

FMVSS No. 226 – Ejection Mitigation

Final Rule

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U.S. Department
of Transportation



Overview

➤ **Goal of the standard**

- ❑ **Increase occupant containment in rollover and side crashes**
 - Belted and unbelted occupants
 - Three rows of seating

➤ **Likely resulting vehicle changes**

- ❑ **Larger air bag curtains with longer inflation**
- ❑ **Improved sensors**

Occupant Injury and Fatality Percentages by Ejection Route in All Crash Types (Annualized 1997 - 2008 NASS and FARS)

Ejection Route	MAIS 3-5	Fatal
Windshield	12.5%	10.5%
First Row Windows	44.5%	54.2%
Second-Row Windows	5.7%	7.7%
Third-Row Windows	0.8%	0.3%
Fourth-Row Windows	0.0%	0.4%
Fifth-Row Window	0.0%	0.1%
Cargo Area Rear of Row 2	0.2%	0.5%
Backlight	12.2%	4.8%
Roof Panel or Glazing	3.3%	3.1%
Roof Other	0.9%	0.8%
Multiple Windows	0.2%	0.0%
Not Glazing	19.7%	17.6%
Subtotals		
Rows 1-3	51.0%	62.2%
4 th , 5 th Row and Cargo	0.2%	1.0%
Total	100.0%	100.0%

Field Breakage Pattern



MY 2000 Audi A8, 4 ¼-turn rollover



MY 2003 Lincoln Aviator, 8 ¼-turn rollover

Regulatory Approach

➤ **Impact test of side windows/curtains at multiple locations**

- ❑ Impact locations selected to assure full opening coverage
- ❑ Impact velocities and timing bound ejection problem
- ❑ Assures robust occupant containment



➤ **No sensor test requirement**

- ❑ Complexities in test procedure development
- ❑ No indication of need based upon field data and industry reports
- ❑ FRIA assumes sensor benefits and accounts for their costs

Final Rule Test Specifics

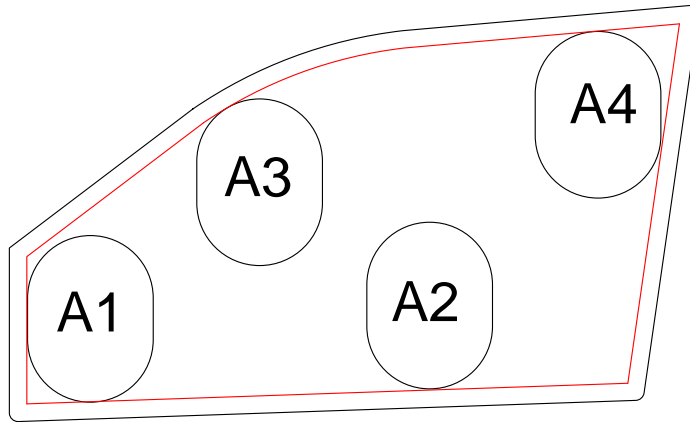
➤ **Test device**

- ❑ Linear impactor with headform end
- ❑ Total impactor mass = 40 lb (18 kg).

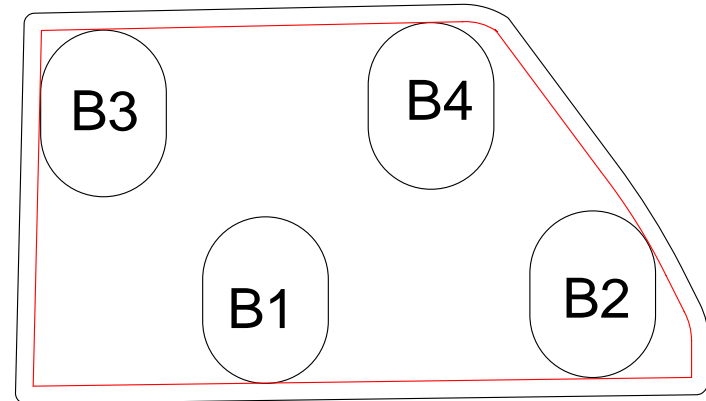
➤ **Critical parameters affecting requirement stringency**

- ❑ Performance criterion: ≤ 100 mm displacement
- ❑ Target locations: 4 per window opening
- ❑ Impact velocity/timing: 16 & 20 km/h
 - High speed @ 1.5 sec → fast roll rate, early ejections
 - Low speed @ 6 sec → severe multiple rolls, late ejections

Final Rule Target Location Selection and Window Condition



Front Window



Rear Window

- **Goal of target pattern is full coverage**
 - ❑ Rollover is a random event
 - ❑ Any opening of sufficient size provides exit route
- **Window (Glazing) preparation**
 - ❑ Advanced glazing ~ up and pre-broken for some window (see next slide)
 - ❑ Tempered ~ down/removed

Additional Information about Advanced Glazing

- **Final rule doesn't allow use of advanced glazing in movable windows in 16 km/h-6 sec. Test.**
 - ❑ Effectively requires the use of curtains in movable windows.
- **Concerns about the use of advanced glazing in movable windows.**
 - ❑ 30% of ejections are through windows that were open prior to crash.
 - ❑ Field data show loss of integrity.
- **Advanced glazing bonded to fixed windows potentially more effective.**
 - ❑ Could be used as standalone countermeasure at these locations.
 - ❑ But even windshields (bonded laminated glazing) can be breached (11% of fatal ejections).
- **Advanced glazing is expensive - \$20 for a side window.**

Final Rule Phase-in Schedule

- **Lead-time: 2 model years after final rule publication, with advanced credits for certified vehicles.**

- **Phase-in if final rule publication between 9/2/10 and 8/31/11.**
 - ❑ **1st year – 25% (begin 9/1/2013)**
 - ❑ **2nd year – 50% (begin 9/1/2014)**
 - ❑ **3rd year – 75% (begin 9/1/2015)**
 - ❑ **4th year – 100% with credits allowed (begin 9/1/2016)**

Final Rule Benefit Estimate

Lives Saved (w/ 100% ESC installation rate and FMVSS 214 Benefits accounted for)

Restraint Use/Level of Ejection	Fatal Target Population	Total Effectiveness[†]	Lives Saved
Belted/partial	117	37.6%	44
Belted/complete	8	0%	0
Unbelted/partial	298	26.5%	79
Unbelted/complete	951	26.4%	251
Total	1,374		374

† Considers effectiveness of sensors, containment countermeasures, containment fatality reduction factor, and adjusted with MY 2011 voluntarily installed rollover bag system

Final Rule Incremental Costs

Costs	Ejection Mitigation System	Weighted MY 2011 Manufacturers' Plan	Incremental Costs	ELS	Cost per ELS
Per Vehicle	\$53	\$22	\$31	458†	\$1.4 M/L*
Total†	\$880 million	\$373 million	\$507 million		\$1.7 M/L**

† Assumes 16.5 million light vehicle sales

‡ Serious and fatal injuries (AIS 3+)

* Discounted at 3%

** Discounted at 7%

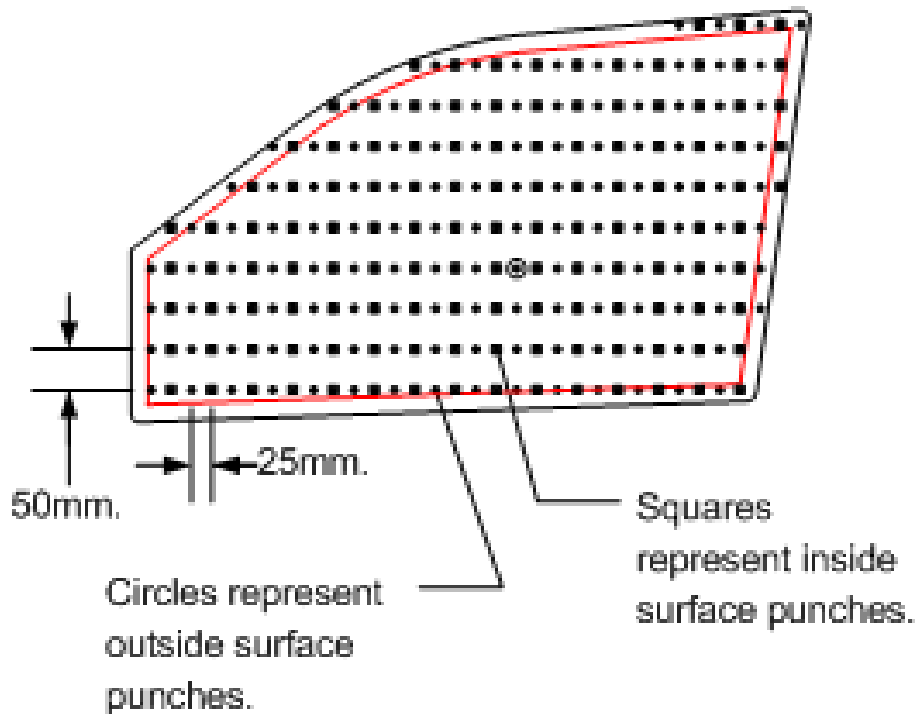
For More Information

- **Final Rule published on Jan 19, 2011 (76FR3211)**
- **www.regulations.gov**
 - **Docket: NHTSA-2011-0004**

Glazing Breakage Pattern

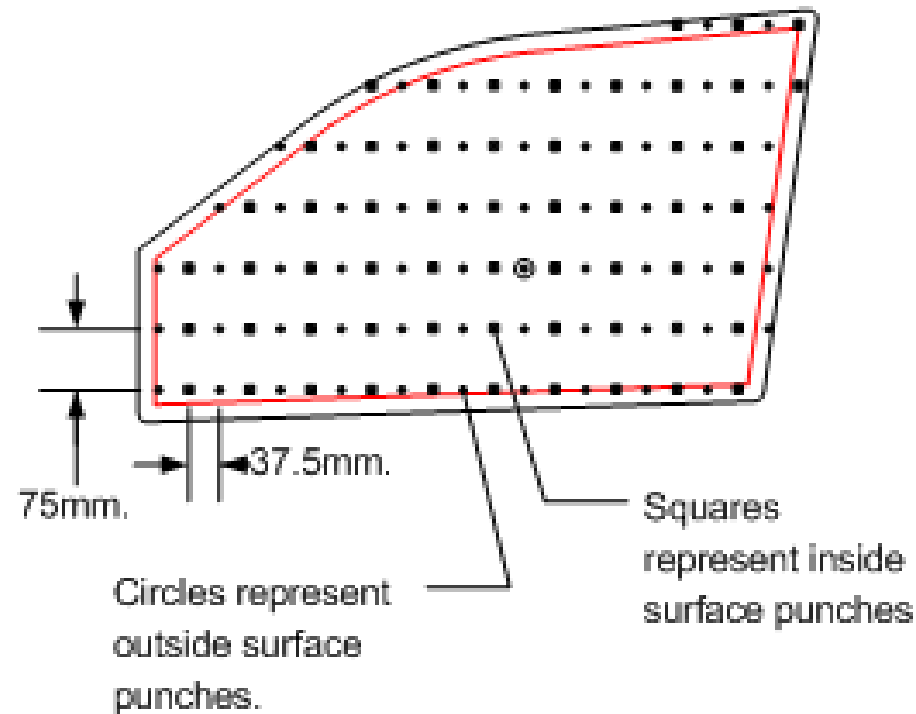
NPRM

50 mm Offset
Hole Punch Pattern



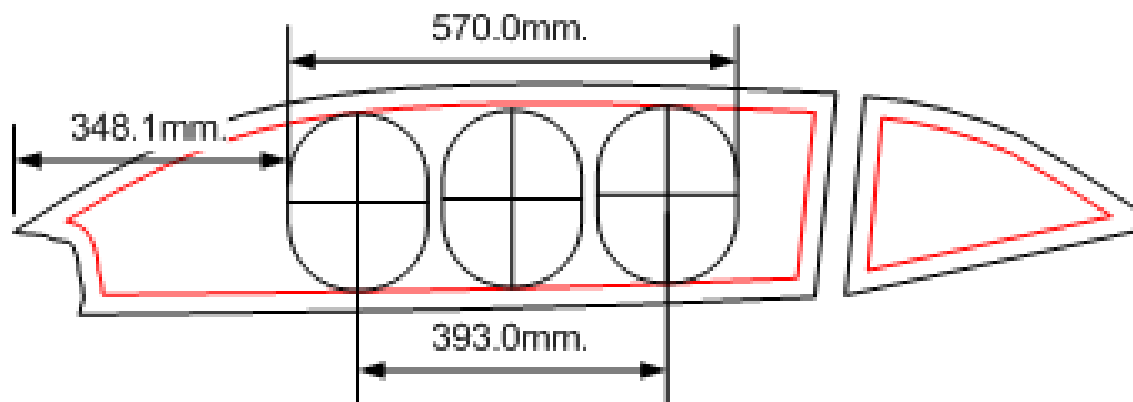
Final Rule

75 mm Offset
Hole Punch Pattern

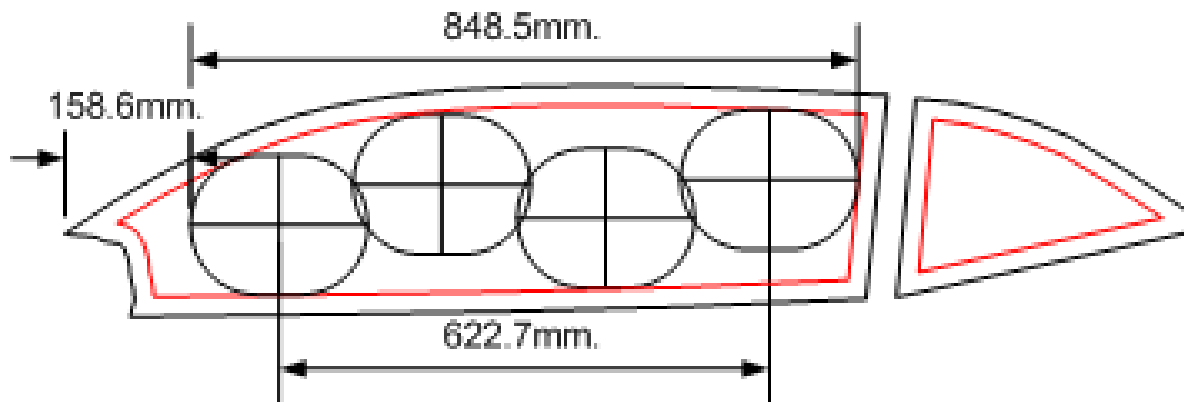


Rotate Headform to Increase Impact Locations

Final Vertical Targets after Reduction



Final Targets – Horizontal Orientation



Lead Time for Standards Relevant to Rollover/Ejection Mitigation

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	
FMVSS No. 214 Upgrade	Lead Time		Phase-in ($\leq 3,856$ kg) 20%, 40%, 60%, 80%				100% ≤ 3856	100% ≥ 3856	100% Multi-Stage			
FMVSS No. 216 Roof Crush Resistance			Lead Time		Phase-in ($\leq 2,722$ kg) 25%, 50%, 75%			100% ≤ 2722	100% LTV Bus	100% Multi-Stage		
FMVSS No. 226 Ejection Mitigation				Lead Time		Phase-in 25%, 50%, 75%, 100% w/credit				100% No Credit	100% Multi-Stage	
All years refer to September 1st effective date												