

Head Restraint GTR Informal Working Group

OICA

Data Submission

September 7-9, 2005

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Design Data: Backset vs Torso Angle

DaimlerChrysler Head Restraint Backset Design Data

Vehicle↓-----Torso Angle -->	Backset by Design (CATIA)				Δ Backset mm/deg
	16	19	Design (Srg)	25	
2005 Chrysler 300 (Leather Seats)	21.7	32.7	<u>51.0@24</u>	54.6	3.7
2005 Jeep Grand Cherokee (Leather Seats)	7.1	19.4	<u>39.4@24</u>	43.3	4.0
2005 Dodge Durango (Leather Seats)	7.2	21.5	<u>34.8@22</u>	48.2	4.6

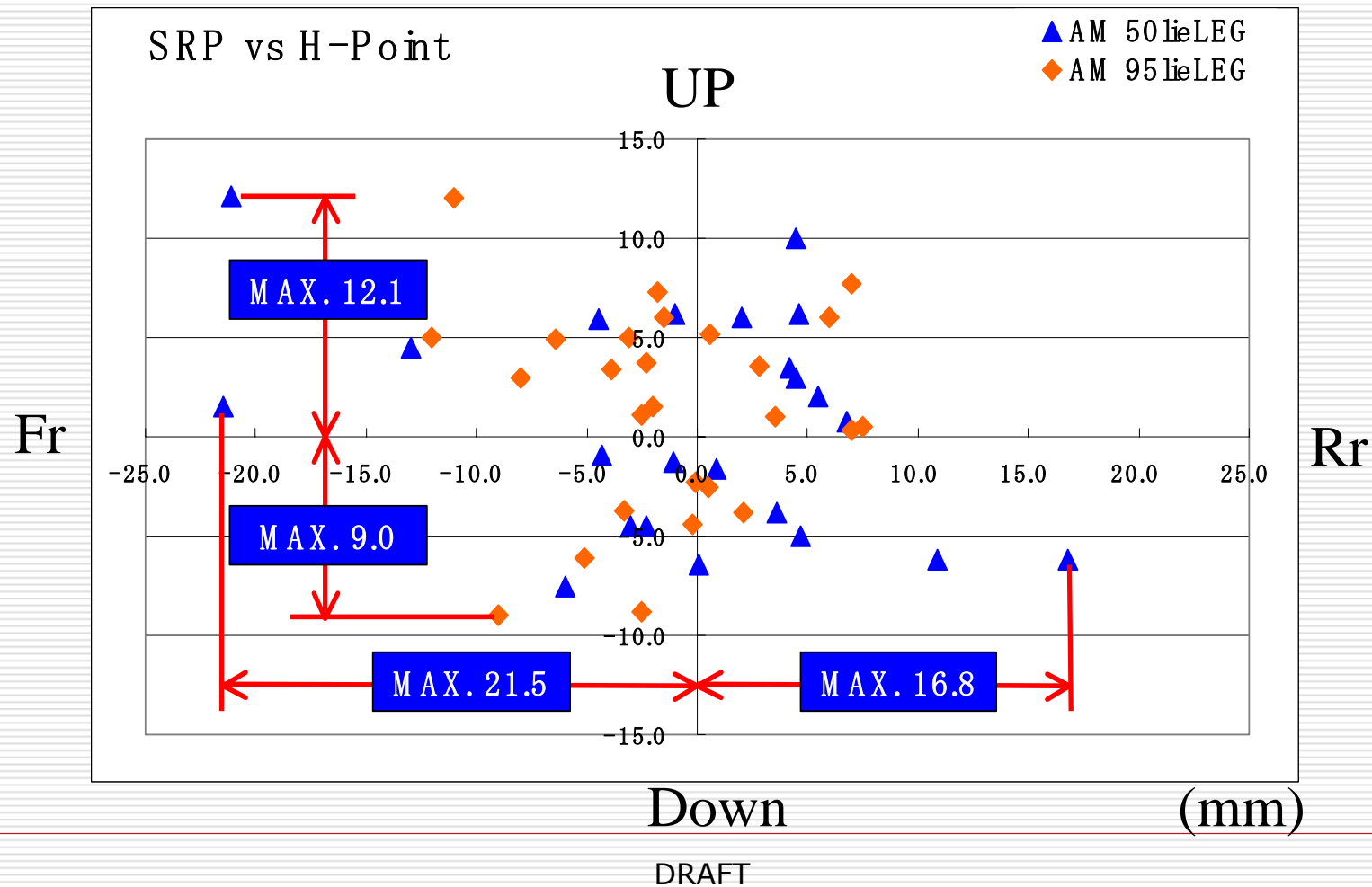
Backset Variation due to Changes in Torso Angle

Question:

What is the change of backset resulting from torso rotation by 1 degree?

Vehicle: 2004MY Ford Focus	Test data	
First torso angle =	25.5	deg
Second torso angle =	15.4	deg
Backset at 1st torso angle =	45.0	mm
Backset at 2nd torso angle =	2.0	mm
Difference in torso angles =	10.1	deg
Difference in measured backsets =	43.0	mm
<u>Answer:</u>		
The average backset change per 1 deg of torso rotation =	4.3	mm

Seat Setup and R-Point and H-Point



Recommendation

- Use seating reference point (R-/SgRP-point) instead of "H" point.
- Repeatability of measurements
- Reproducibility of measurements
- R-point is basic reference point for vehicle design and other regulations (e.g. seat belt anchorages)

Vehicle Backset Measurement Repeatability Data



Vehicle Backset Measurement Repeatability Data

DaimlerChrysler H Point & Head Restraint Repeatability Data

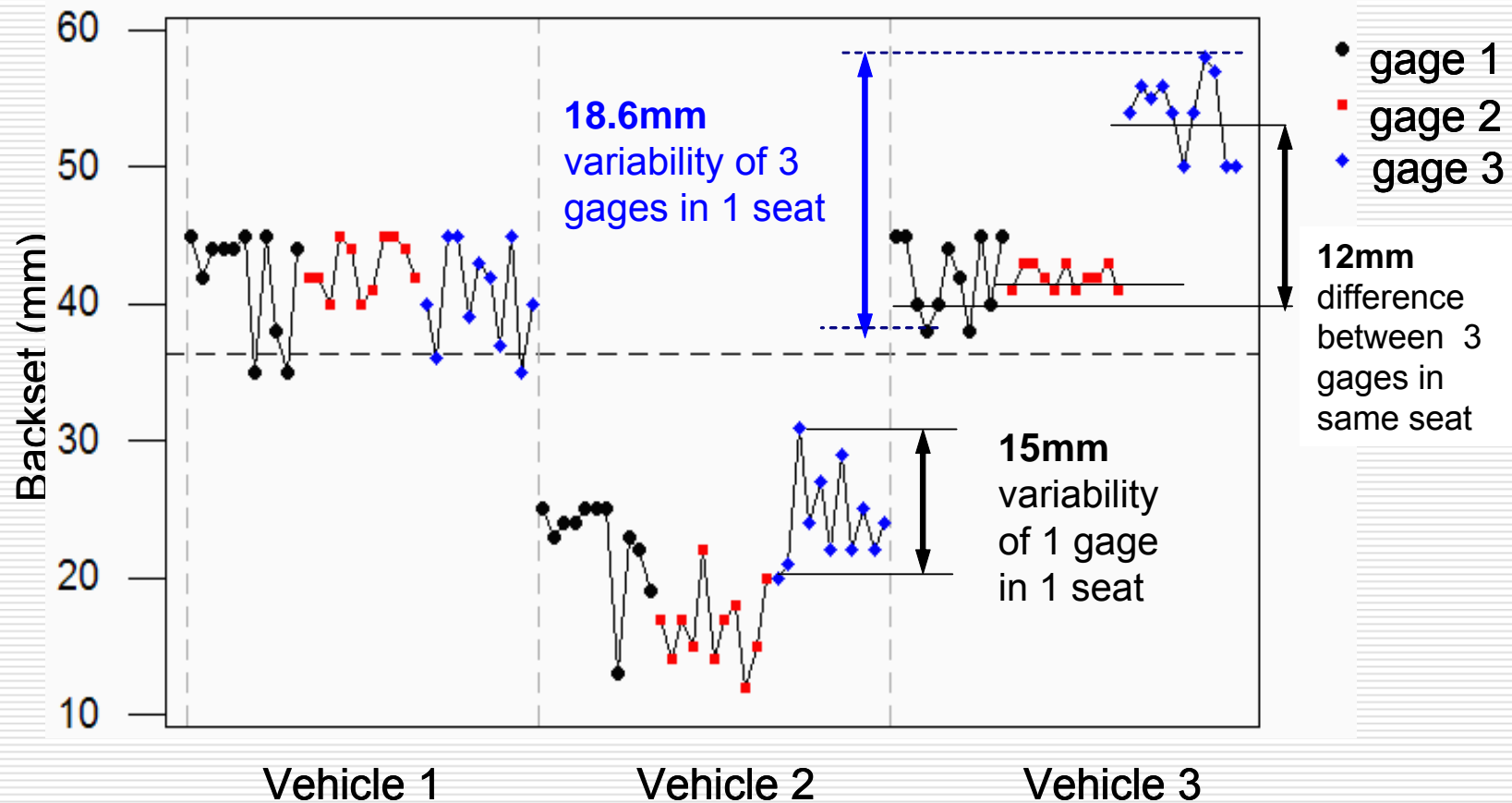
	H Point Variability		Backset Average (Up)	Backset Variability (Up)
	1 σ mm	1 σ z mm	mm	1 σ mm
2005 Jeep Grand Cherokee				
Driver @ 16°	0.82	2.30	N/A	N/A
Driver @ 25°	0.55	1.46	25.75	2.99
Passenger @ 16°	0.83	2.39	9.25	1.50
Passenger @ 25°	0.55	2.50	40.50	2.52
2005 Chrysler 300				
Driver @ 16°	0.42	0.49	N/A	N/A
Driver @ 25°	0.07	0.85	12.25	3.59
Passenger @ 16°	3.05	1.21	N/A	N/A
Passenger @ 25°	2.94	2.00	14.75	4.92
2005 Dodge Durango				
Driver @ 16°	2.44	1.27	2.50	2.89
Driver @ 25°	2.44	1.39	39.00	3.46
Passenger @ 16°	5.80	2.58	N/A	N/A
Passenger @ 25°	5.20	1.69	31.75	8.81

ICBC Test Procedure

N/A = Interference; data is not applicable

Backset Measurement Error

Ford Data: 3 Vehicles & 3 US Gages



Backset Variation due to Build Variability

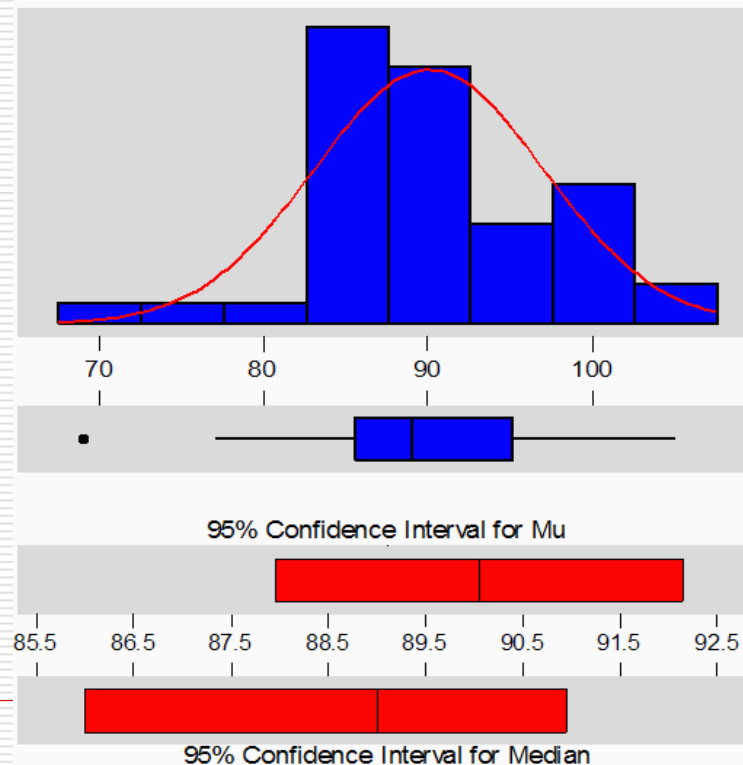
- 45 Lincoln TownCars MY 2005 measured with a single operator and gauge.

	Backset (mm)			Torso Angle (deg)
	Full up	Full down	Rated Point	
Sigma	6.993359	7.226704	7.044501	
3 sigma	20.98008	21.68011	21.1335	
Mean	90.04444	80.95556	85.5	24.95556
Max	105	95	100	25.9
Min	69	58	63.5	24
Range	36	37	36.5	1.9
3+1.5sigma	31.47012			

Backset Variation due to Build Variability (cont)

- 45 Lincoln TownCars MY 2005 measured with a single operator and gauge.

Descriptive Statistics



Variable: Full up

Anderson-Darling Normality Test

A-Squared: 0.920
P-Value: 0.018

Mean 90.0444
StDev 6.9934
Variance 48.9071
Skewness -1.1E-01
Kurtosis 0.909831
N 45

Minimum 69.000
1st Quartile 85.500
Median 89.000
3rd Quartile 95.000
Maximum 105.000

95% Confidence Interval for Mu
87.943 92.145

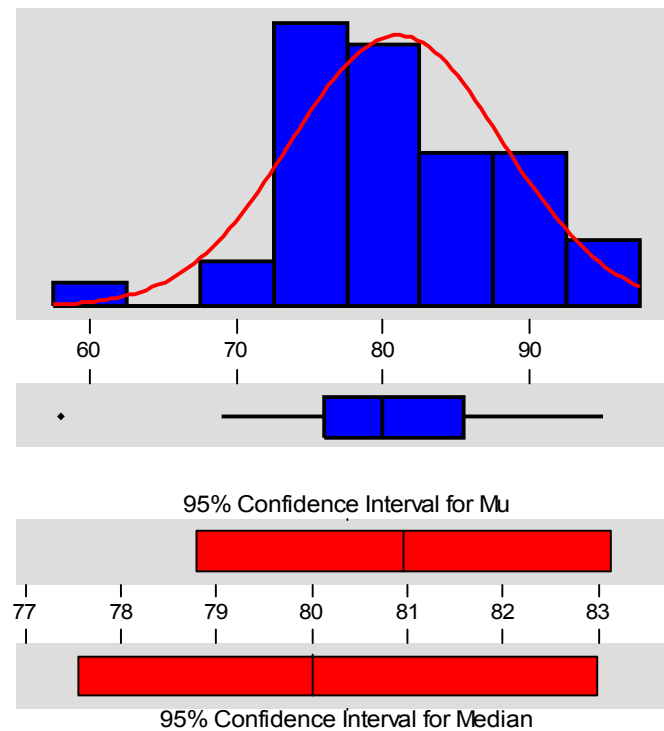
95% Confidence Interval for Sigma
5.789 8.834

95% Confidence Interval for Median
86.000 90.928

Backset Variation due to Build Variability (cont)

- 45 Lincoln TownCars MY 2005 measured with a single operator and gauge.

Descriptive Statistics



Variable: Full down

Anderson-Darling Normality Test

A-Squared: 0.687
P-Value: 0.068

Mean 80.9556
StDev 7.2267
Variance 52.2253
Skewness -2.9E-01
Kurtosis 1.08115
N 45

Minimum 58.0000
1st Quartile 76.0000
Median 80.0000
3rd Quartile 85.5000
Maximum 95.0000

95% Confidence Interval for Mu
78.7844 83.1267

95% Confidence Interval for Sigma
5.9827 9.1288

95% Confidence Interval for Median
77.5358 83.0000

Field Complaint Data on Inadequate Backset

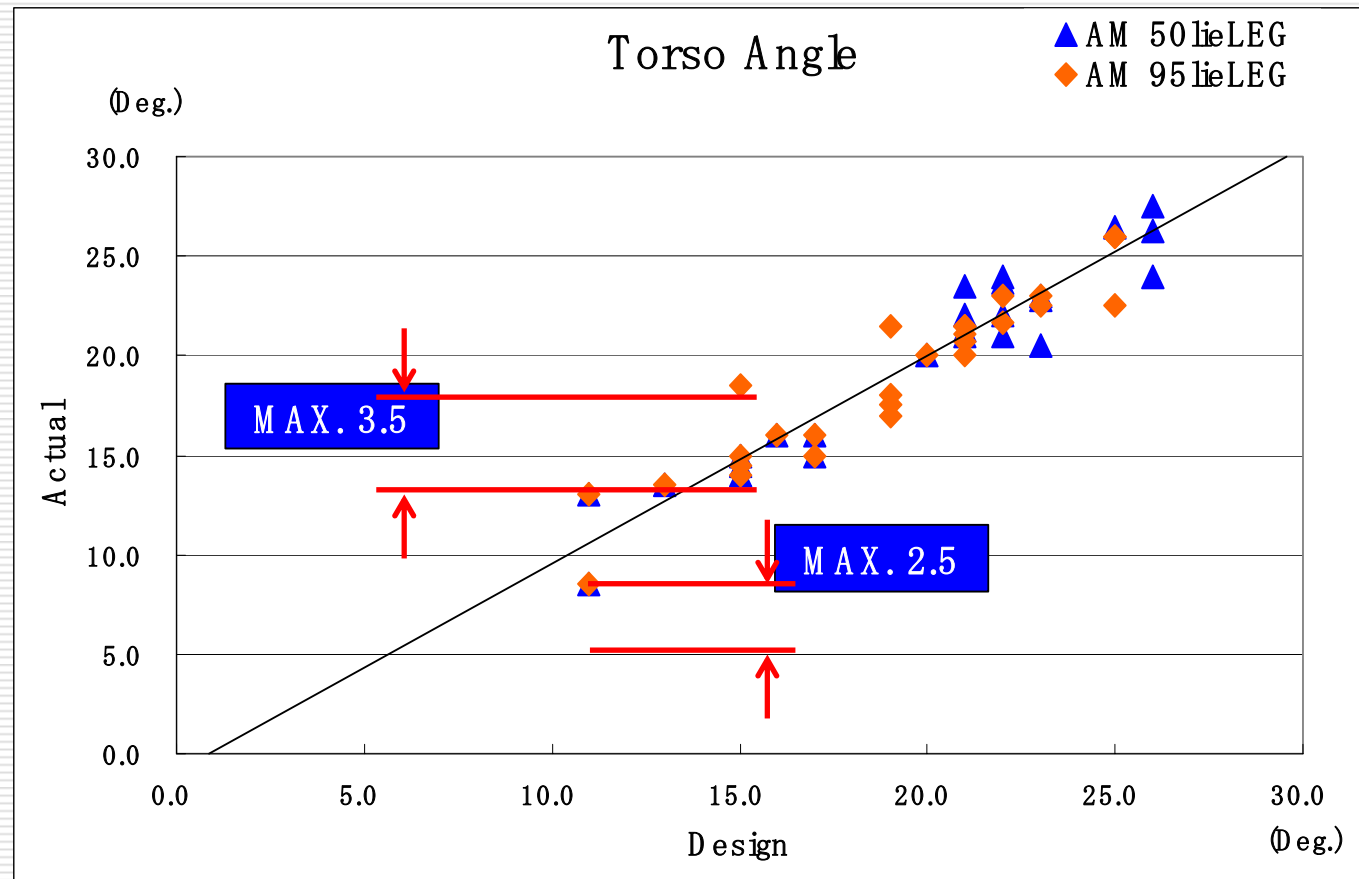
- ❑ 2005 DaimlerChrysler SUV
- ❑ Designed to meet FMVSS 202 NPRM 50mm requirement (44 mm backset at 25° to provide compliance margin)
- ❑ Field survey intended to duplicate and predict JD Power survey (268 questions)
- ❑ Aug '04 through May '05 build data
- ❑ 2945 respondents (8/1/05)
 - #1 Miscellaneous Interior (6.9%)
 - #8 Headrests (3.6%, 1.8% backset, 0.9% rearward visibility)
 - #21 Seat Belt Retractors (2.8%)
 - #37 Seat Belt Buckle (1.8%)

Field Complaint Data on Inadequate Backset

- Sample Narratives:
 - "HEAD RESTRAINTS ARE VERY UNCOMFORTABLE FOR A PERSON UNDER 5 FOOT 4. TILTS HEAD FORWARD IN AWKWARD POSITION.
 - HEADRESTS SET TOO FAR FORWARD. AGGREGATED/PINCHED NERVE IN NECK REQUIRING PHYSICAL THERAPY TO MINIMIZE PAIN/DISCOMFORT. NEED TO REMOVE HEADRESTS.
 - HEADREST IS TOO FAR FORWARD. WE HAVE TO BEND OUR NECK FORWARD, AS WE CAN'T SIT STRAIGHT UP IN THE SEAT. I'M 5'8" & MY HUSBAND IS 6'. VERY BOTHERSOME AND I WISH I'D HAVE NOTICED ON OUR TEST DRIVE, I REALLY WOULD HAVE THOUGHT TWICE ABOUT PURCHASE.
 - HEADREST TOO FORWARD, UNCOMFORTABLE DURING LONG TRIPS.
 - HEADRESTS BOTHERS HAIR
 - VERY POOR-DOESN'T ALLOW ME TO SIT TALL W/GOOD SPINAL POSTURE-HITS BACK OF HEAD WHEN I TRY TO SIT TALL. IT'S NOT ADJUSTABLE, I REMOVED AND REINSERTED IT FACING 180 DEGS FROM ITS INTENDED POSITION."

Design and Actual Torso Angle

There are many vehicles which are not 25 degree design angle.



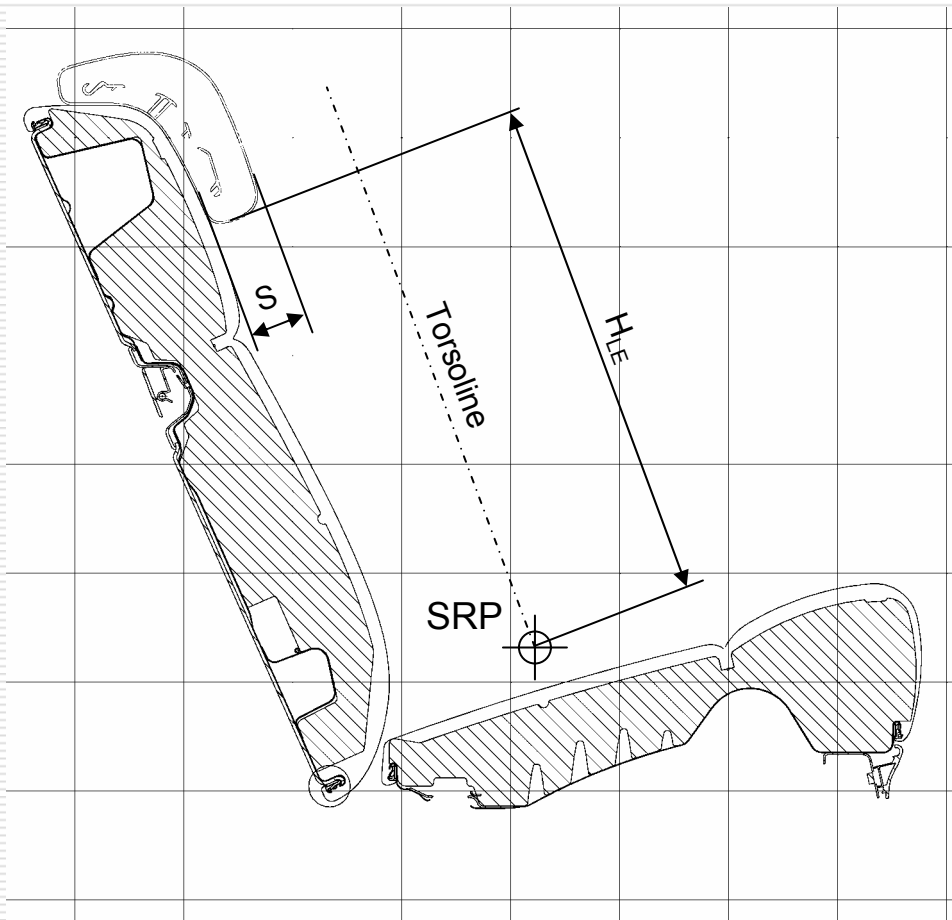
Backset Recommendation:

- 80 mm (Alliance petition for reconsideration) at design torso angle allows for design, manufacturing and audit tolerance
- Short stature people expected to benefit most from increased backset
- Wide variety of design torso angles depending on the vehicle type

Non-use Position: Objective Criteria

- Retain +/- 60° rotation criteria
- Expand objective alternatives and add:
 - Discomfort metric
 - 5° torso angle change between in use and non use positions
 - Pop up telltale
 - Warning label

Non-use Position: “Discomfort Metric”



Definition of lower edge of head restraint in non-use position:

$$460 \text{ mm} \geq H_{LE} \geq 250 \text{ mm}$$

and

$$S \geq 25 \text{ mm}$$

Maximum height (460 mm) needed to get discomfort even for small people.

Minimum height (250 mm) needed to prevent misinterpretation of non-use position as upright seating position.

Non-use Position: “Discomfort Metric”

Validation of proposed maximum height for lower edge of head restraint:

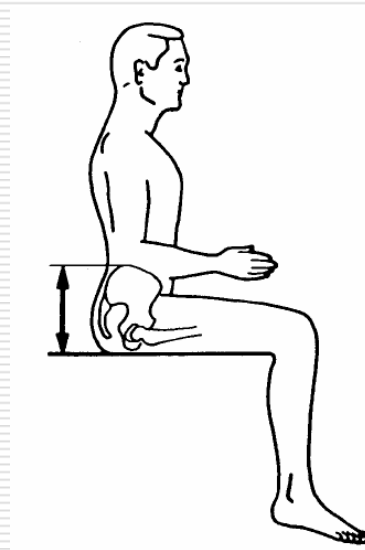
- 460 mm height is below the shoulder height of 5%-women



Non-use Position: “Discomfort Metric”

Validation of proposed minimum height for lower edge of head restraint:

- 250 mm height is above the pelvic bone of 95%-man, so that the back of even tall passengers can always touch the seat back. Misinterpretation of the “non-use position” as a “proper head restraint” position is very unlikely.



Data from „handbook of ergonomics“ from Prof. Dr. H.W. Jürgens, Kiel, Germany:
Iliocristale height (see picture) of a 95%-male is 270 mm. With consideration of overlapping with smooth upholstery and location of hip point this corresponds with a dimension of 160 mm above the SRP.

Non-use Position: "Discomfort Metric" Chrysler Stow 'n' Minivan Parameters

□ $H_{LE} = 375.8 - 391.5 \text{ mm}$

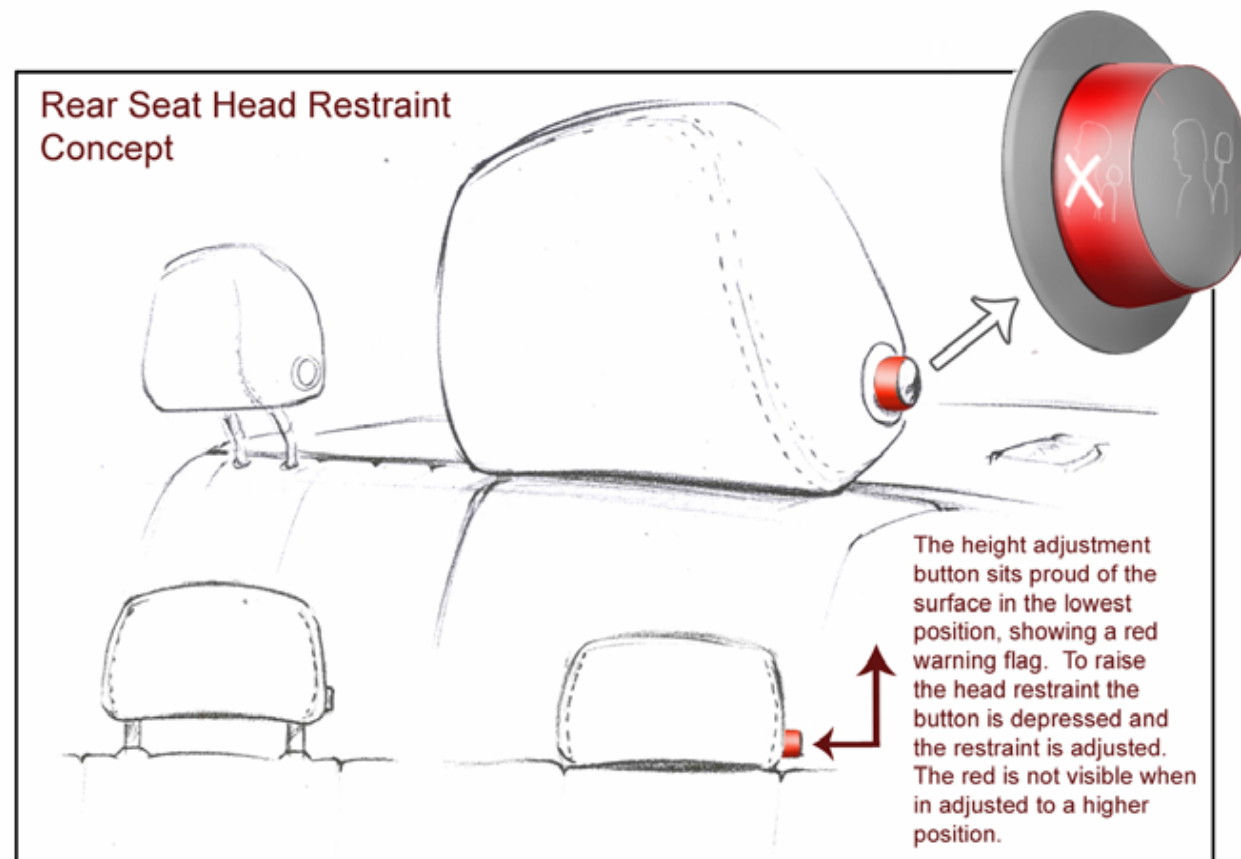
□ $S = 28 - 29 \text{ mm}$

□ $\Delta\text{Torso Angle} = 5.5^\circ - 7^\circ$

Non-use Position: "Discomfort Metric" Chrysler Stow 'n' Go Minivan Complaint Narratives

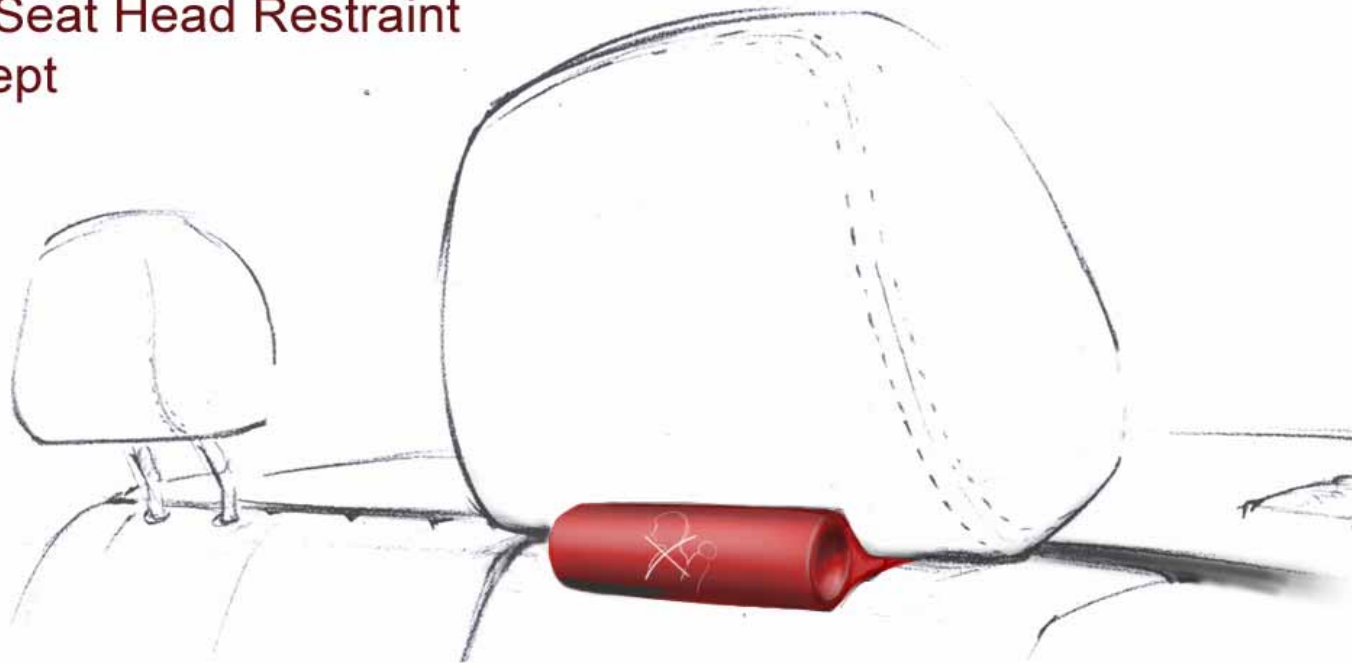
- ❑ "VERY UNCOMFORTABLE TO SIT IN THE SEATS W/THE HEADREST ALL THE WAY DOWN.
- ❑ MIDDLE AND REAR MUST BE RAISED FOR OCCUPANT COMFORT, BUT THEN LOWERED TO BE STOWED
- ❑ THE SEATS BACKS ARE SO LOW THAT ANY ADULT SITTING THERE MUST ADJUST THE HEADREST SO IT'S NOT IN THEIR BACK.
- ❑ THEY HIT MY BACK AWKWARDLY UNLESS I MOVE THEM TO AN EXTENDED POSITION.
- ❑ WITH HEADRESTS IN DOWN POSITION, IT IS VERY UNCOMFORTABLE, AS THEY HIT YOU IN THE LOWER NECK AND IN THE RAISED POSITION THEY ARE IN DRIVER'S VIEW (WHEN NO PASSENGERS ARE PRESENT)."

Non-Use Position: Indicator Proposal



Non-Use Position: Indicator Proposal

Rear Seat Head Restraint Concept



The warning tag could appear, perhaps inflated as the head restraint is pressed down into the lowest position. As the head restraint is raised the tag would deflate and flatten against the bottom of the head restraint.

Volvo XC90 Second Row with Non-use Position Warning Label



Volvo XC90 2nd Row Center with Non-use Position Warning Label



Volvo XC90 2nd Row Center In-use Position (Close up view)



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Volvo XC90 2nd Row Center Non-use Position Warning Label (Close up view)

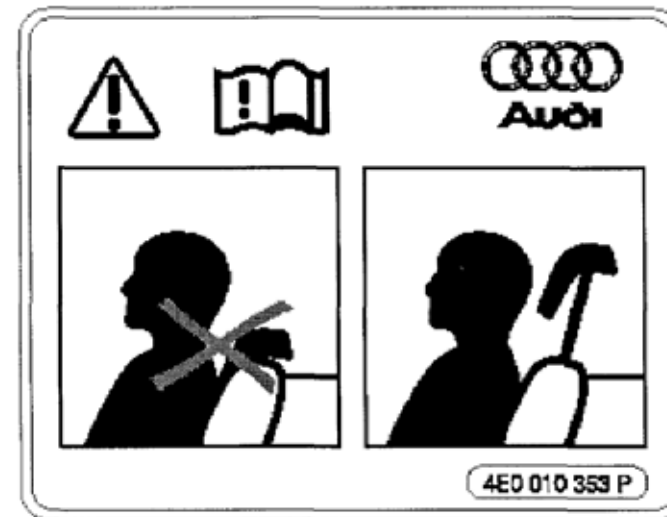


Non-Use Position: Warning Label



**Warning label coupled
with owner's manual
verbiage to educate
occupant as to correct
head restraint positioning**

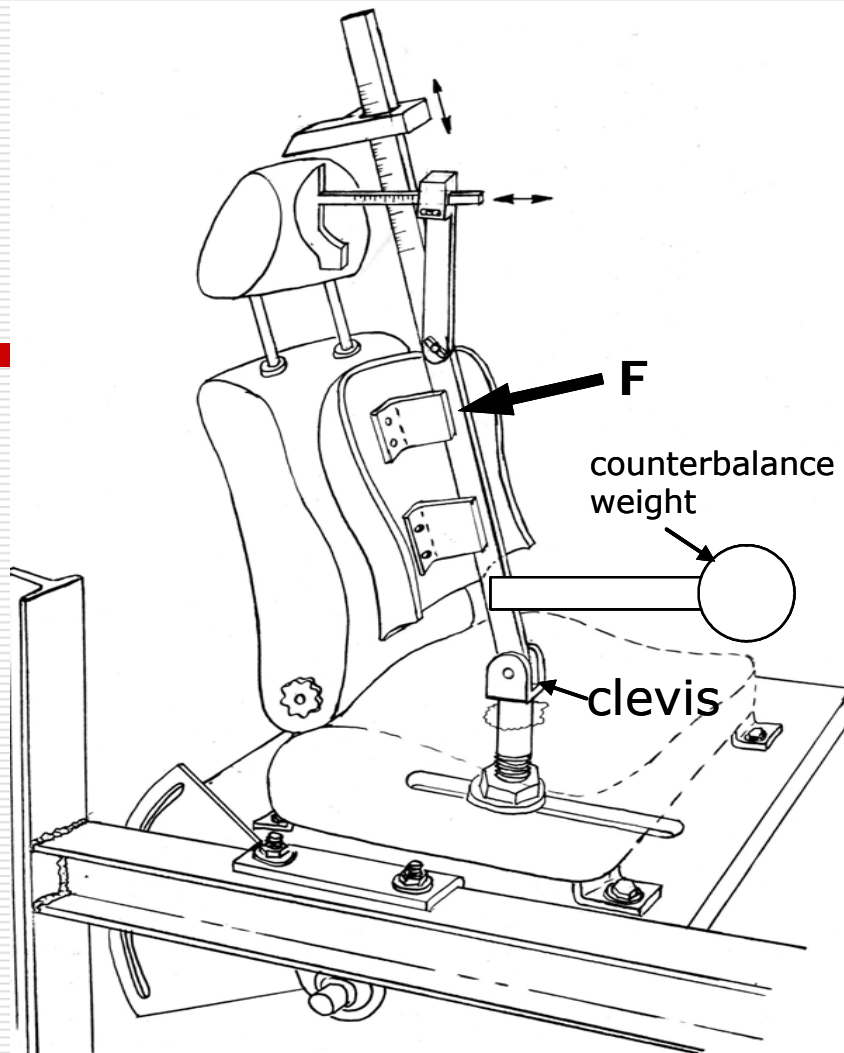
Non-Use Position: Warning Label



Lock Retention Test: Proposal

- ❑ Measure head restraint vertical deflection on the bottom of the head restraint relative to adjustment rods.
- ❑ This is not a cushion force deflection test, but a lock retention test.

Backset Test Procedure – Possible Concept

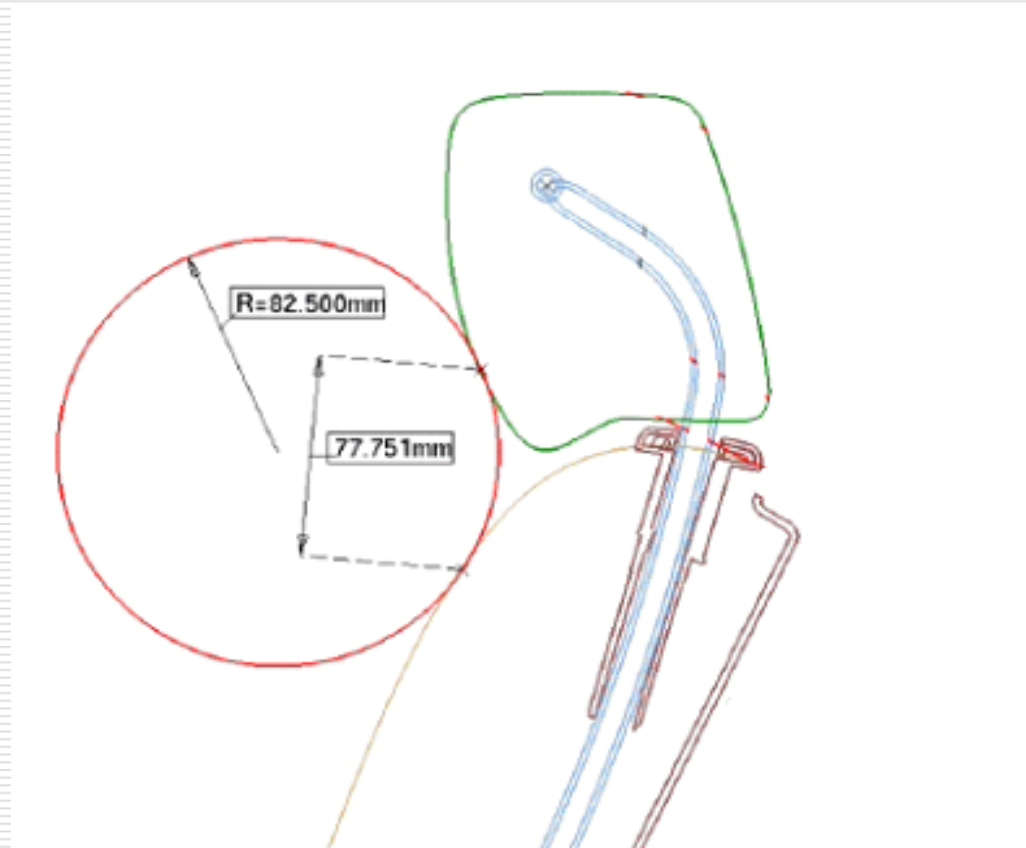


Procedure:

1. Mount the seat to the test fixture.
2. Mount the clevis to the fixture and adjust its location until the pivot line of the clevis is aligned with theoretical SgRP location with respect to the recliner pivot line.
3. Apply force F to the torso form to produce a rearward moment (with respect to SgRP) equal to the moment (TBD) generated by the SAE-J826 manikin at the design torso angle.
4. Recline the seat back to achieve the design torso angle
5. Measure the head restraint height in all positions of adjustment at which downward retention is provided.
6. Level the backset measuring arm and measure the head restraint backset at all HR positions at which the height is within 700-800mm range.

Goal: Reduce backset measurement variability by eliminating the contribution of H-point variability

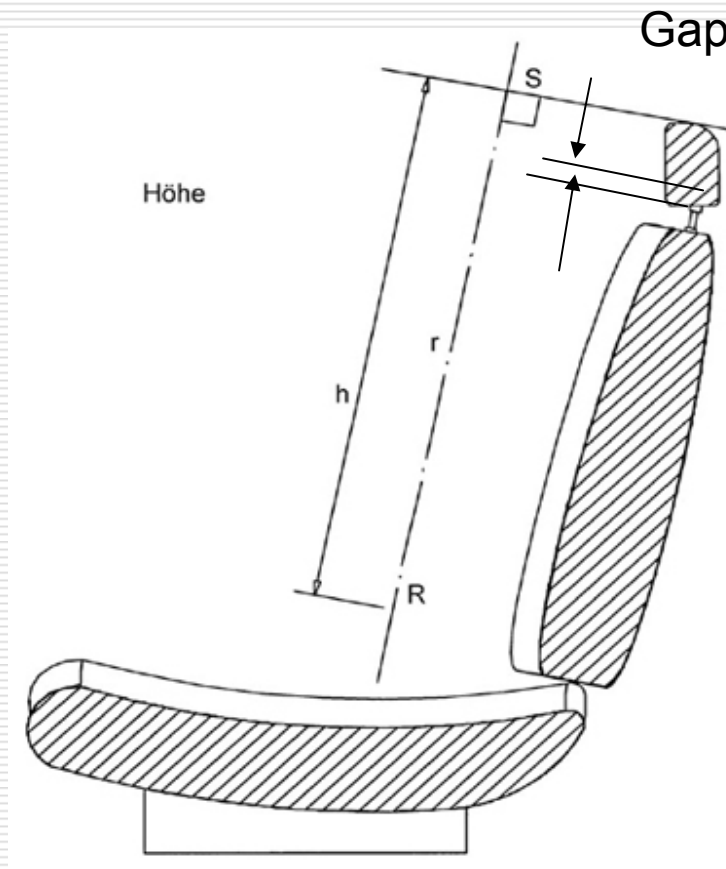
FMVSS 202a Gap Measurement Procedure



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Preferred Gap Measurement Procedure (ECE R17)



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Surrogate Testing for Automatic “Return to In-use” Position

- ❑ Objective test device (Hybrid III 5%F or 50%M) alternative is mandatory for self certification countries.
- ❑ Human volunteers may be permitted under a type approval authority.

Recommendations Summary

- ❑ Backset is torso angle, "H" point, and measurement method sensitive.
- ❑ Backset Proposed 80 mm at design torso angle
- ❑ Effective "non-use position" alternatives exist besides +/- 60° rotation
- ❑ Lock retention test should measure relative motion between the lock and adjustment rod, not cushion deflection
- ❑ Backset/height measurement proposal eliminates "H" point variability
- ❑ Use ECE R17 gap measurement procedure for seat back to head restraint gap measurement.
- ❑ Objective test needed as alternative to surrogate testing for self certification markets