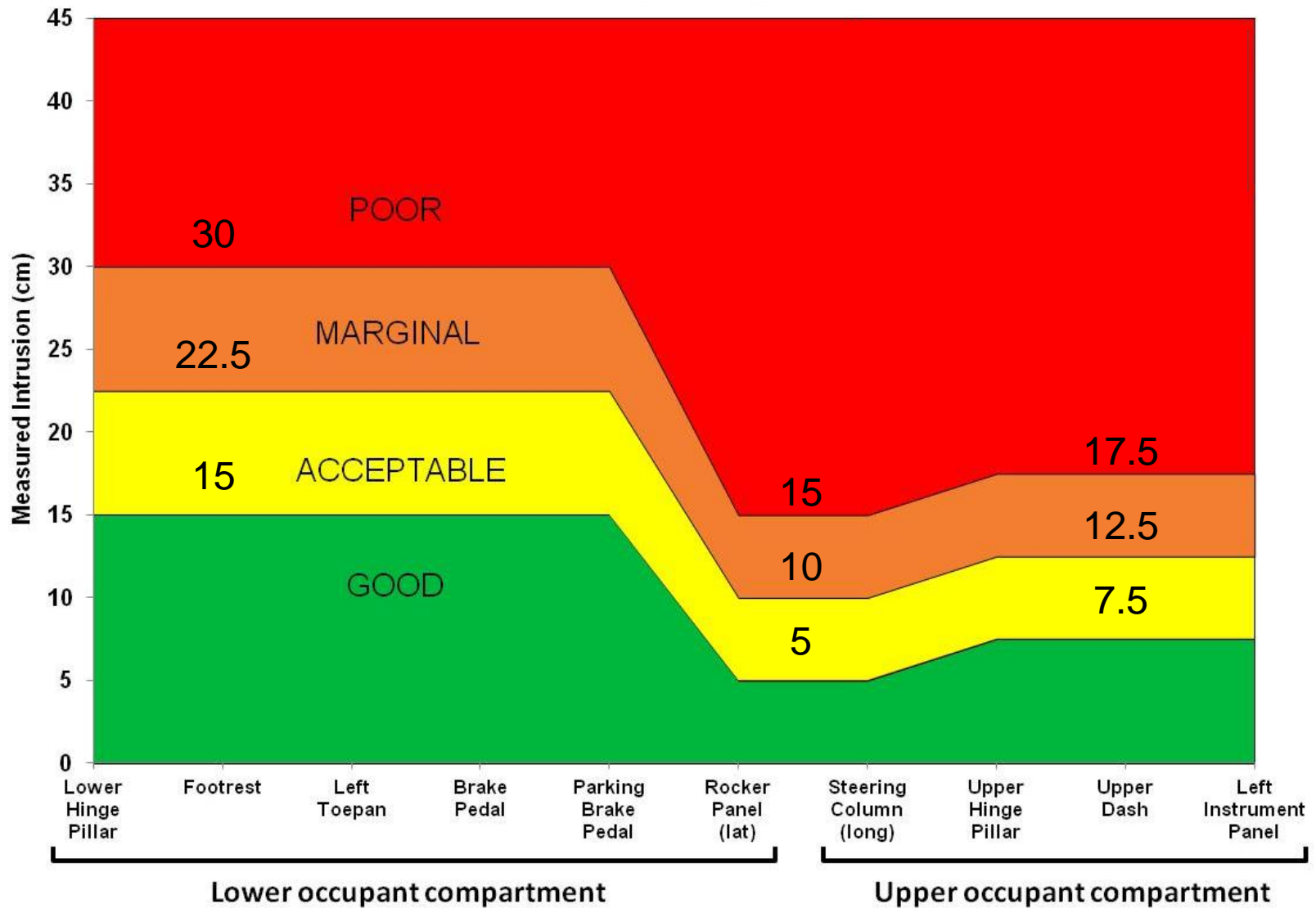
- 10 measurement locations
  - 6 lower occupant compartment
    - lower hinge pillar, footrest, left toepan, brake pedal, parking brake pedal, rocker panel
  - 4 upper occupant compartment
    - steering column, upper hinge pillar, upper dash, left instrument panel
- Deformation adjusted to reflect movement of 2 rear seat bolts in longitudinal direction only
- X Y Z resultant deformation for all points except steering column (longitudinal only) and rocker panel (lateral only)



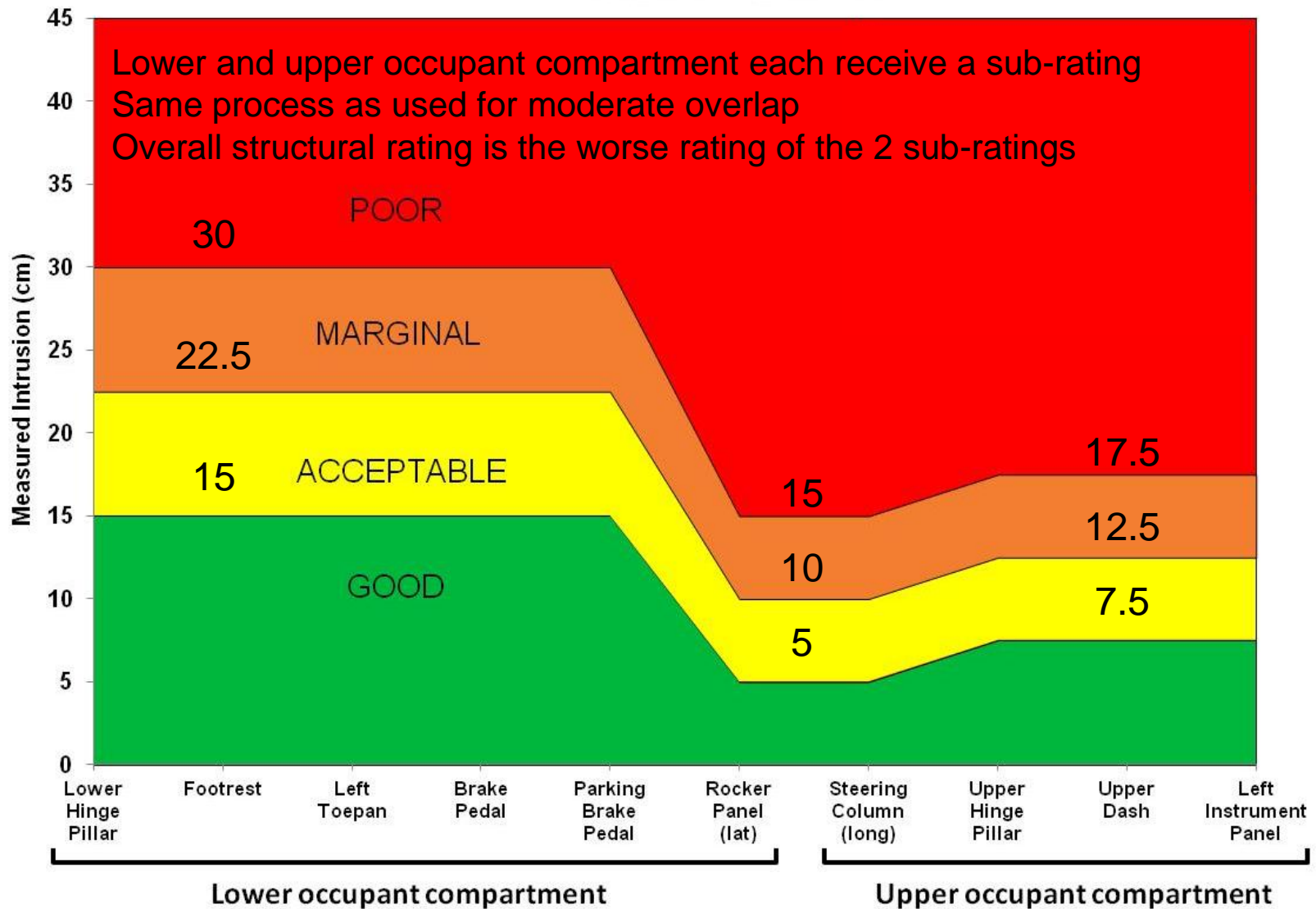
# Structure

- For all points, if X movement is forward, then only Y & Z vectors are used to calculate resultant
- For the upper hinge pillar, lower hinge pillar, rocker panel, and parking brake pedal locations, if the Y movement is outboard, then only the X & Z vectors are used to calculate the resultant
- The upper and lower hinge pillar points are the maximum resultant value of the three measured locations
- The rocker panel value is the average of the three measured locations

# Structure



# Structure



# Structure

- Other possible downgrades to structural rating
  - Dummy entrapment
  - Significant structural failure (complete tearing of hinge pillar)

# Restraints & Dummy Kinematics

- Good injury results not sufficient indicator of low injury risk
- Rating system based on a demerit system
  - Frontal head protection
  - Lateral head protection
  - Frontal and lateral chest protection
  - Occupant containment and miscellaneous

## Demerits for Restraints and Dummy Kinematics

<b>Frontal head protection</b>	
Stable frontal airbag interaction, OR	0 demerits
Partial frontal airbag interaction, OR	1 demerit
Minimal frontal airbag interaction	2 demerits
Excessive lateral steering wheel movement (> 10 cm)	1 demerit
Two or more hard head contacts with structure	1 demerit
Late deployment or non deployment of frontal airbag	Automatic poor
<b>Lateral head protection</b>	
Side head protection airbag deployment with sufficient forward coverage, OR	0 demerits
Side head protection airbag deployment with limited forward coverage, OR	1 demerit
No side head protection airbag deployment	2 demerits
Excessive head lateral movement	1 demerit
<b>Front and lateral chest protection</b>	
Excessive vertical steering wheel movement (> 10 cm)	1 demerit
Excessive lateral steering wheel movement (> 15 cm)	1 demerit
No side thorax airbag protection	1 demerit
<b>Occupant containment and miscellaneous</b>	
Excessive occupant forward excursion	1 demerit
Occupant burn risk	1 demerit
Seat instability	1 demerit
Seat attachment failure	Automatic poor
Vehicle door opening	Automatic poor
<b>Overall Restraint and Dummy Kinematics rating</b>	
Good	0-1 demerits
Acceptable	2-3 demerits
Marginal	4-5 demerits
Poor	6+ demerits

# Frontal head protection

Frontal head protection	
Stable frontal airbag interaction, OR	0 demerits
Partial frontal airbag interaction, OR	1 demerit
Minimal frontal airbag interaction	2 demerits
Excessive lateral steering wheel movement (>10 cm)	1 demerit
Two or more hard head contacts with structure	1 demerit
Late deployment or non deployment of frontal airbag	Automatic poor

- Stable frontal airbag interaction
  - Dummy moves forward into a fully-deployed airbag and then returns directly to the seat during rebound, with the head and body staying within the extended perimeter of the airbag
- Partial frontal airbag interaction
  - The head receives significant restraint from the frontal airbag but does not stay within its extended perimeter and there are no other countermeasures to prevent head contact with hard structures forward of the airbag
- Minimal frontal airbag interaction
  - The head moves into the gap between the door and frontal airbag with little or no restraint from the airbag and there are no other countermeasures to prevent head contact with hard structures forward of the airbag

# Frontal head protection

Stable frontal airbag interaction





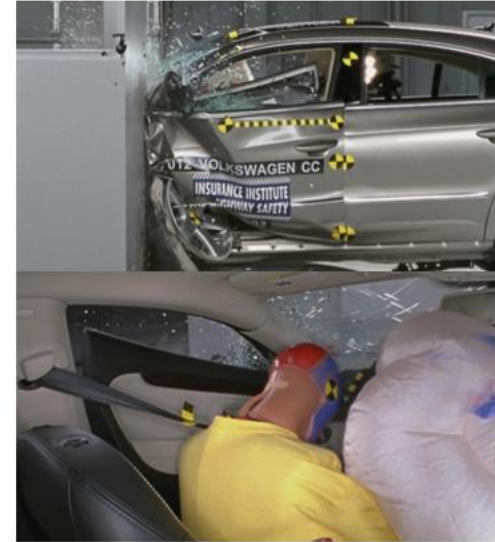
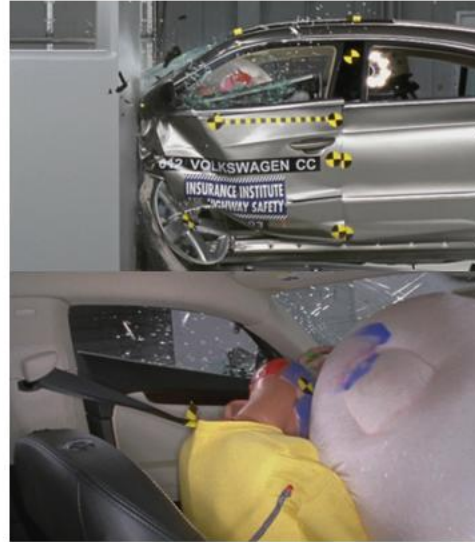
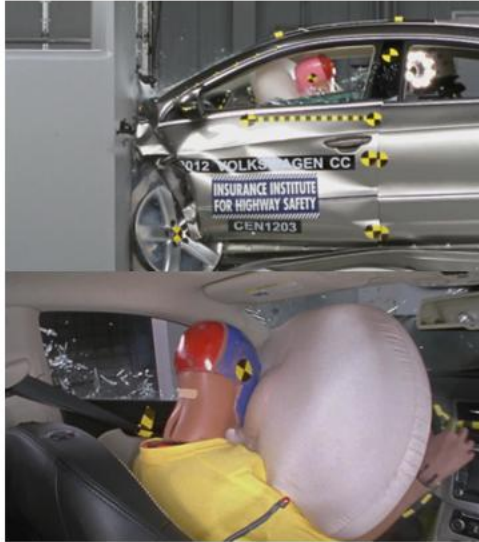
# Frontal head protection

Partial frontal airbag interaction



# Frontal head protection

Minimal frontal airbag interaction



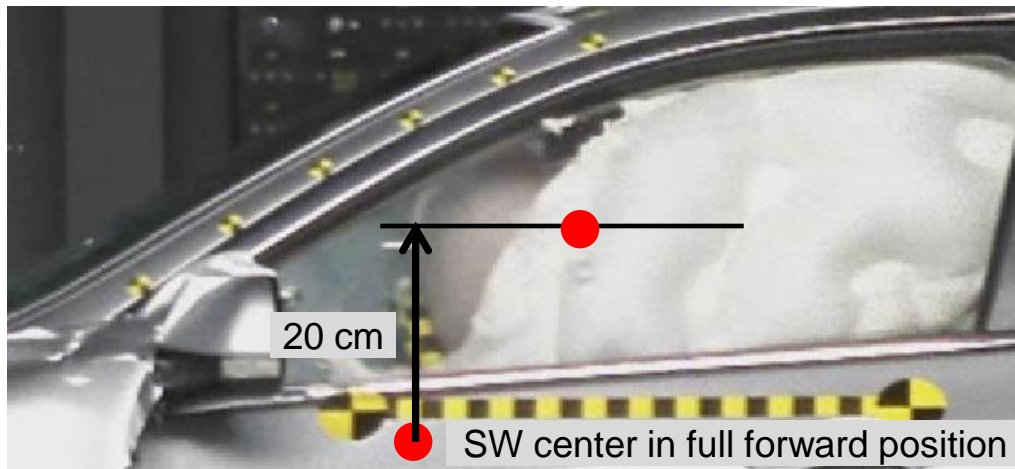
# Lateral head protection

## Lateral head protection

Side head protection airbag deployment with sufficient forward coverage, OR	0 demerits
Side head protection airbag deployment with limited forward coverage, OR	1 demerit
No side head protection airbag deployment	2 demerits
Excessive head lateral movement	1 demerit

- Sufficient forward coverage

- The airbag chamber (measured at position 20 cm above the center of the steering wheel) extends at least to the longitudinal position of the center of the steering wheel when positioned in its fully forward telescoping position (if adjustable)



- Excessive head lateral movement

- Most of the head moves outside of the precrash plane of the driver's side window

# Front and lateral chest protection

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## Front and lateral chest protection

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Excessive vertical steering wheel movement (>10 cm)	1 demerit
Excessive lateral steering wheel movement (>15 cm)	1 demerit
No side thorax airbag protection	1 demerit

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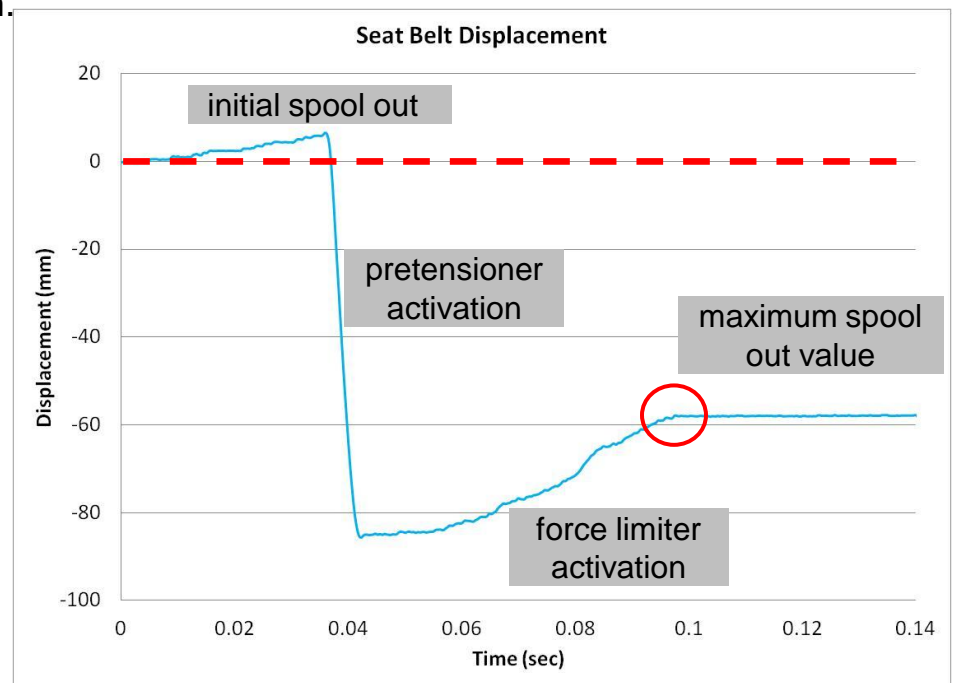


# Occupant containment and miscellaneous

## Occupant containment and miscellaneous

Excessive occupant forward excursion	1 demerit
Occupant burn risk	1 demerit
Seat instability	1 demerit
Seat attachment failure	Automatic poor
Vehicle door opening	Automatic poor

- Excessive occupant forward excursion
  - The maximum shoulder belt spool out exceeds the precrash belt position, or lap belt slack greater than 100 mm is observed after the crash.



# Overall Restraints and Dummy Kinematics Rating

Overall Restraint and Dummy Kinematics rating	
Good	0-1 demerits
Acceptable	2-3 demerits
Marginal	4-5 demerits
Poor	6+ demerits

# Injury Rating

**Table 2 Injury Parameter Cutoff Values Associated with Possible Injury Protection Ratings**

Body Region	Parameter	IARV	Good –	Acceptable	Marginal
			Acceptable	– Marginal	– Poor
Head and neck	HIC-15	700	560	700	840
	N <sub>ij</sub>	1.00	0.80	1.00	1.20
	Neck axial tension (kN)*	3.3	2.6	3.3	4.0
	Neck compression (kN)*	4.0	3.2	4.0	4.8
Chest	Thoracic spine acceleration (3 ms clip, g)	60	60	75	90
	Sternum deflection (mm)	–50	–50	–60	–75
	Sternum deflection rate (m/s)	–8.2	–6.6	–8.2	–9.8
	Viscous criterion (m/s)	1.0	0.8	1.0	1.2
Thigh and hip	Knee-thigh-hip injury risk		5%	15%	25%
Leg and foot	Tibia-femur displacement (mm)	–15	–12	–15	–18
	Tibia index (upper, lower)	1.00	0.80	1.00	1.20
	Tibia axial force (kN)	–8.0	–4.0	–6.0	–8.0
	Foot acceleration (g)	150	150	200	260

\*Neck axial force duration corridors are shown in Figures 8 and 9.

# Injury Rating

## Knee – thigh - hip

- KTH injury risk evaluated on basis of injury criteria developed by Rupp et al. (2009)
  - Uses combination of peak compressive force and impulse recorded at each femur to determine risk of an AIS 2+ knee/distal femur fracture and AIS 3+ hip fracture
- 
- Rupp, Reed, et al. 2009. Development of new criteria for assessing the risk of knee-thigh-hip injury in frontal impacts using Hybrid III femur force measurements. *Proceedings of the 21<sup>st</sup> International Technical Conference on the Enhanced Safety of Vehicles (Paper 09-0306)*. Washington, DC: National Highway Traffic Safety Administration.
  - Kirk, K. and Kuppa, S. 2009. Application and evaluation of a novel KTH injury criterion for the Hybrid III dummy in frontal crash test environments. *Proceedings of the 21<sup>st</sup> International Technical Conference on the Enhanced Safety of Vehicles (Paper 09-0196)*. Washington, DC: National Highway Traffic Safety Administration.

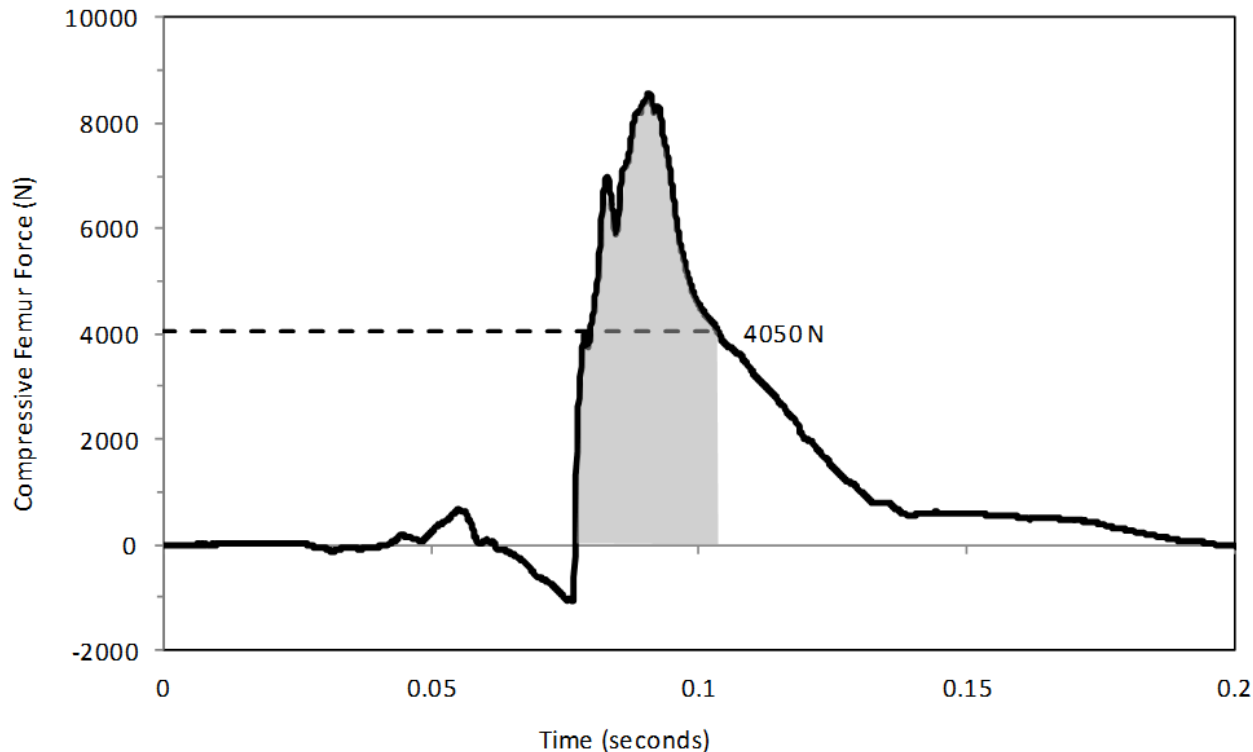


# Injury Rating

Knee – thigh - hip

- The KTH impulse is calculated by integrating the femur force from the start of femur compression to the time after the peak force when the compressive force first equals 4050 N

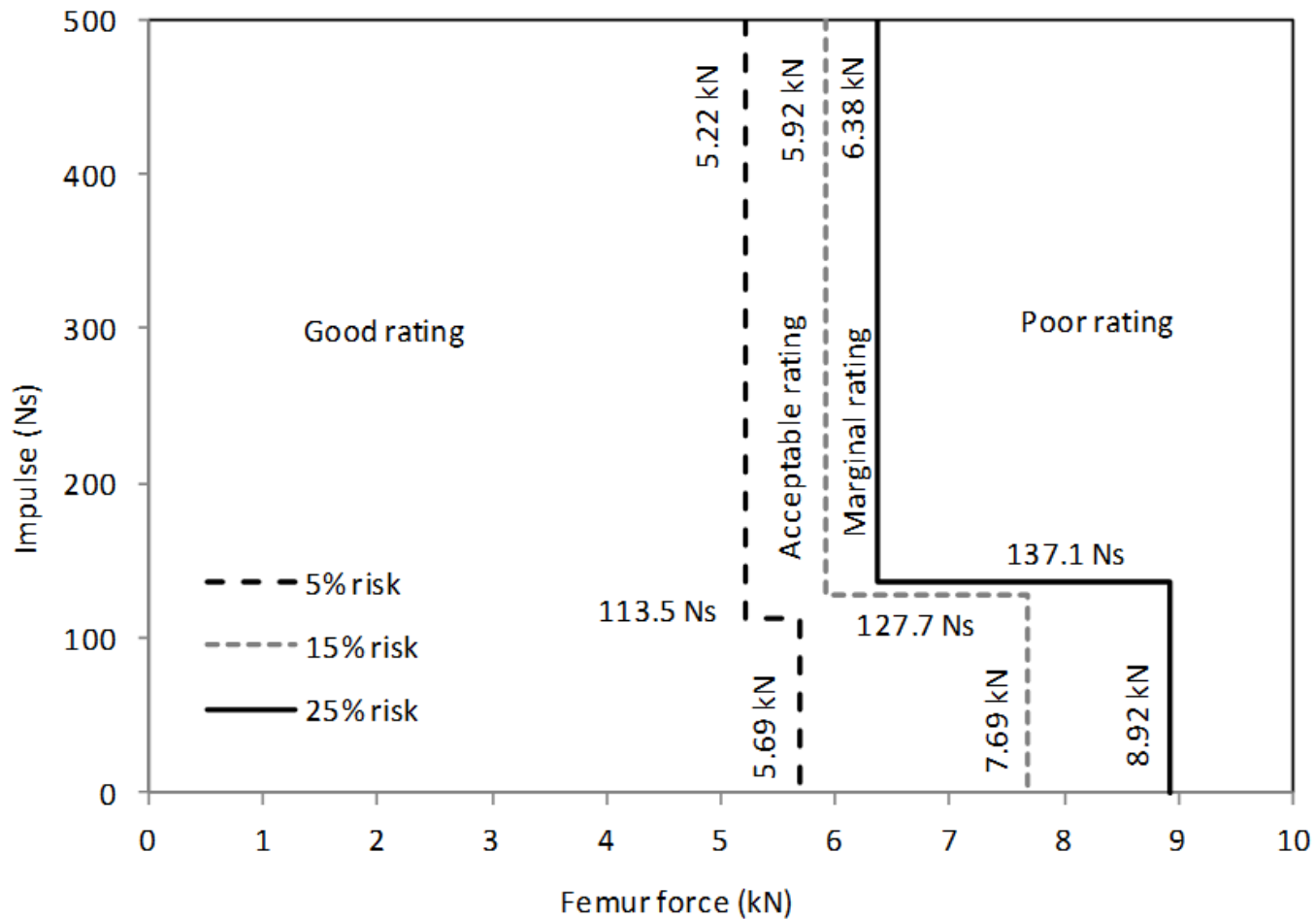
Integration Limits for Calculation of Femur Impulse for the Hybrid III 50<sup>th</sup> Dummy



# Injury Rating

## Knee – thigh - hip

Force and Impulse Corridor Limits for Knee-Thigh-Hip Injury Risk



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<b>Overall Evaluation:</b>		<b>ACCEPTABLE</b>	
		Reset	Quit

Rating



GOOD	ACCEPTABLE	MARGINAL	POOR
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# Overall rating

**Weighting of Individual Components**  
**IIHS Crashworthiness Evaluation – Frontal Small Overlap Crash Test**

<b>Component</b>	<b>Rating</b>			
	<b>Good</b>	<b>Acceptable</b>	<b>Marginal</b>	<b>Poor</b>
Vehicle structure	0	2	6	10
Head and neck	0	2	10	20
Chest	0	2	10	20
Thigh and hip	0	2	6	10
Leg and foot	0	1	2	4
Restraints and dummy kinematics	0	2	6	10
<b>Overall rating cutoffs</b>	<b>0-3</b>	<b>4-9</b>	<b>10-19</b>	<b>20+</b>



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