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Head Restraint Height and Backset Measured from H-point versus R-Point

The data from the Alliance/OICA head restraint and backset measurement study of September 5,2006 was analyzed to determine the change in benefits from that reported in the FMVSS No. 202a Final Regulatory Impact Analysis (NHTSA docket no. 19807) when measurements are made from R-point rather than the H-point.

The initial study was conducted using 10 OEM seats. The measurements were made using 2 methods – H-point and R-point. The H-point, backset, and height measurement for each seat was repeated four times. In this study, the repeatability of the backset and height measurement using the H-point method was better than that with the R-point method. The Alliance/OICA then changed the R-point measurement procedure to improve its repeatability. The new procedure was evaluated with three of the seats examined before which demonstrated that the repeatability of the new R-point method was better than that of the H-point method. For this analysis, the measurements from the 10 OEM seats are taken to represent fleet performance.

Figure 1 shows the difference in R-point and H-point from the study. The difference in Hpoint and Rpoint in the x-direction has a mean of -0.4 mm and a standard deviation of 16.2 mm while that in the z-direction is 3.7 mm with a standard deviation of 12.3 mm.

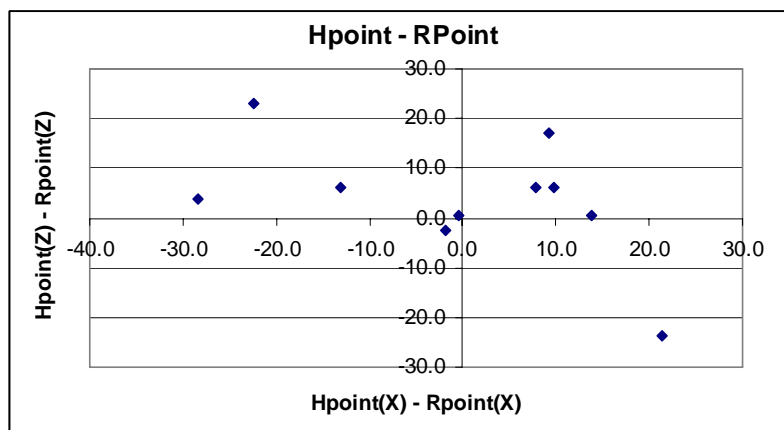


Figure 1: H-point – Rpoint for the 10 OEM seats.

Backset Measurement – Rpoint versus Hpoint method:

Figure 2 presents the difference in the Hpoint and Rpoint backset measurement for 10 seats as a function of the difference in the Hpoint and Rpoint measurement in the x direction. The backset measurement using the new Rpoint method is also plotted on Figure 2 for three seats.

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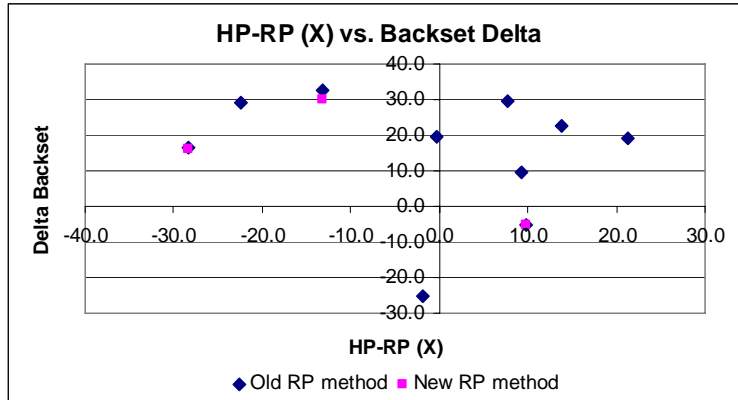


Figure 2. Difference in Hpoint and Rpoint backset measurement versus hpoint – Rpoint distance in x direction

Though the difference in HP and RP in the x direction was somewhat evenly distributed about zero, the difference in backset from the two methods is clearly biased in the positive direction. The correlation between backset difference and HP-RP (x-direction), HP-RP (z-direction), and HP –RP (resultant) were all very poor ($R^2 < 0.05$). The data from these 10 seats shows that irrespective of the difference in HP and RP, the average difference in backset is 14.8 ± 17.87 mm. In addition, the new R-point method improved repeatability of the backset measurement but did not alter the average backset value.

This data suggests that the H-point backset measurement is on an average approximately 15 mm greater than R-point backset measurement. Therefore to obtain the same benefits as that reported in the FMVSS 202a FRIA (H-point backset measurement limit of 55mm), the limit on R-point backset measurement should be changed from 55 mm to 40 mm (55-15 mm). If the same backset of 55 mm is used with the R-point backset measurement, then the equivalent h-point backset measurement will be 70 mm. The effectiveness of a backset of 70 mm is given by Figure 3 (from FRIA chapter V) and is equal to 1.0%. This effectiveness is for all AIS 1 injuries. Head restraints are meant for whiplash injuries and the effectiveness for mitigating whiplash injuries alone = $1.0/0.6=1.67\%$

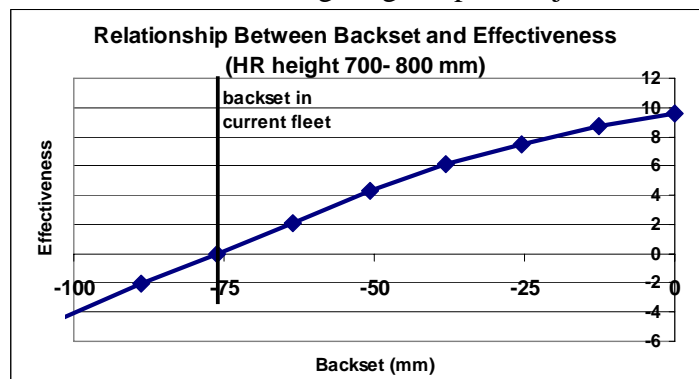


Figure 3: Effectiveness versus backset for head restraint heights between 700 to 800 mm.

Height Measurement – Hpoint versus Rpoint:

The difference in Hpoint and Rpoint height measurement versus the Hpoint-Rpoint distance in the z direction is presented in Figure 4.

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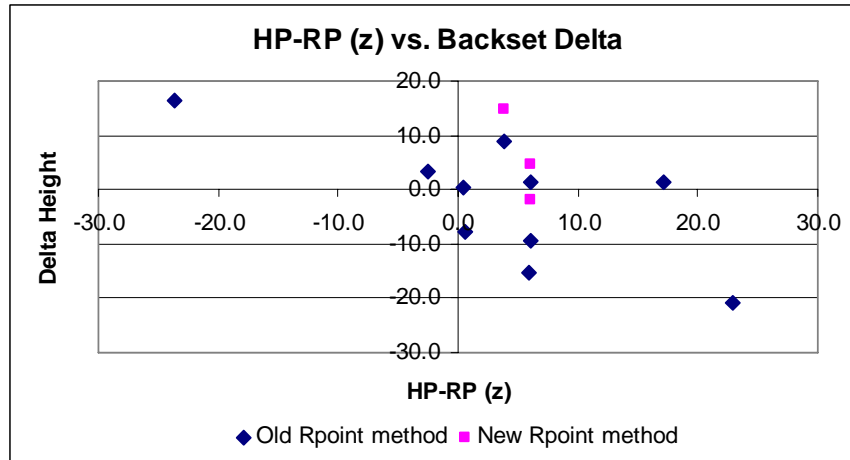


Figure 4: Difference in Hpoint and Rpoint height measurement versus hpoint – Rpoint distance in z direction

The difference in HP and RP distance in the z direction is positive for most seats indicating that the Hpoint is lower than the Rpoint. The difference in height measurement and the difference in Hpoint and Rpoint exhibit some level of correlation ($R^2=0.43$). The average height difference (Hpoint – Rpoint) for these ten seats is -2.2 with a standard deviation of 11.2. For all practical purposes, this difference is small and one can assume that the average head restraint height for the fleet measured using Rpoint or Hpoint method is about the same. Therefore, there is no change in effectiveness for height measurement using Rpoint or Hpoint.

Benefits Computation:

The average head restraint height and backset measurement for front seats in the current fleet using H-point method is 767mm and 75 mm, respectively (from FRIA). The average head restraint height and backset measurement for rear seats in the current fleet using H-point method is 650 mm and 121 mm, respectively. In the FRIA, the effectiveness of head restraint height and backset were not combined. Instead, only the higher of the two estimated effectiveness was computed. Assuming Alternative 1 for rear seats (Any rear seat that measures 700 mm or higher, must meet 750 mm at its lowest height and backset of 55 mm), Table 1 presents the effectiveness estimates from the FRIA and the estimated effectiveness from equivalent Rpoint measurement to meet FMVSS No. 202a.

Table 1: Passenger Car Effectiveness Estimates

Seat Type	H-point			R-Point			HP- RP effect
	height	backset	Higher effective	height	backset	Higher effect	
Front Seat integral	1.68	5.83	5.83	1.68	1.67	1.68	4.15
Front seat adjust (up)	1.68	5.83	5.83	1.68	1.67	1.68	4.15
Front seat adjust (dn)	5.83	5.83	5.83	5.83	1.67	5.83	0
Rear seat	17.45	7.5	17.45	17.45	7.5	17.45	0

The total number of potential front seat whiplash injuries is 314,526 (both integral and adjustable head restraints – FRIA computation). Using the effectiveness listed in Table 1 for H-point measurement, the FRIA computed benefits of 15,272 injuries prevented for front seats and 1,559 injuries prevented for the rear seat with a total of 16,831 injuries prevented.

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For the R-point measurement, using the effectiveness listed in Table 1 and the procedure outlined in the FRIA in chapter V, the benefits using R-point measurements are as follows

The number of whiplash injuries that could be prevented if there were head restraints with a height of 800 mm and a backset of 55 mm or less as measured from the Rpoint for front seat head restraints: $=314,526 \times 0.0168=5,284$.

We assume that half the fleet is passenger cars and the other half are light trucks. The adjustment for head restraint effectiveness in light trucks is 0.656.

Injuries prevented in passenger cars = $5,284 \times 0.5 = 2,642$

Injuries prevented in light trucks = $0.6656 \times 5,284 \times 0.5 = 1759$

Total benefits estimated for front seats = 4,401 (2,642 + 1,759) whiplash injuries

For the rear seat, there were 21,429 rear seat whiplash injuries. As in the FRIA, the effectiveness rates for passenger cars and LTVs are the same for rear seats. Assuming Alternative 1 in the Final Rule (Only rear seats with head restraints that meet 700 mm must meet 750 mm at its lowest height in the rear). As a result of this definition of head restraint presence, only 41.7 percent (5/12) of the vehicles would be considered as having a head restraint. All the benefits in this option accrue due to the height effectiveness.

Rear seat benefits (whiplash injuries prevented) = $21,429 \times 5/12 \times 0.1745 = 1559$

The total benefits from front and rear seats = 5,959 (4,401+1,559) reduction in whiplash injuries.

Table 2 presents the benefits from the H-point and R-point method

Table 2: Benefits (Whiplash Injuries Prevented) Computed from the H-point method and the R-point method

	H-point	R-point	Difference HP-RP
Front Seat	15,272	4,401	10,871
Rear Seat	1,559	1,559	1,559
Total	16,831	5,959	10,871

By measuring from the R-point without adjusting the backset requirement of 55mm will result in a loss of benefits of 10,871 whiplash injuries. Using a whiplash injury cost of \$9,994 (reported in FRIA), this is a loss of \$108,645,000.