

*FMVSS No. 202 Final Rule  
Backset and Height Retention Testing*

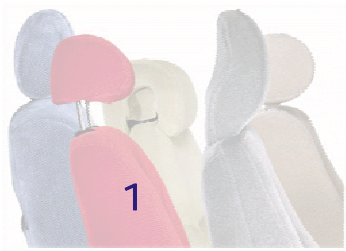
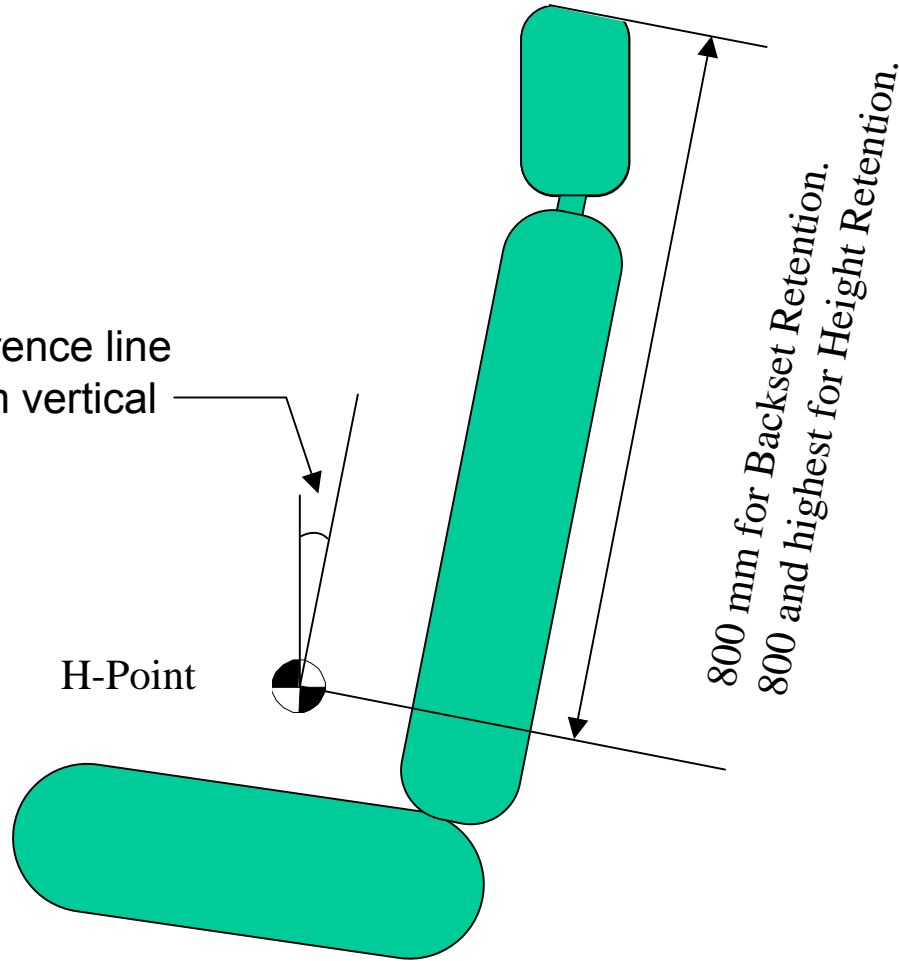
*Justification for Load Values*

**2<sup>nd</sup> Head Restraint Informal Working Group Meeting  
April 11-13, 2005**

# Initial Seat Back Position for Retention Tests

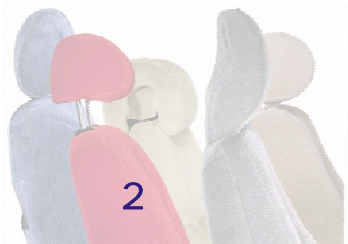
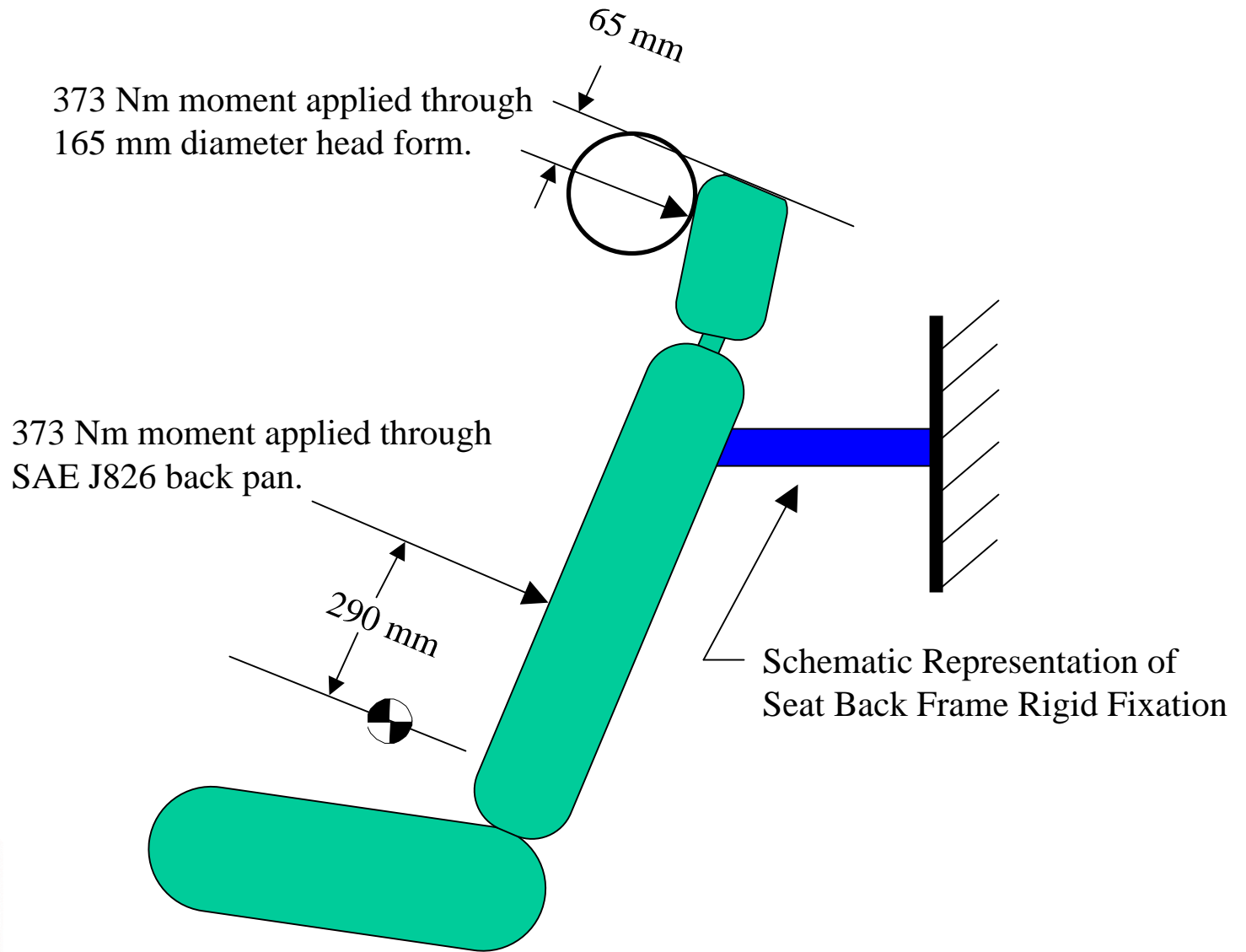
Initial torso reference line  
angle = 25° from vertical

H-Point



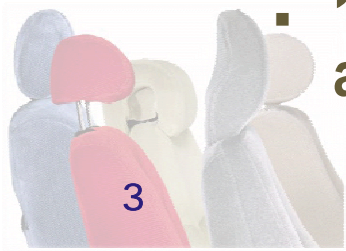
# Backset Retention Force Application

HR-2-8

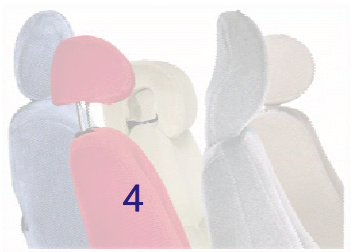
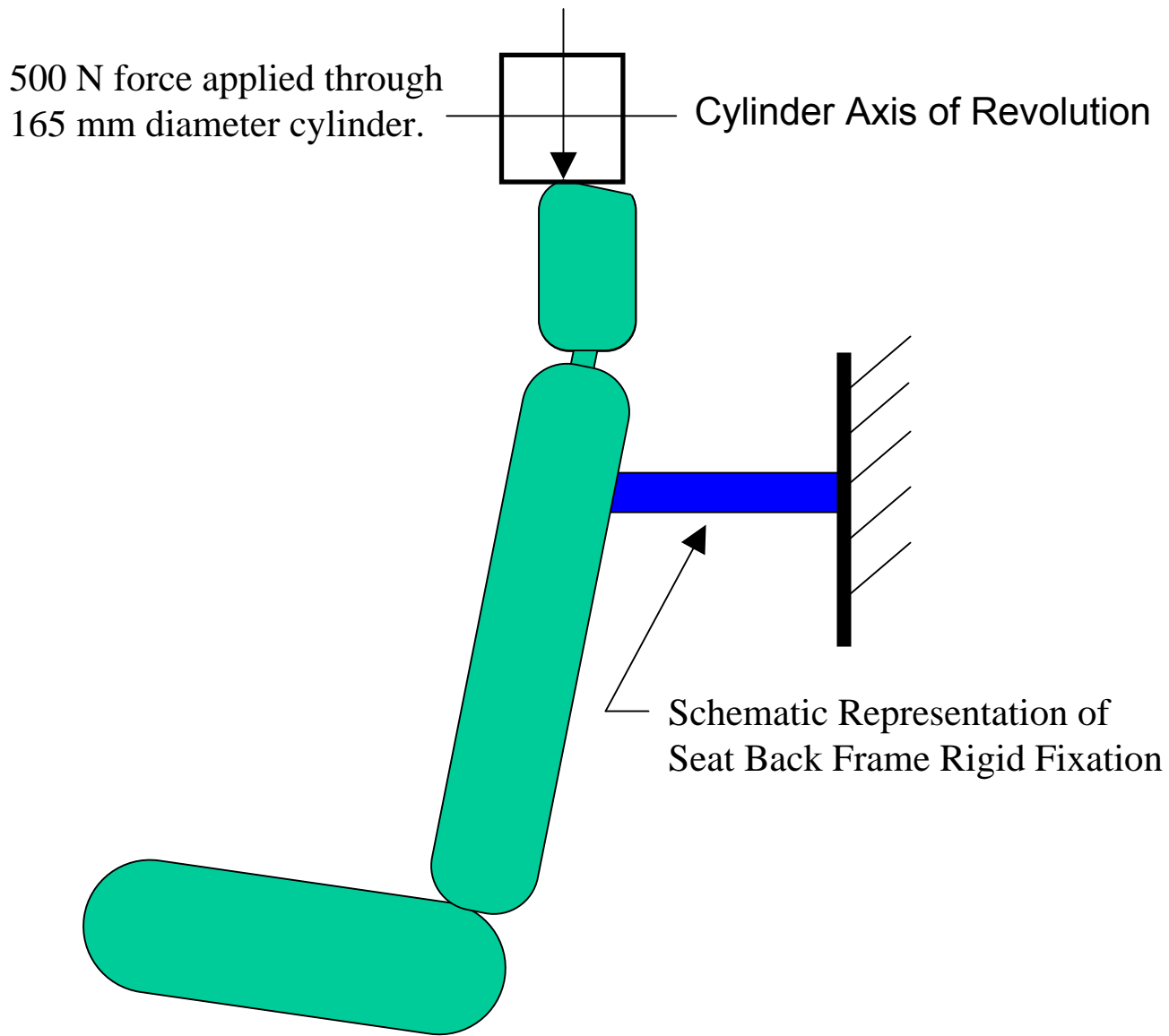


# *Backset Retention Procedure in Final Rule*

- **Displaced torso reference achieved by 373 Nm moment through back pan.**
- **Seat back rigidly fixed.**
- **37 Nm moment applied with head form, 65 mm below top of head restraint, to achieve reference position.**
- **373 Nm moment applied.**
  - For 800 mm head restraint,  $F \times 0.735 \text{ m} = 373 \text{ Nm}$
  - $F = 507 \text{ N}$
  - 102 mm limit on displacement beyond torso reference line.
- **Return to 37 Nm moment.**
  - 13 mm limit on change from reference position to assure locks held.



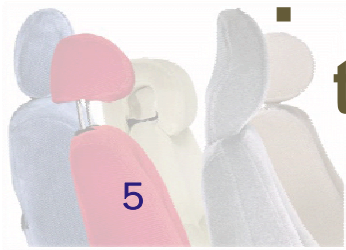
# Height Retention Force Application



Draft

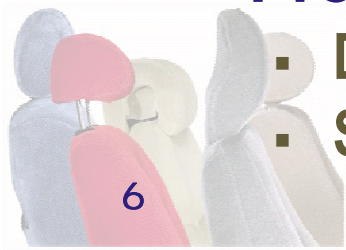
# *Height Retention Procedure in Final Rule*

- **50 N force applied to top of head restraint to achieve reference position.**
  - **25 mm limit on displacement for 50 N force.**
    - Required because some designs with frictional positioning will displace under this small force.
- **500 N force applied.**
  - **Load consistent with that applied during backset retention.**
- **Return to 50 N force.**
  - **13 mm limit on change from reference position to assure locks held.**



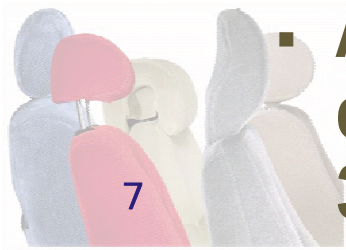
# *Final Rule vs. Original Proposal*

- **NPRM (Notice of Proposed Rulemaking)**  
**Commenters concerned about stringency of test.**
  - NPRM tested unfixed seat back.
- **Performed limited testing on 5 seats. 1 seat had no locks. No paired data.**
  - Fixed and unfixed seat backs
  - 50 N and 100 N initial reference load.
- **Results.**
  - 2 of 4 seats passed height retention @ 13 mm.
  - 3 of 4 passed backset retention @13 mm.
  - Only unfixed seats exceeded limit.
- **Procedure altered to provide relief.**
  - Displacement limit increased from 10 to 13 mm.
  - Seat back rigidly fixed.



# *Appropriateness of Force Level*

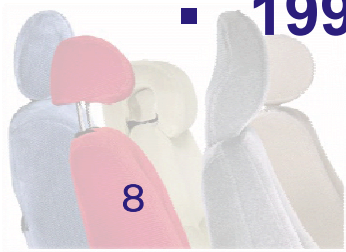
- **For both backset and height retention test the maximum applied load is  $\approx 500$  N.**
- **The rearward force applied in Backset retention test has been the same since 1968.**
- **Justification for height retention force in Final Rule.**
  - **It was reasonable to apply a similar level of force to height retention as was applied to backset retention.**
  - **Average upper neck shear forces in 50<sup>th</sup>ile male dummy in FMVSS No. 301 rear impacts was  $\approx 350$  N.**



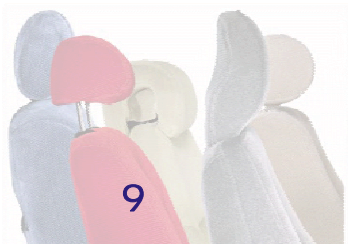
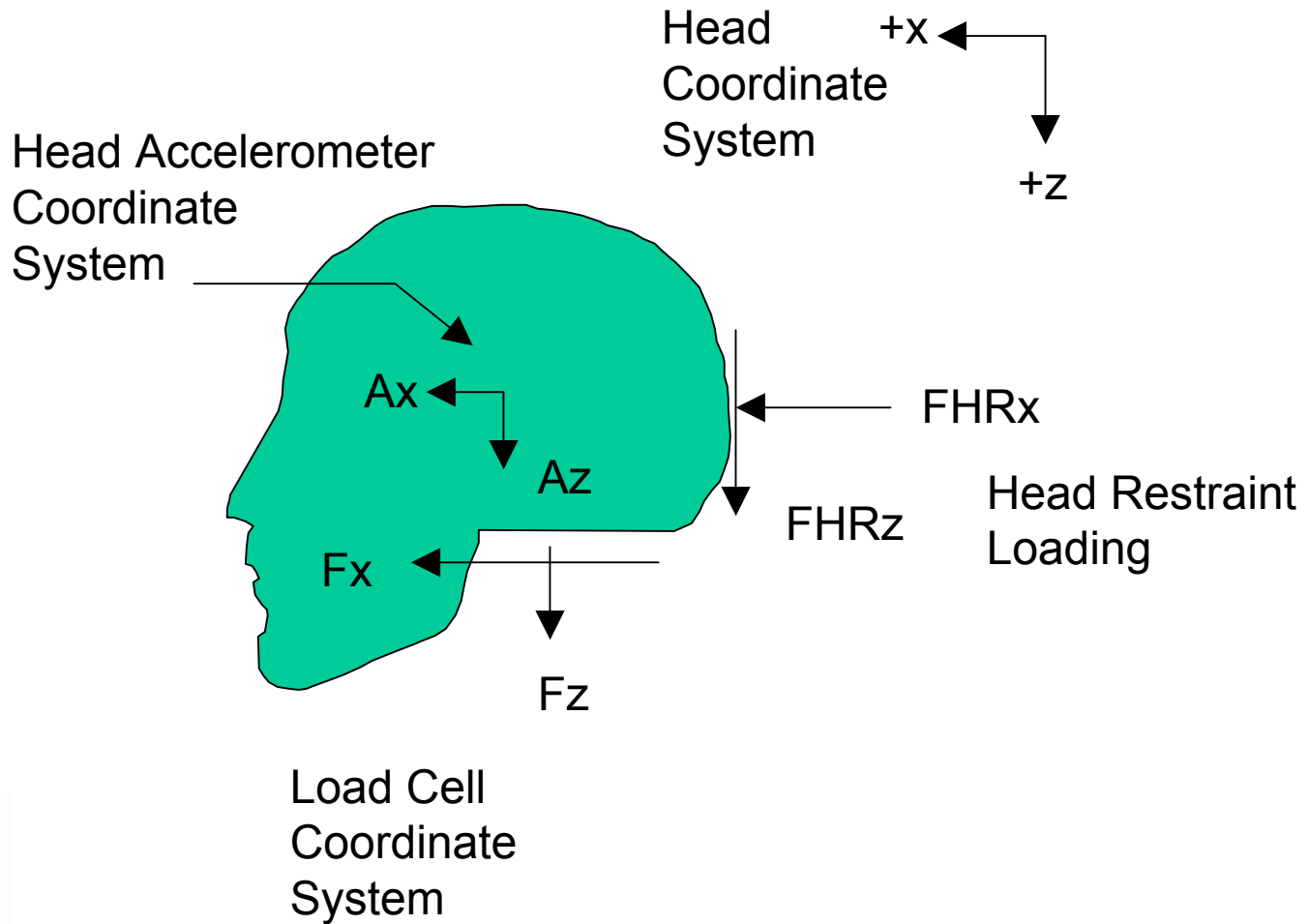


# *More Thorough Examination of Head Restraint Loading*

- **Looked at all previous rear impact testing where seat back rotation was known.**
- **Crash tests**
  - **FMVSS No. 301 Rear Impacts, Avg.  $\Delta V = 26$  km/h**
- **Sled tests**
  - **Simulating FMVSS No. 301,  $\Delta V \approx 30$  km/h.**
  - **FMVSS No. 202 Sled Tests,  $\Delta V \approx 17.3$  km/h.**
- **Hybrid III Dummies**
  - **5<sup>th</sup> %ile Female, 50<sup>th</sup> %ile Male, 95<sup>th</sup> %ile Male**
- **1998 – 2004 Seats**



# Detailed Analysis of Head Restraint Loading



# *Detailed Analysis of Head Restraint Loading*

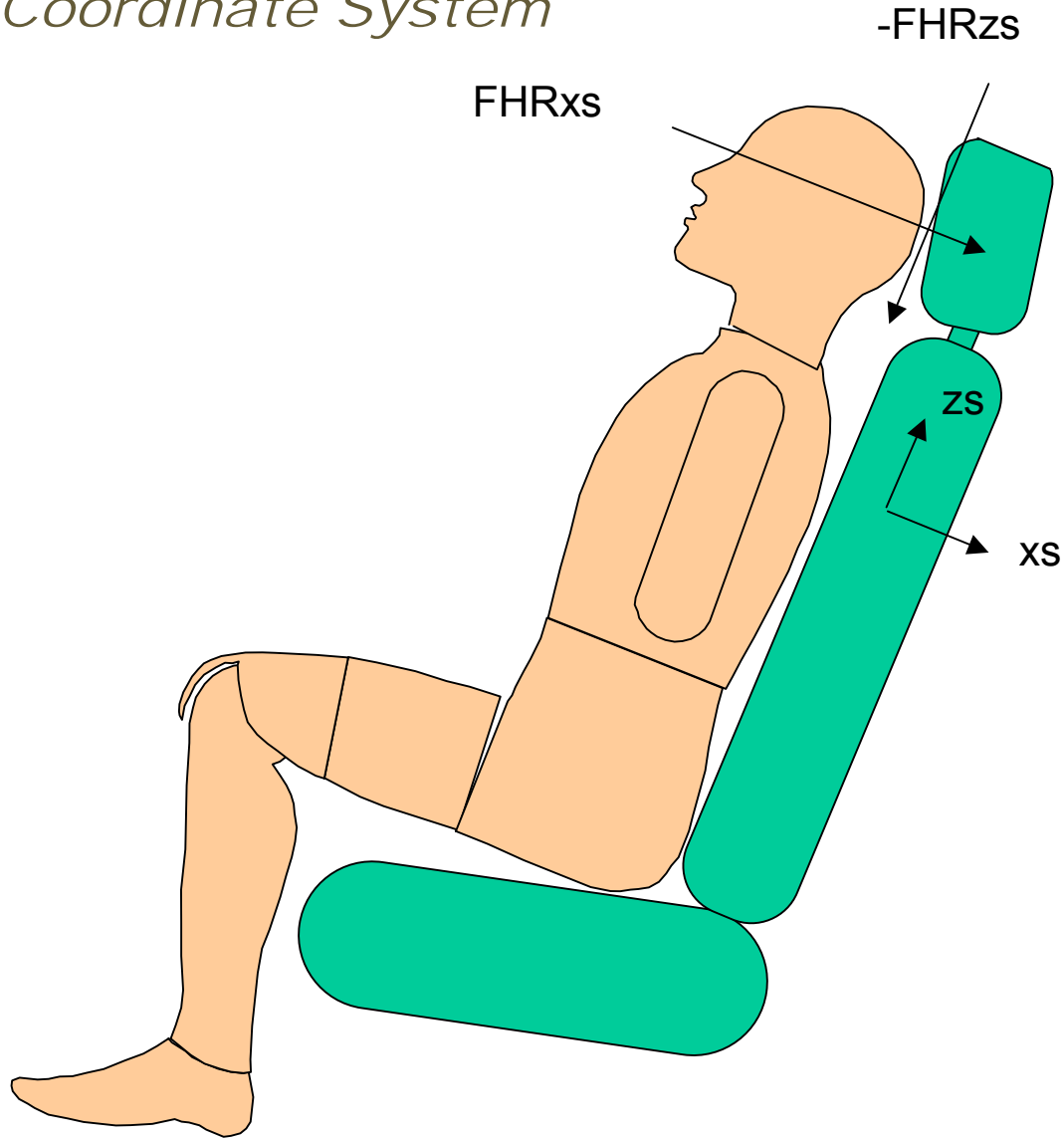
- **Equations in head coordinate system**
- **$FHR_x + F_x = mA_x$**
- **$FHR_z + F_z = mA_z$** 
  - $m \rightarrow$  head mass
  - $A \rightarrow$  CG acceleration
  - $FHR \rightarrow$  Force on the head applied by the head restraint.
  - $F_x \rightarrow$  Shear force at the top of the neck
  - $F_z \rightarrow$  Tensile force at the top of the neck.
- **$FHR_x = mA_x - F_x$**
- **$FHR_z = mA_z - F_z$**

# *Detailed Analysis of Head Restraint Loading*

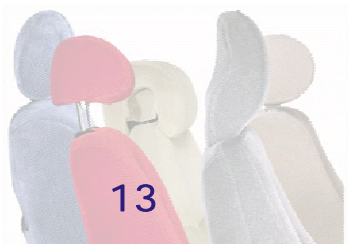
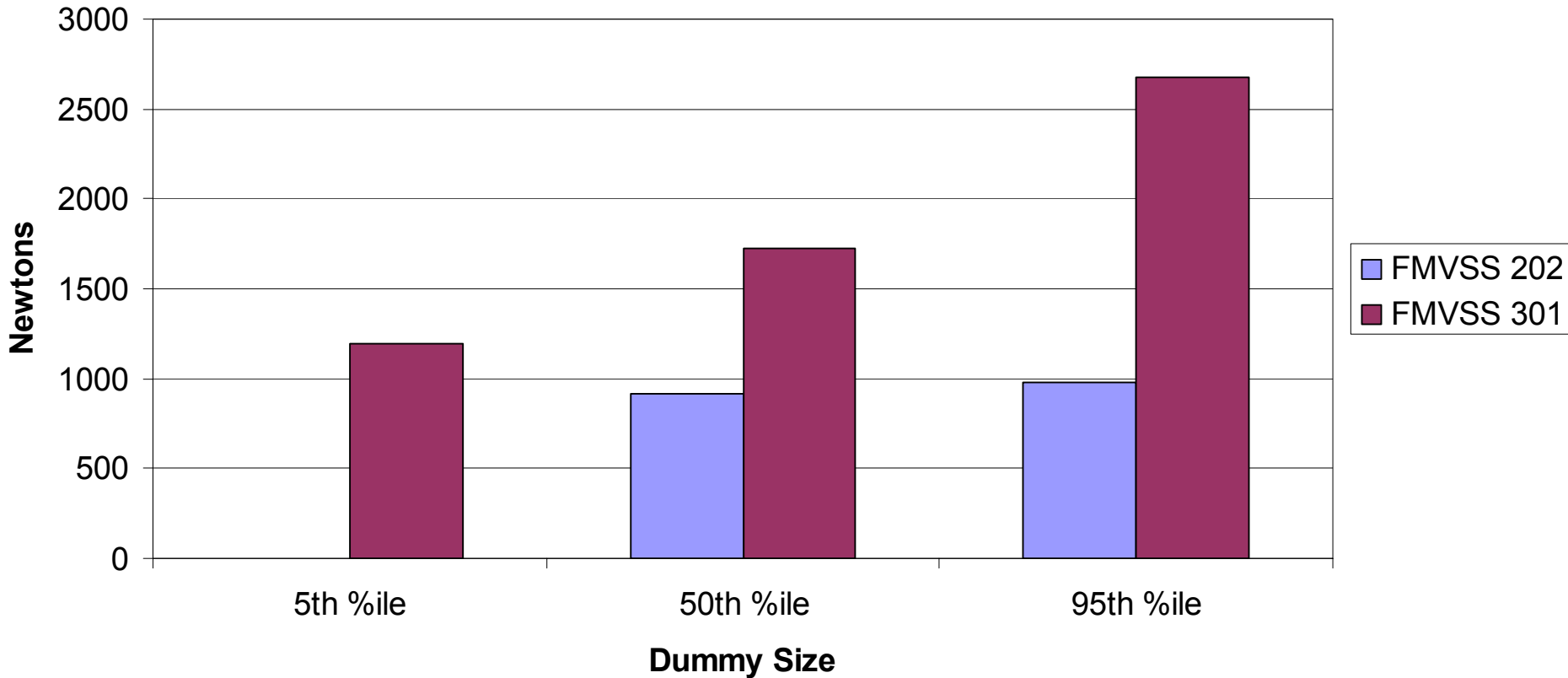
- $\varphi \rightarrow$  the angle of the head and seat back in the global coordinate system.
- $\theta = \varphi_s - \varphi_h$
- The transformation in the head coordinate system to the seat back coordinate systems.
- $FHR_{xs} = FHR_x \cos\theta - FHR_z \sin\theta$
- $FHR_{zs} = FHR_x \sin\theta + FHR_z \cos\theta$



# Head Restraint Loading in Seat Coordinate System

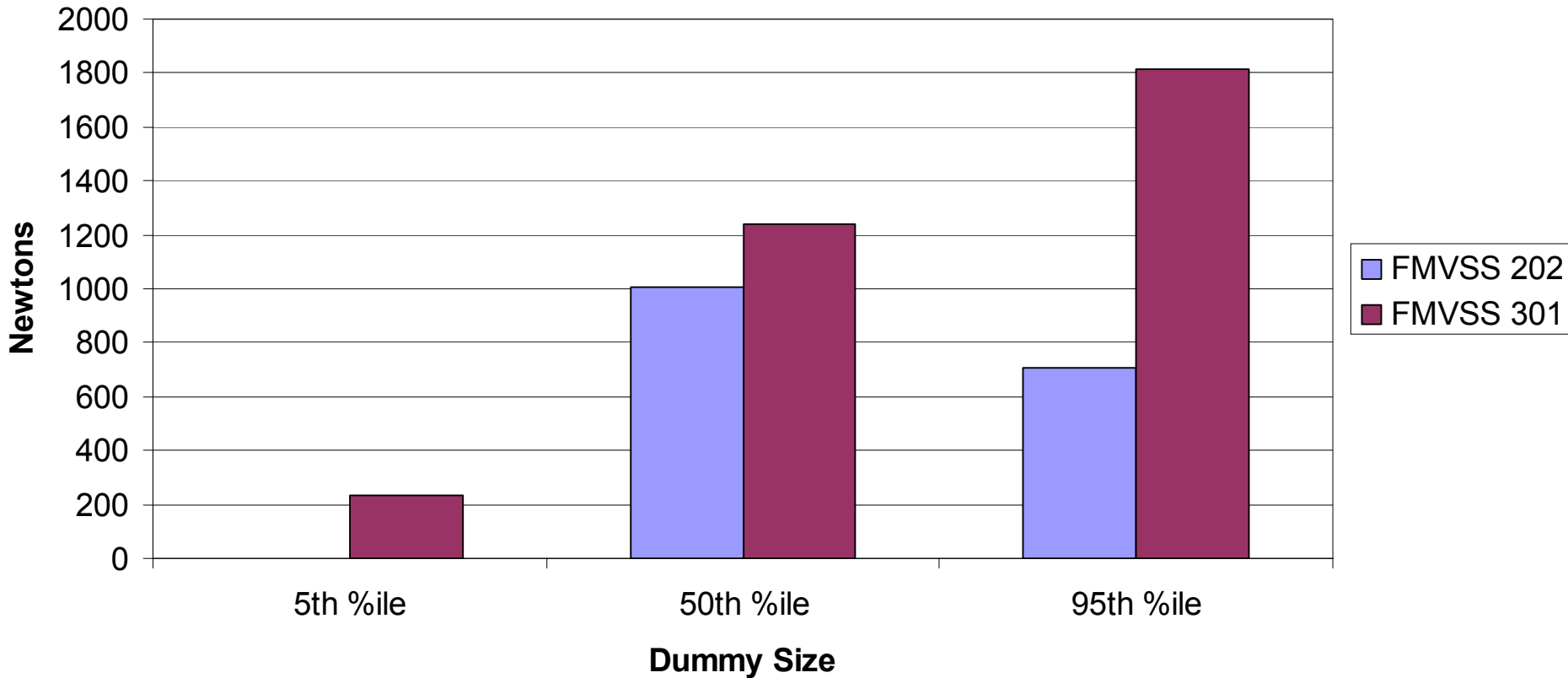


## Maximum Rearward Force on Head Restraint

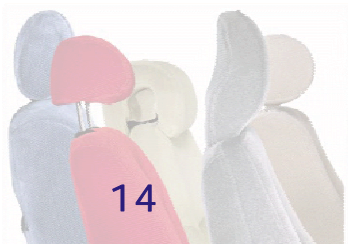


FMVSS No. 301  $\Delta V \approx 22 - 30$  km/h  
 FMVSS No. 202  $\Delta V \approx 17$  km/h

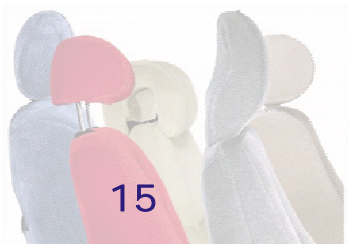
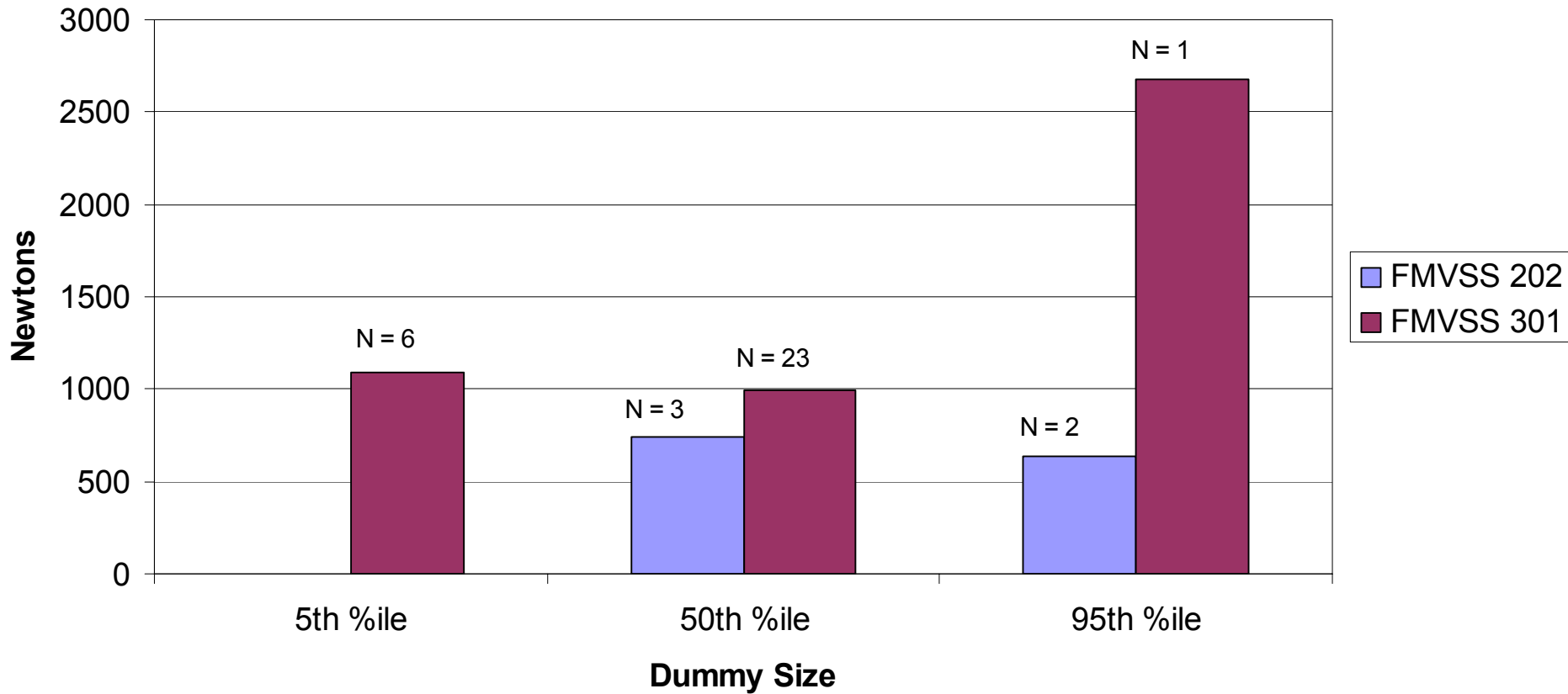
## Maximum Downward Force on Head Restraint



FMVSS No. 301  $\Delta V \approx 22 - 30$  km/h  
 FMVSS No. 202  $\Delta V \approx 17$  km/h



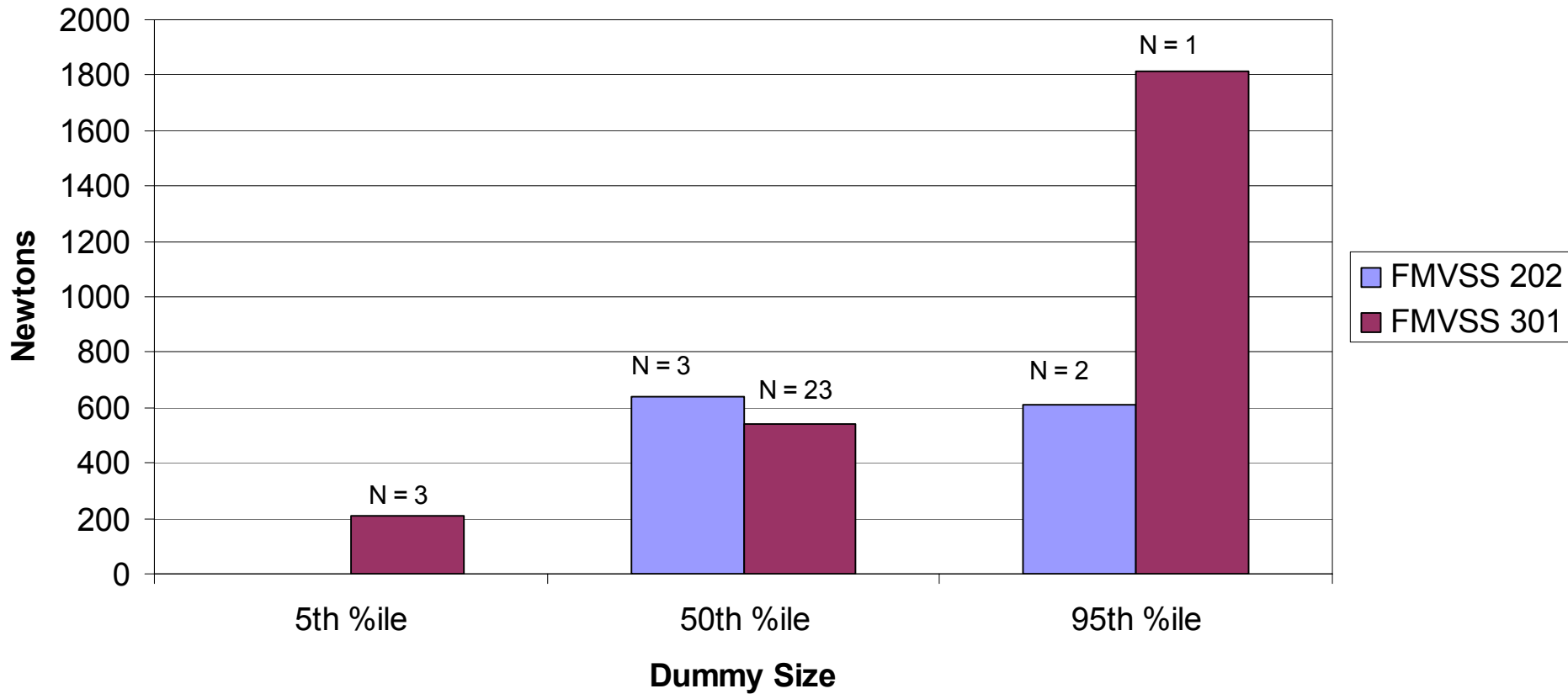
### Average Maximum Rearward Force on Head Restraint



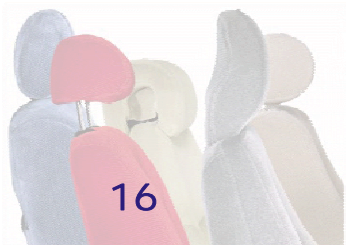
FMVSS No. 301  $\Delta V \approx 22 - 30$  km/h  
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## Average Maximum Downward Force on Head Restraint



FMVSS No. 301  $\Delta V \approx 22 - 30$  km/h  
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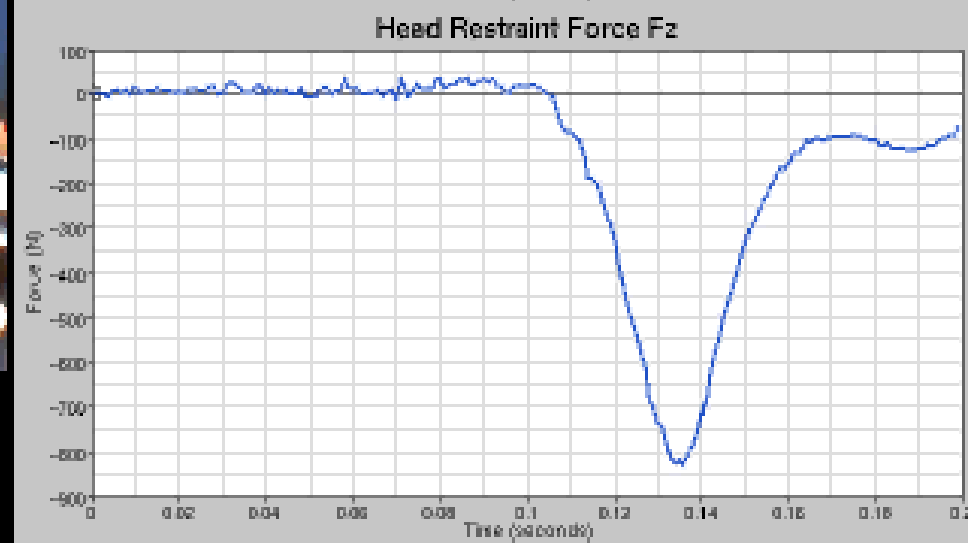
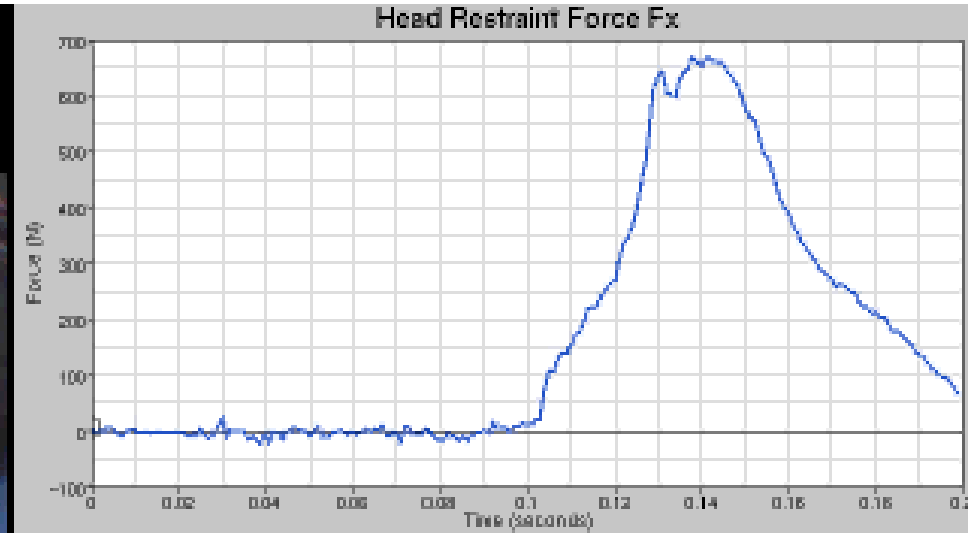


# *Test Video*

- **1999 Cadillac Deville**
- **50<sup>th</sup> %ile Male Dummy**
- **800 mm height**
- **50 mm backset**
- **FMVSS No. 301 sled test ( $\approx 30$  Km/h  $\Delta V$ )**
- **Peak FHRxs = 672 N**
- **Peak FHRzs = -842 N**
- **Resultant load = 1054 N @ -51°**

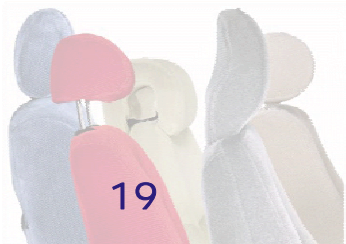


# 1999 Cadillac Deville – 50<sup>th</sup> Male, 301 Speed

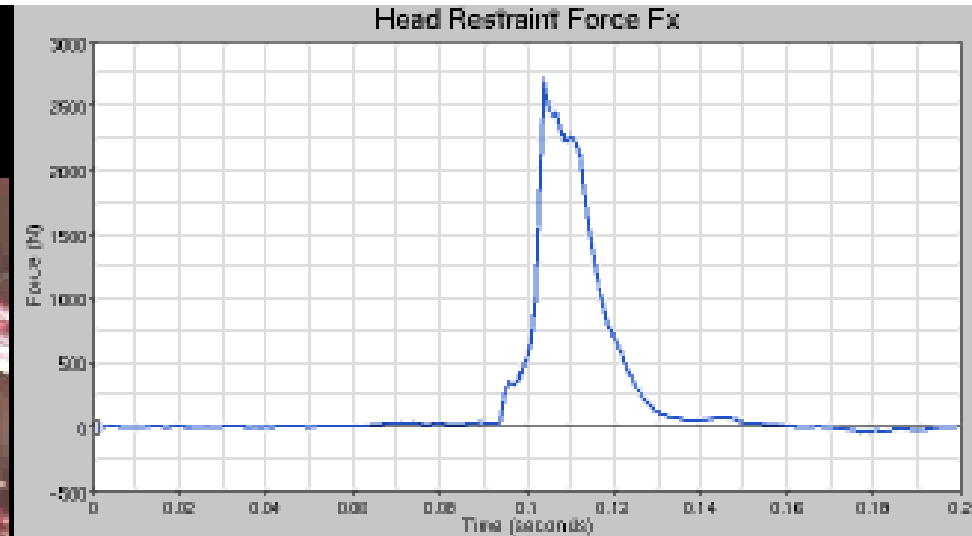


# *Test Video*

- **1999 Sebring**
- **95<sup>th</sup> %ile Male Dummy**
- **800 mm height**
- **50 mm backset**
- **FMVSS No. 301 sled test ( $\approx 30$  Km/h  $\Delta V$ )**
- **Peak FHRxs = 2676 N**
- **Peak FHRzs = -1816 N**
- **Resultant load = 2986 N @ -34°**

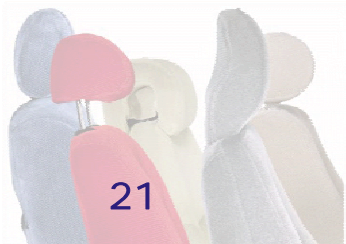


# 1999 Sebring - 95<sup>th</sup> Male, 301 Speed<sup>HR-2-8</sup>



# *Test Video*

- **1999 Toyota Camry**
- **50<sup>th</sup> %ile Male Dummy**
- **800 mm height**
- **50 mm backset**
- **FMVSS No. 202 sled test ( $\approx 17$  Km/h  $\Delta V$ )**
- **Peak FHRxs = 575 N**
- **Peak FHRzs = -1006 N**
- **Resultant load = 1153 N @ -60°**



# 1999 Camry - 50<sup>th</sup> Male, 202 Speed <sup>HR-2-8</sup>



# *Test Video*

- **2000 Saab 9-3**
- **95<sup>th</sup> %ile Male Dummy**
- **800 mm height**
- **50 mm backset**
- **FMVSS No. 202 sled test ( $\approx 17$  Km/h  $\Delta V$ )**
- **Peak FHRxs = 976 N**
- **Peak FHRzs = -704 N**
- **Resultant load = 1184 N @ -35°**





2000 Saab 9-3, 95<sup>th</sup> Male, 202 speed<sup>HR-2-8</sup>

