

Transport Canada
Transports Canada

Head Restraint Height Comparison Methods

5th Head Restraint Informal Working
Group Meeting

Cologne, Germany
January 23-26, 2006

Draft of Preliminary Evaluation

Objectives

- Compare the variation of the head restraint height measurements between ECE 17-25, FMVSS 202a, and CAD data provided by the vehicle manufacturer.
- Verify if one method provides better repeatability results in terms of height measurements.
- Verify the affect of using the 95th leg segments instead of the 50th leg segments and vice versa for each of the two proposed methods.

Procedure

- For purposes of repeatability, the same two trained-technologists were used for all tests to respectively position the H-point machine in the seat and collect the measurement coordinates.
- The height of the head restraint and H-point location were measured three times per method per vehicle.
- In total, measurements were taken on five vehicles originating from two different vehicle manufacturers.

Test Vehicles from GM



2005 Chevrolet Silverado



2005 Pontiac Montana



Test Vehicles from Ford



2005 Ford F-150

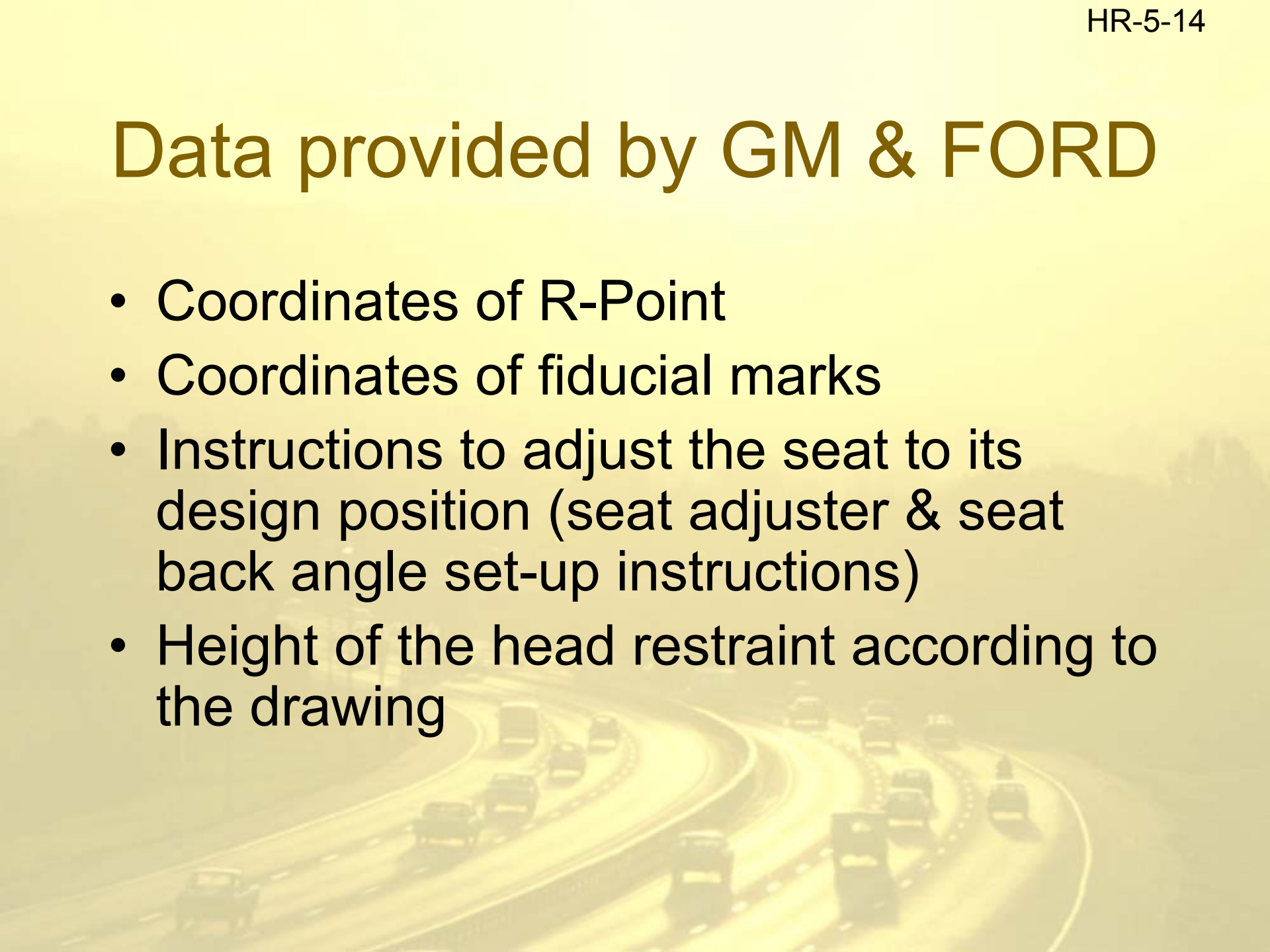


2005 Ford Escape



2005 Ford Mustang

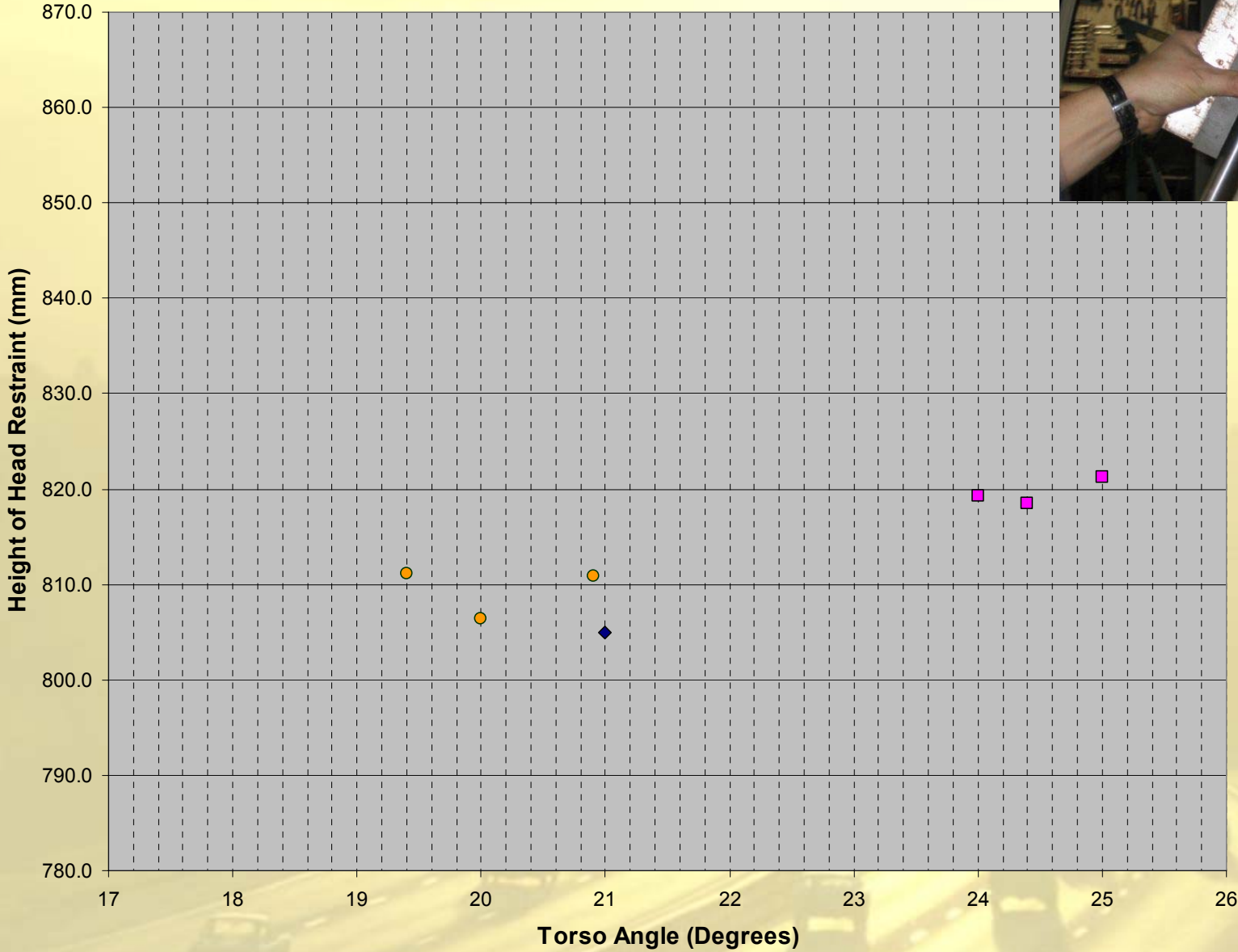
Data provided by GM & FORD

- Coordinates of R-Point
 - Coordinates of fiducial marks
 - Instructions to adjust the seat to its design position (seat adjuster & seat back angle set-up instructions)
 - Height of the head restraint according to the drawing
- 

Differences Between Methods

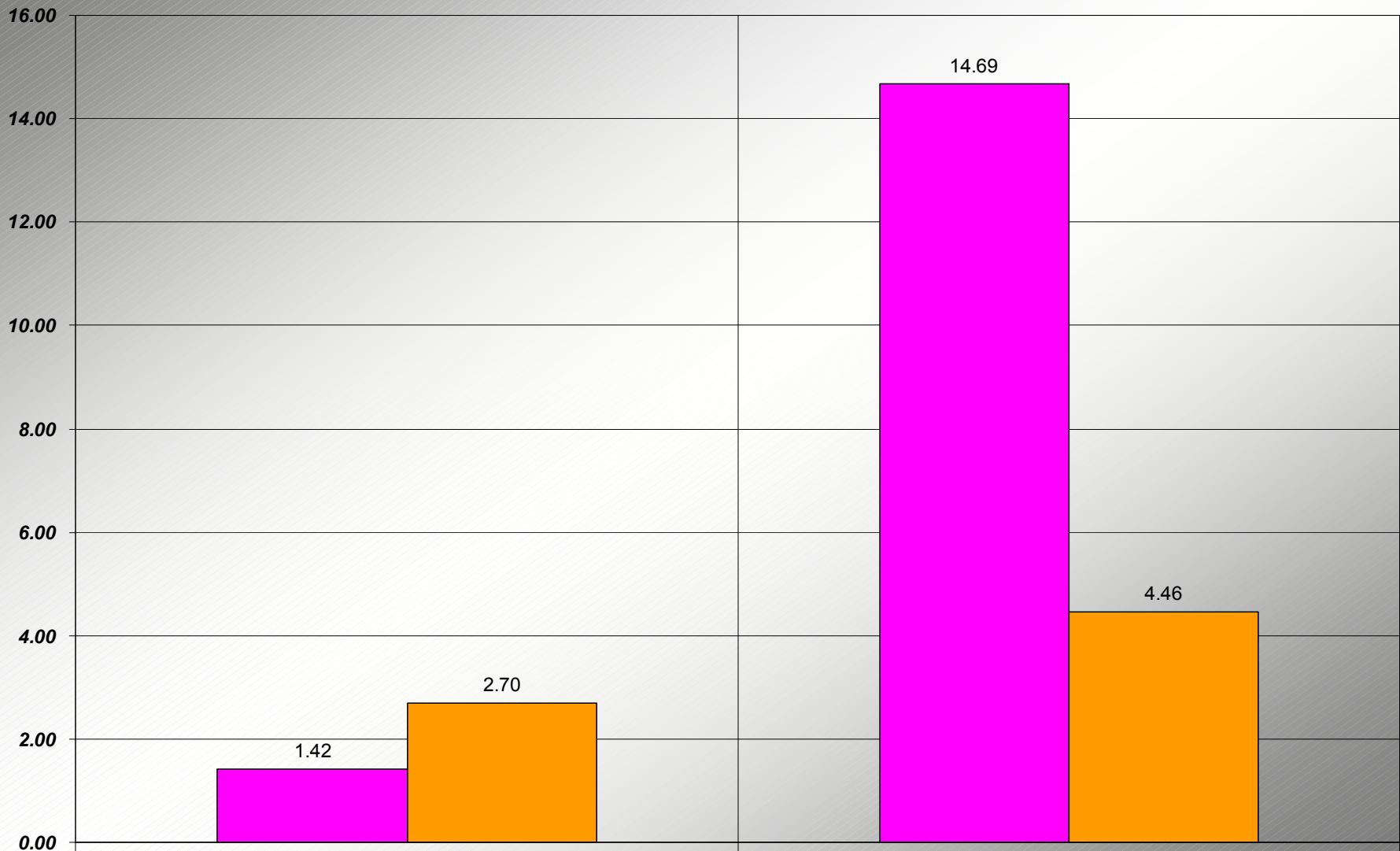
	NHTSA's Final Rule	ECE 17 and ECE 25
Leg Segments of H-Point Machine as defined by SAE J826 (April 1980)	95th	50th
Longitudinal Position on Seat Track	Rearmost normal driving and riding position as specified by the vehicle manufacturer.	Rearmost normal driving and riding position as specified by the vehicle manufacturer.
Torso angle	Minimum 25° (?)	Within 5 degrees of the angle specified by the vehicle manufacturer.
Seat Cushion Height	Highest	As specified by the vehicle manufacturer.
Tolerance of H-point	Within 10mm in vertical coordinates from R-Point (?)	Within 25mm in vertical and longitudinal coordinates from R-Point

2005 Ford F150 - Height Measurement Methods Comparison



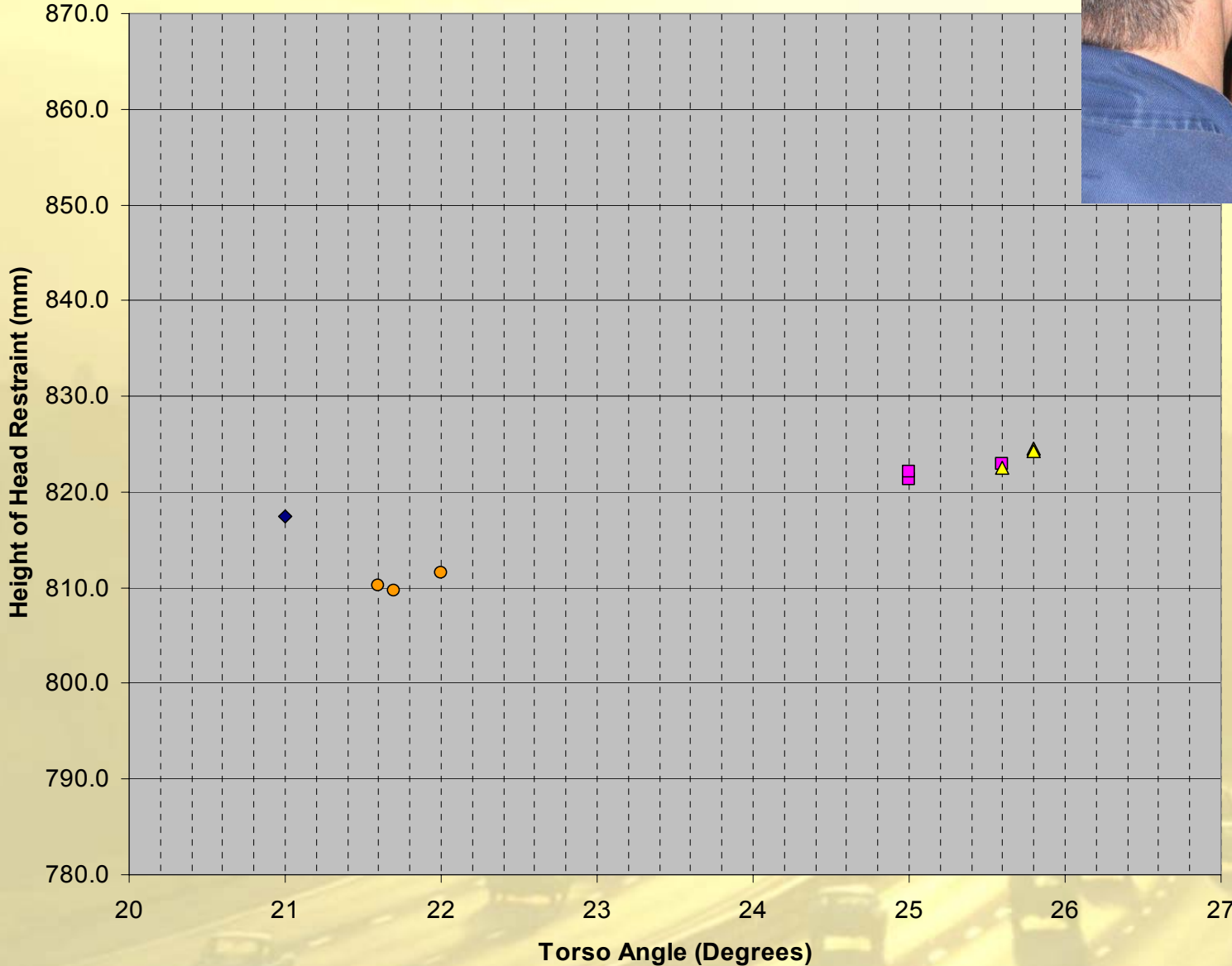
- ◆ Height according to manufacturer's drawing
- NHTSA's Final Rule
- ECE 17

2005 Ford F150 - Height Measurement Methods Comparison



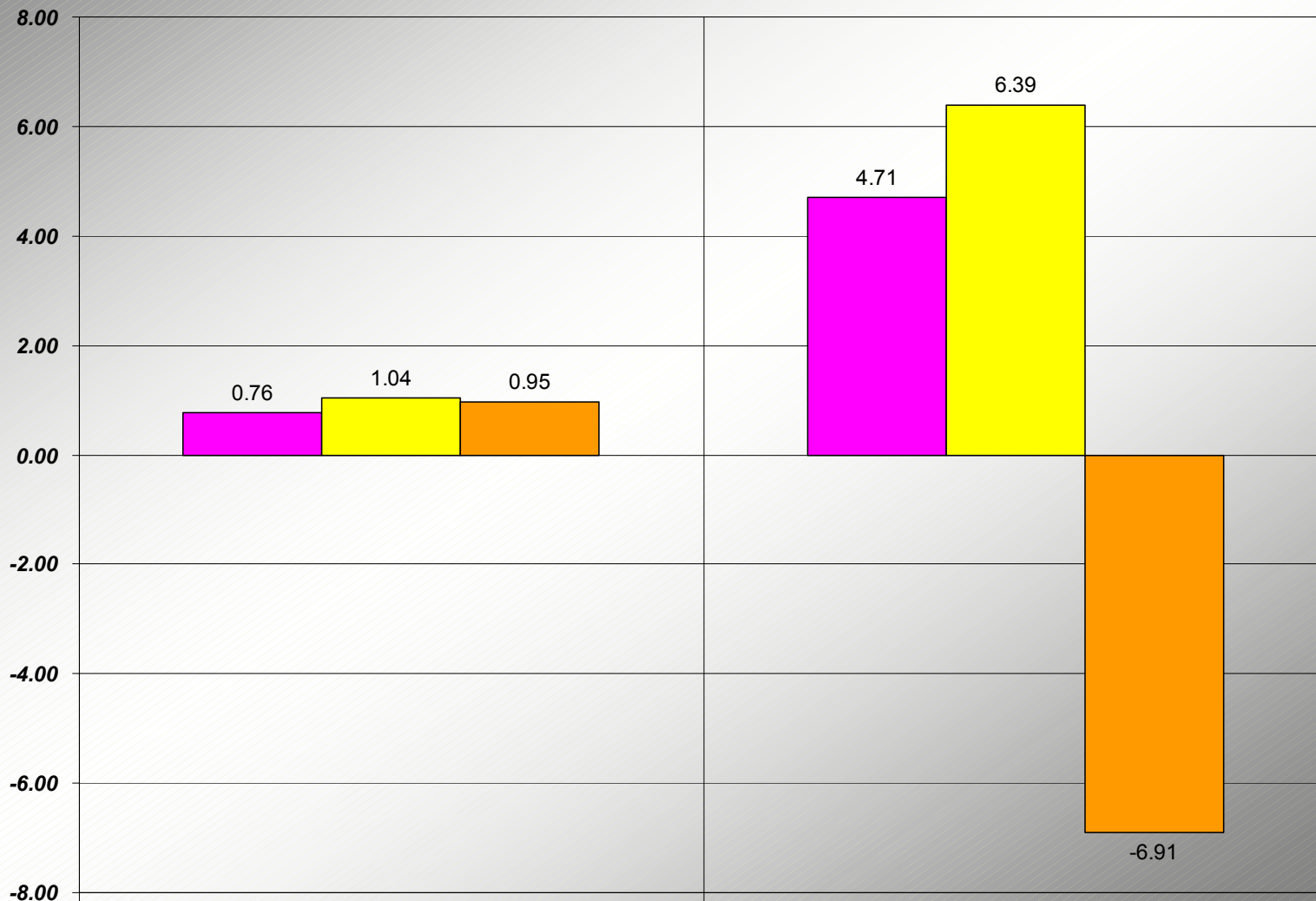
■ FMVSS 202a	1.42	14.69
■ ECE 17	2.70	4.46

2005 Ford Escape - Height Measurement Methods Comparison



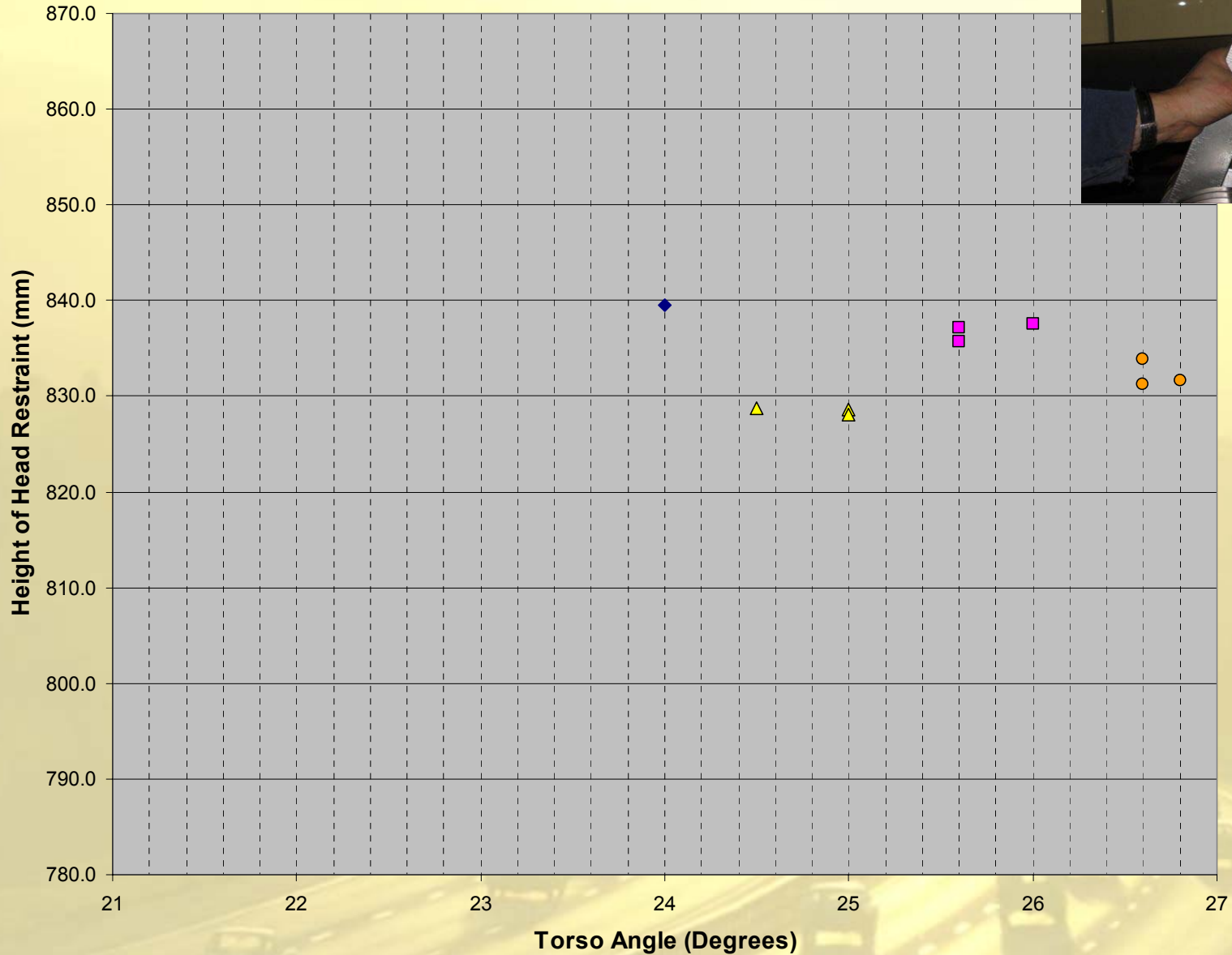
- ◆ Height according to manufacturer's drawing
- FMVSS 202a (highest seat position)
- ▲ FMVSS 202a (seat height within 10mm of R-point)
- ECE 17

2005 Ford Escape - Height Measurement Methods Comparison



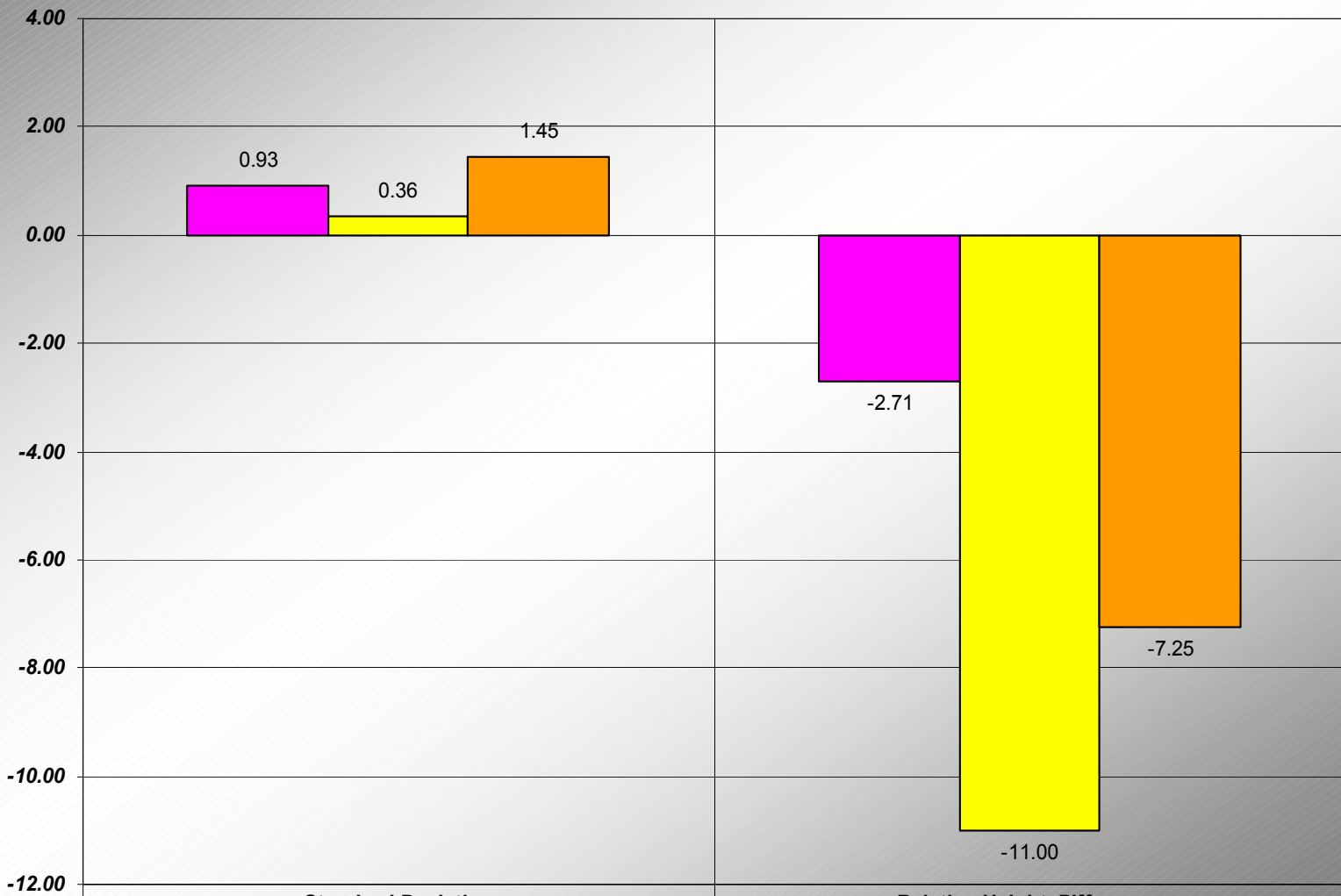
	Standard Deviation	Relative Height Difference
FMVSS 202a (highest)	0.76	4.71
FMVSS 202a (z<10mm of R-point)	1.04	6.39
ECE 17	0.95	-6.91

2005 Ford Mustang - Height Measurements Methods Comparison



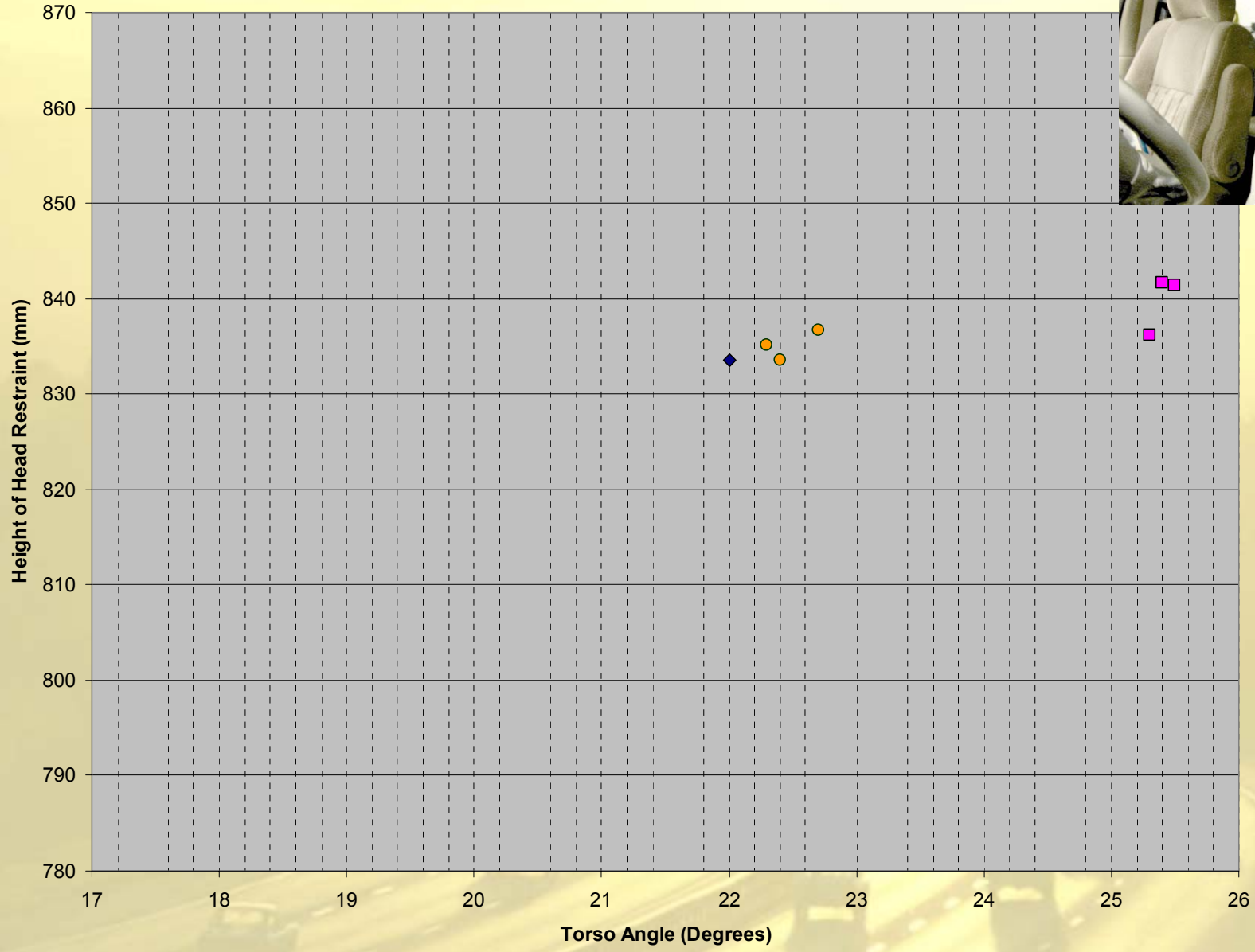
- ◆ Height according to manufacturer's drawing
- FMVSS 202a (highest seat position)
- ▲ FMVSS 202a (Seat height within 10mm of R-point)
- ECE 17

2005 Ford Mustang - Height Measurement Methods Comparison



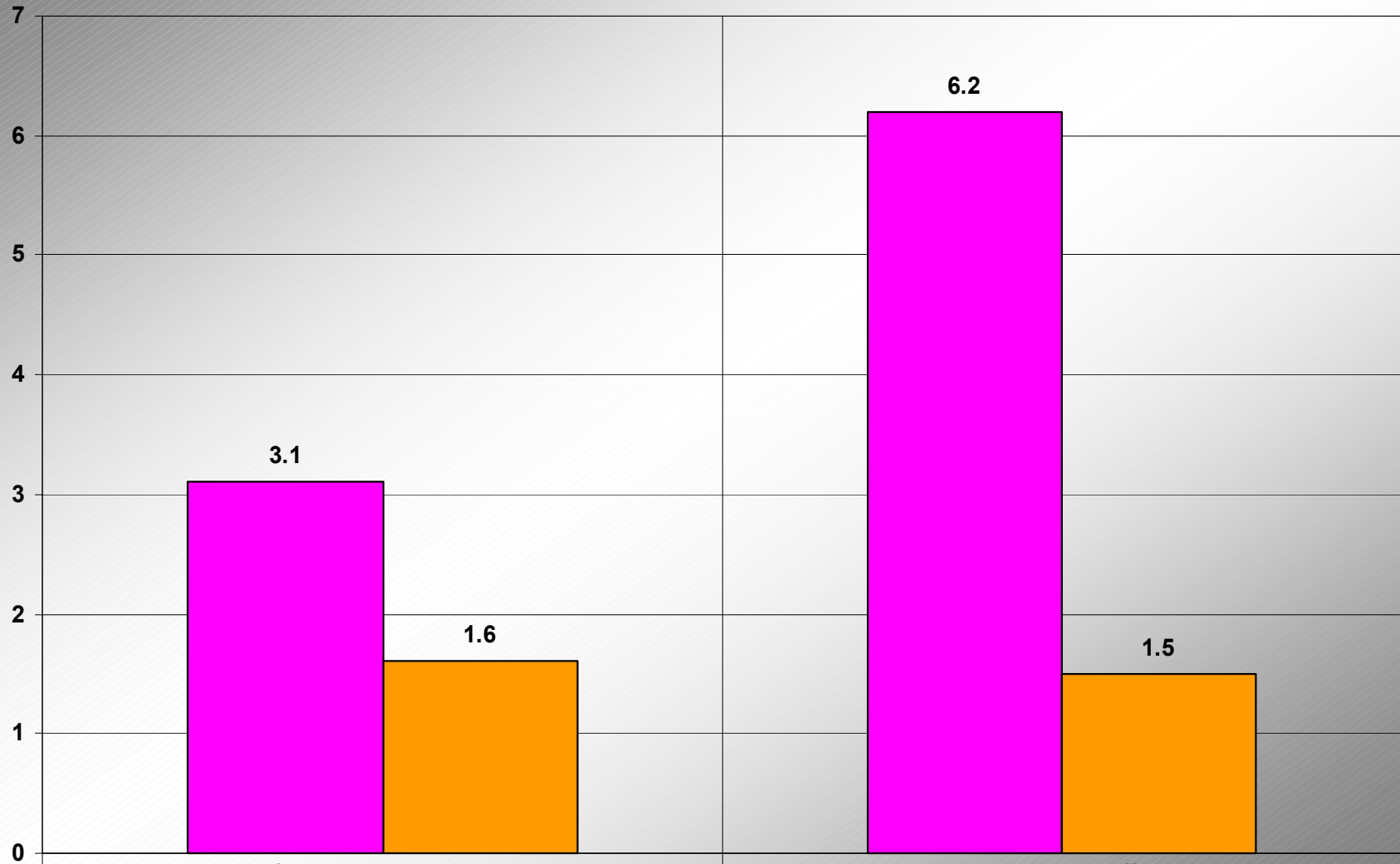
	Standard Deviation	Relative Height Difference
■ FMVSS 202a (highest)	0.93	-2.71
■ FMVSS 202a (z<10mm of R-point)	0.36	-11.00
■ ECE 17	1.45	-7.25

2005 Pontiac Montana - Height Measurement Methods Comparison



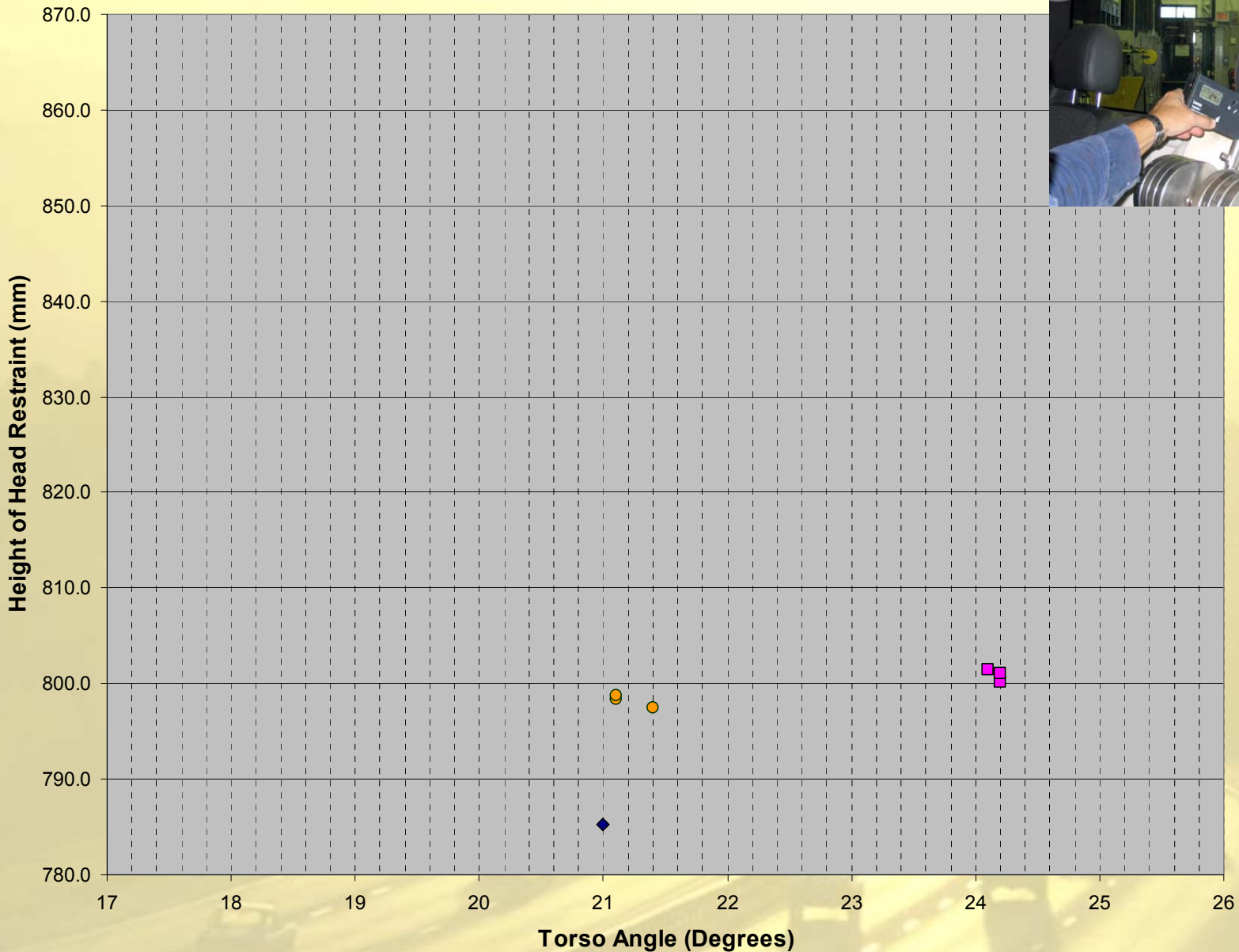
- ◆ Height according to the manufacturer's drawing
- NHTSA's Final Rule
- ECE 17

2005 Pontiac Montana - Height Measurement Methods Comparison



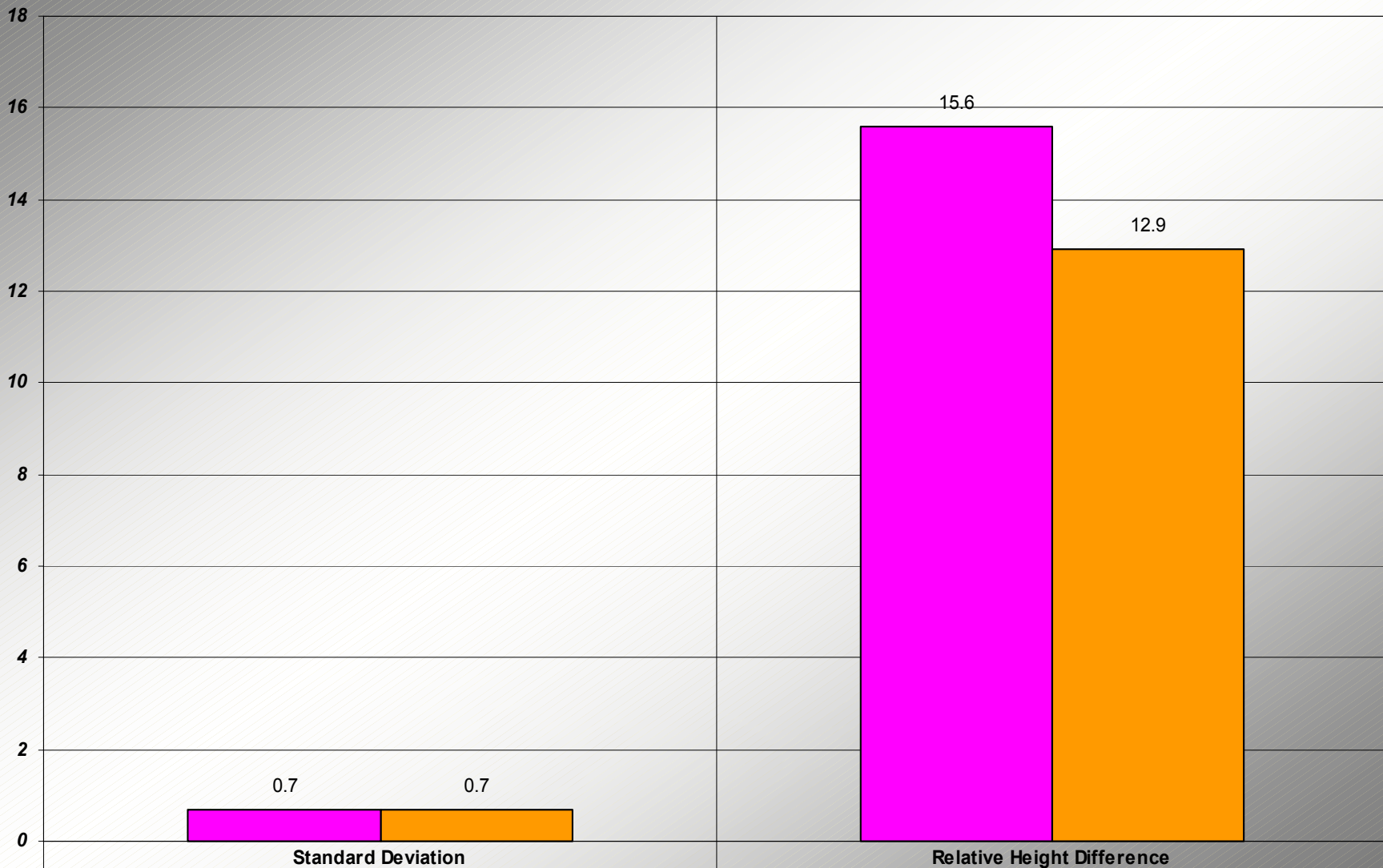
■ FMVSS 202a	3.1	6.2
■ ECE 17	1.6	1.5

2005 Chevrolet Silverado - Height Measurement Methods Comparison



- ◆ Height according to manufacturer's drawing
- NHTSA's Final Rule
- ECE 17

2005 Chevrolet Silverado - Height Measurement Methods Comparison



■ FMVSS 202a

■ ECE 17

0.7

0.7

15.6

12.9

Summary Results

		Height Measured (mm)						Height Variability		Theoretical Height		Height Difference		
		n=1		n=2		n=3		Average	Standard Deviation	Coefficient of Variation	Height	Design Seat Angle	Relative Difference	Absolute Difference
Vehicle	Test Method	mm	Degrees	mm	degrees	mm	degrees	mm	mm	%	mm	degrees	mm	%
F150	FMVSS 202a	821.25	25	818.49	24.4	819.32	24	819.69	1.42	0.17	805	21	14.69	1.82
	ECE 17	810.84	20.9	806.35	20	811.2	19.4	809.46	2.70	0.33			4.46	0.55
Escape	FMVSS 202a (highest)	822.9	25.6	821.38	25	822.06	25	822.11	0.76	0.09	817.4	21	4.71	0.58
	FMVSS 202a (z<10mm of R-Pt)	824.47	25.8	824.31	25.8	822.59	25.6	823.79	1.04	0.13			6.39	0.78
	ECE 17	809.72	21.7	810.2	21.6	811.56	22	810.49	0.95	0.12			-6.91	-0.84
Mustang	FMVSS 202a (highest)	837.49	26	837.15	25.6	835.74	25.6	836.79	0.93	0.11	839.5	24	-2.71	-0.32
	FMVSS 202a (z<10mm of R-Pt)	828.62	25	828.09	25	828.78	24.5	828.50	0.36	0.04			-11.00	-1.31
	ECE 17	831.21	26.6	833.9	26.6	831.64	26.8	832.25	1.45	0.17			-7.25	-0.86
Silverado	FMVSS 202a	836.2	25.3	841.7	25.4	841.4	25.5	839.8	3.1	0.37	857.8	22	-18	2.10
	ECE 17	833.6	22.4	835.1	22.3	836.7	22.7	835.1	1.6	0.19			-22.7	2.6
Montana	FMVSS 202a	800.2	24.2	801.5	24.1	801	24.2	800.9	0.7	0.08	785.26	21	15.64	2
	ECE 17	797.5	21.4	798.4	21.1	798.8	21.1	798.2	0.7	0.08			12.94	1.6

50th versus 95th leg segments

Vehicle	Test Method	Height Measured (mm)						Height Variability		
		n=1		n=2		n=3		Average	Standard Deviation	Coefficient of Variation
		mm	Degrees	mm	degrees	mm	degrees	mm	mm	%
F150	FMVSS 202a (95th)	821.25	25.0	818.49	24.4	819.32	24.0	819.69	1.42	0.17
	FMVSS 202a (50th)	818.04	24.6	817.15	24.0	819.73	24.5	818.31	1.31	0.16
	ECE 17 (50th)	810.84	20.9	806.35	20.0	811.20	19.4	809.46	2.70	0.33
	ECE 17 (95th)	808.89	20.4	809.27	20.0	808.88	19.9	809.01	0.22	0.03
	Transport Canada	821.09	25.4	823.34	25.7	820.36	24.9	821.60	1.55	0.19
Escape	FMVSS 202a (95th)	822.90	25.6	821.38	25.0	822.06	25.0	822.11	0.76	0.09
	FMVSS 202a (z<10mm of R-point)	824.47	25.8	824.31	25.8	822.59	25.6	823.79	1.04	0.13
	FMVSS 202a (50th)	825.57	26.3	821.18	26.0	820.57	25.6	822.44	2.73	0.33
	FMVSS 202a (50th & z<10mm of R-point)	839.06	25.9	823.65	25.4	824.57	25.3	829.09	8.64	1.04
	ECE 17 (50th)	809.72	21.7	810.20	21.6	811.56	22.0	810.49	0.95	0.12
	ECE 17 (95th)	808.83	21.0	810.48	21.3	811.46	21.2	810.26	1.33	0.16
Transport Canada	824.20	25.1	822.07	24.8	822.55	24.9	822.94	1.12	0.14	
Mustang	FMVSS 202a (95th)	837.49	26.0	837.15	25.6	835.74	25.6	836.79	0.93	0.11
	FMVSS 202a (z<10mm of R-point)	828.62	25.0	828.09	25.0	828.78	24.5	828.50	0.36	0.04
	FMVSS 202a (50th)	835.17	25.7	833.48	25.6	832.82	25.8	833.82	1.21	0.15
	FMVSS 202a (50th & z<10mm of R-point)	825.53	24.6	821.99	25.0	825.42	25.2	824.31	2.01	0.24
	ECE 17 (50th)	831.21	26.6	833.90	26.6	831.64	26.8	832.25	1.45	0.17
	ECE 17 (95th)	833.40	26.1	830.35	26.0	833.72	26.2	832.49	1.86	0.22
	Transport Canada	827.75	25.2	827.39	25.0	828.49	24.8	827.88	0.56	0.07
Silverado	FMVSS 202a	836.20	25.3	841.70	25.4	841.40	25.5	839.80	3.10	0.37
	FMVSS 202a (50th)	838.10	24.8	837.90	24.6	839.50	24.6	838.50	0.90	0.10
	ECE 17 (50th)	833.60	22.4	835.10	22.3	836.70	22.7	835.10	1.60	0.19
	ECE 17 (95th)	835.50	22.6	833.40	22.2	835.30	22.2	834.70	1.20	0.14
Montana	FMVSS 202a (95th)	800.20	24.2	801.50	24.1	801.00	24.2	800.90	0.70	0.08
	FMVSS 202a (50th)	805.40	25.6	802.00	25.3	810.00	25.1	805.80	4.00	0.50
	ECE 17 (50th)	797.50	21.4	798.40	21.1	798.80	21.1	798.20	0.70	0.08
	ECE 17 (95th)	799.70	21.2	800.70	21.5	799.60	21.1	800.00	0.60	0.08

Observations

- The height of the head restraint measured increases in conjunction with the inclination of the seat back.
- If the manufacturer's design seat back angle is lower than 25 degrees, NHTSA's method provided in the Final Rule will likely provide superior height measurement values than the ECE method.



Observations (2)

- Where the seat was adjustable in height, the highest seat position was not within 10mm of the R-point. The effect of the vertical seat positioning on the height measurement would have to be further assessed.



Observations (3)

- Using the 95th instead of the 50th leg segments for ECE 17-25 or 50th instead of the 95th leg segments for FMVSS 202a has little to no affect on the height measurement.
- Both methods, ECE 17-25 and FMVSS 202a, provided similar results in terms of repeatability.



Observations (4)

- Positioning the seat in order to make the H-point of the 3-D manikin coincide with that of the R-point, as required in ECE 17, ensures that the position of the H-point along longitudinal and vertical axis stands within a certain range. However, the effect that this may have on the height measurement variations still needs further assessment.

Torso angle	Range of HR height in CAD (mm) [800 mm ref]	
	For +/- 15 mm tolerance of H-Point	For +/- 25mm tolerance of H-Point
23 degrees	780.3 - 819.7 mm	767.2 - 832.8 mm
25 degrees	780.1 - 819.9 mm	766.8 - 833.2 mm
27 degrees	779.8 - 820.2 mm	766.4 - 833.6 mm

Data provided by Ford Canada.

Future projects

- Verify the effect that the vertical seat positioning has on height measurement.
- Verify the benefit of the R-point tolerance of $\pm 25\text{mm}$, as currently present in ECE 17-25, for purposes of height measurement.

