National Highway Traffic Safety Administration
www.nhtsa.gov
2009 SAE Government Industry Meeting

Motorcoach Roof Crush/Rollover Testing

February 2009

Existing Test Protocols Examined

- FMVSS No. 220 – School Bus Rollover Protection
- ECE r.66 – Uniform Technical Prescriptions Concerning The Approval Of Large Passenger Vehicles With Regard To The Strength Of Their Superstructure
- Determine the feasibility of their application to motorcoaches sold in the United States

FMVSS No. 220

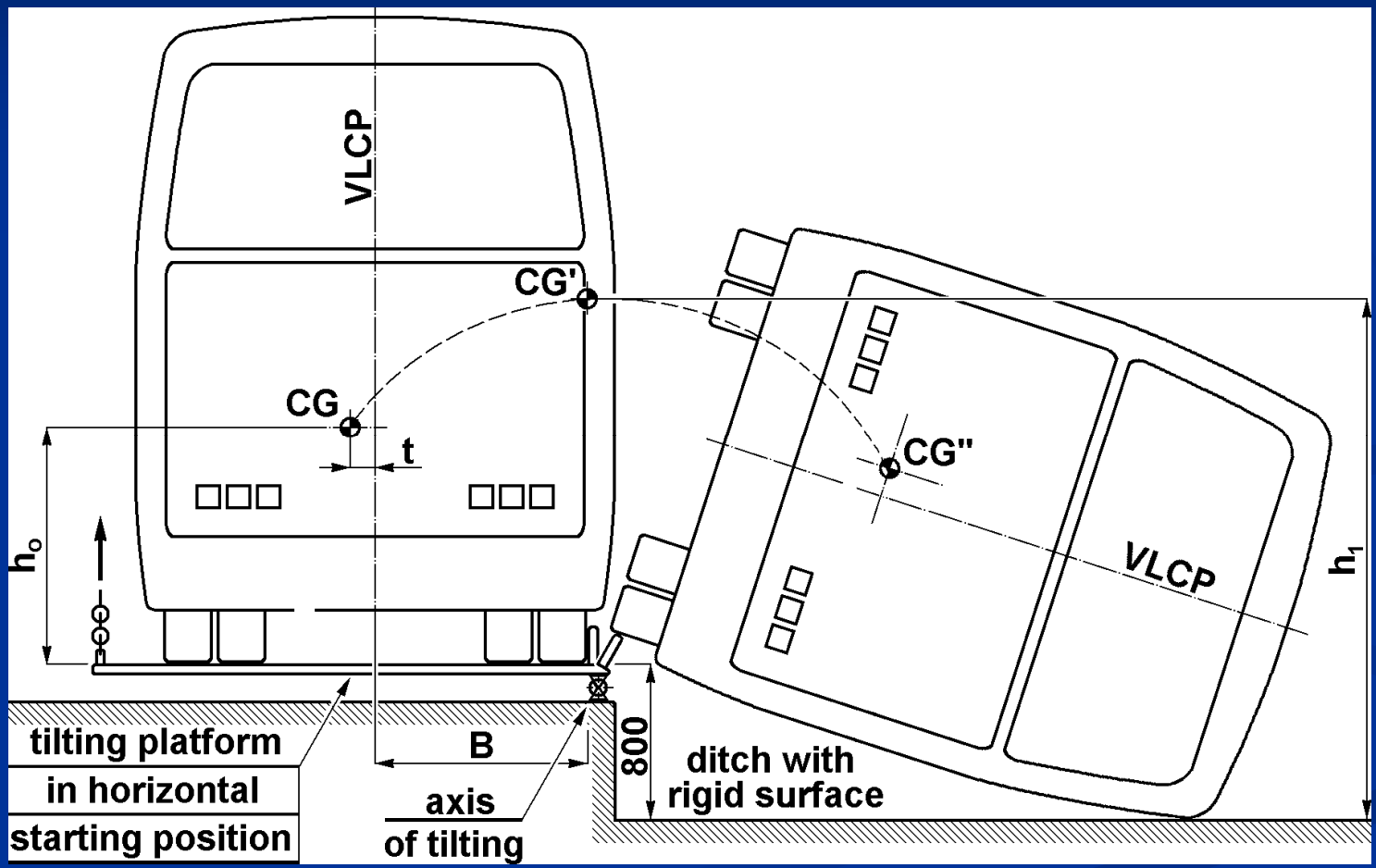
- Uniformly distributed load equal to 1.5 times the unloaded vehicle weight (UVW)
- 36 inch wide plate, one foot shorter than the bus length, placed along the longitudinal centerline of the roof
- Maximum crush 5 $^{1}/_{8}$ inches
- Emergency exits remain operable during and after the test

FMVSS No. 220 Test setup

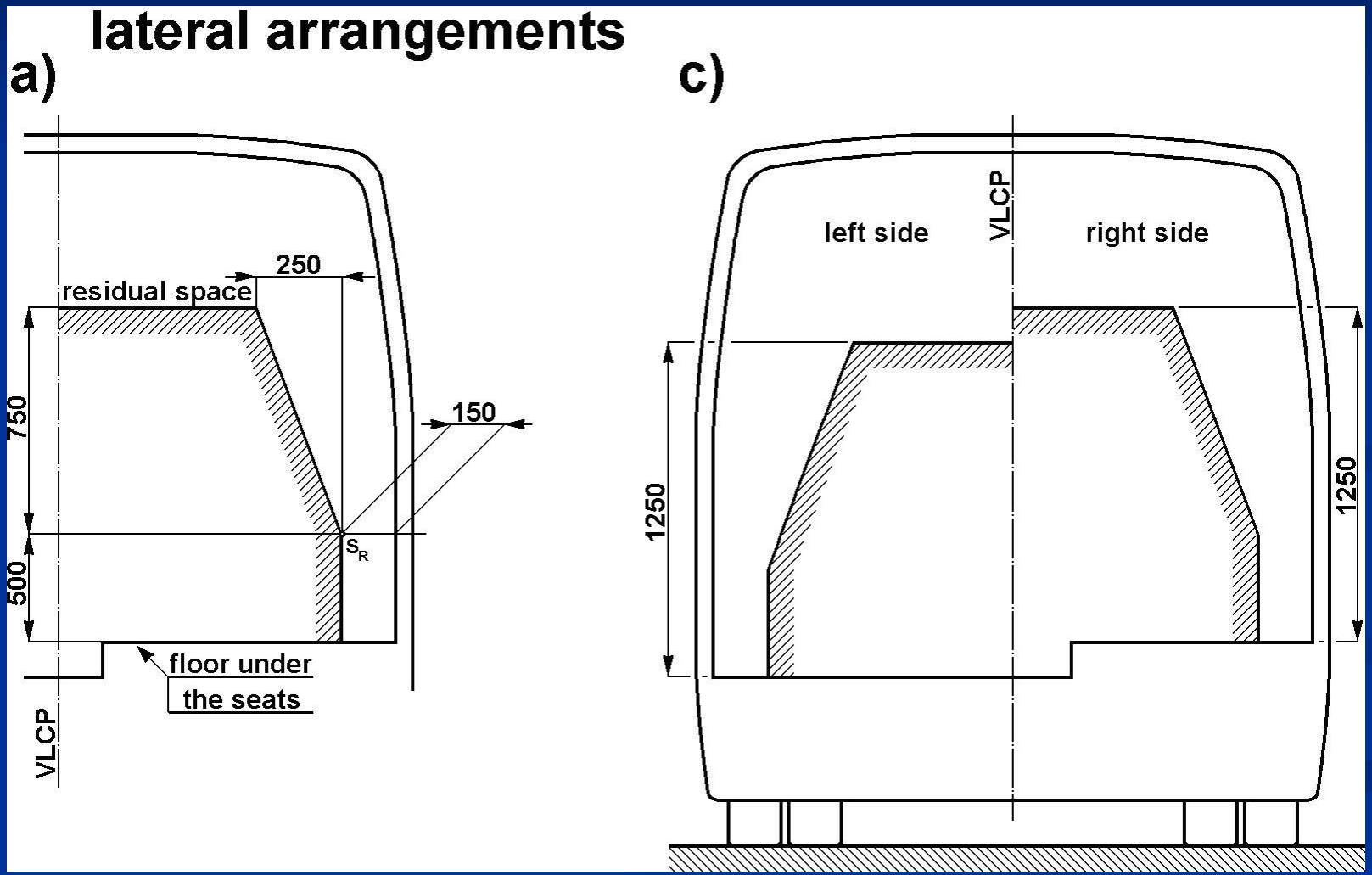
ECE r.66

- The vehicle with blocked suspension is placed on a raised platform with a nominal depth of 800 mm (31.50 in) and is tilted slowly to its unstable equilibrium position into a ditch, having a horizontal, dry and smooth concrete ground surface
- Cannot intrude upon predefined residual space

ECE r.66


VLCP
CG'
CG
t
CG"
VLCP
h_o
h_1
tilting platform
in horizontal
starting position
B
axis
of tilting
800
ditch with
rigid surface

ECE r.66 Residual space



Test Vehicles

Chosen to "bracket" existing buses in the fleet

- 1992 MCI MC-12 40' coach
- Weight: 27,853 lbs UVW
- Window spacing: ~58" CTC

- 1991 Prevost LeMirage 40' coach
- Weight: 29,270 lbs UVW
- Window spacing: ~40" CTC

Additional Test Equipment

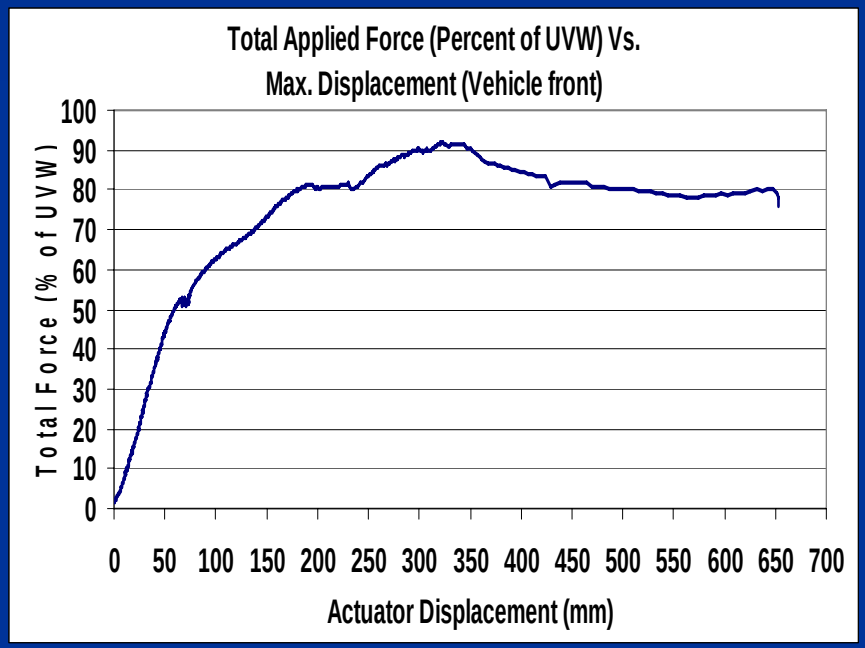
- ECE r.66 Residual space templates in the FMVSS No. 220 tests
- Accelerometers placed along the transition from the sidewall to the roof in the ECE r.66 test
- One restrained and one unrestrained test dummy placed in the ECE r.66 rollover test

Test Results – FMVSS No. 220

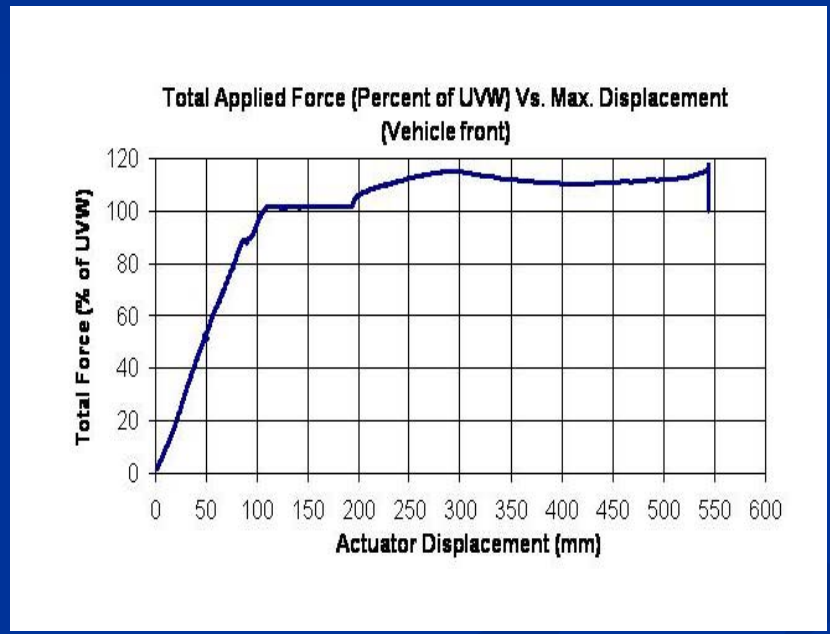
- MCI bus reached a maximum of 0.91 UVW
  - Reached FMVSS No. 220 limit ~ 0.7 UVW
- Prevost bus reached maximum of 1.31 UVW
  - Reached FMVSS No. 220 limit ~ 1.0 UVW
- Emergency exits remained operable during and after the test

Test Results – FMVSS No. 220

MCI – MC12



Prevost LeMirage



Test Results – ECE r.66

MCI

Test Results – ECE r.66

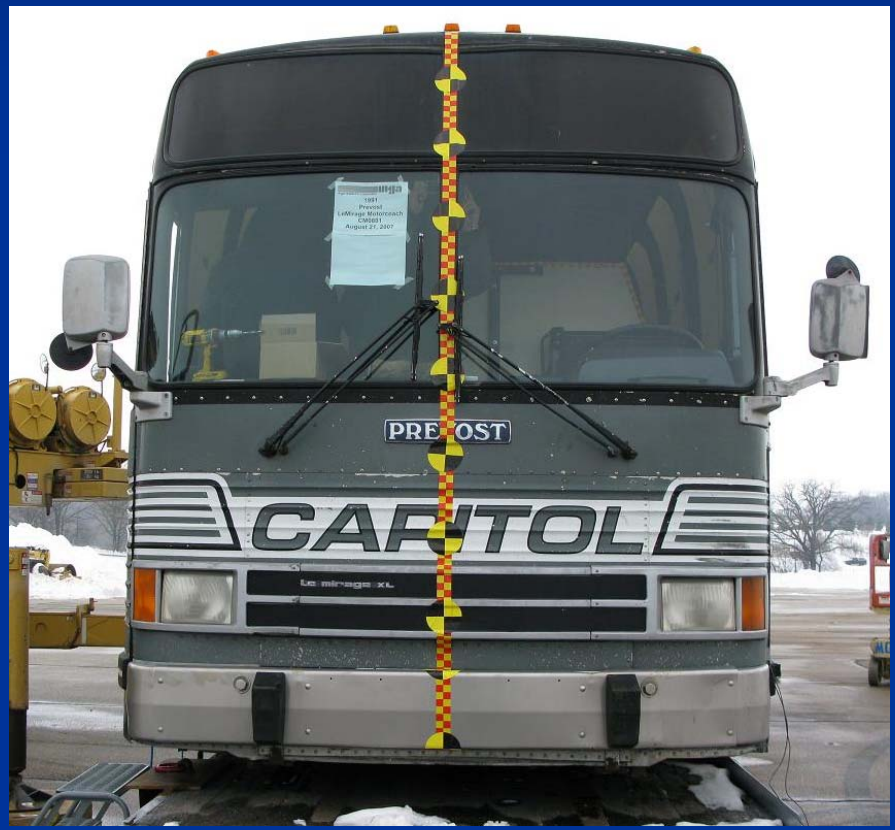
Prevost

Test Results – ECE r.66

MCI

Test Results – ECE r.66

Prevost



Test Results – ECE r.66

- Both buses the front residual space template struck the side window in the front

Test Results – ECE r.66

- The front of these two buses is weaker than the back - Contact between the front residual space template and side window
- The roof emergency exits opened when the roof of the bus impacted the ground - provides a potential ejection portal
- MCI bus, the unrestrained ATD, one IAV (Nij (compression-extension) 1.10) that was slightly over the acceptable limit.
- Prevost bus, the ATD fell across the bus head first on to the side window on the ground, resulted in multiple IAVs that were well above the acceptable limits
- Average accelerations from the roof accelerometers when the buses impacted the ground ranged from 7.59 to 8.2 g's

Conclusions

- Either test protocol is practicable
- The Prevost bus withstood more load because of its construction
- Qualitatively, the FMVSS No. 220 test protocol may be more stringent
- The ECE r.66 complete vehicle test is better protocol for determining if emergency exits remain closed during rollover
- ECE r.66 test protocol is more representative to real world rollovers and is easier to adapt in the test lab

Additional Information

- Available at: www.regulations.gov
- Search under: “motorcoach”, or;
- Docket No.: NHTSA-2007-28793