

Rear Underride Prevention

Creating Crash Compatibility:

Rear Guard Standards

Rear Guard Weight

Rear Guard Retrofit

Rear Guard NRPM 1970 Test Protocol

National Highway Safety Bureau

[49 CFR Part 571]

[Docket No. 1-11; Notice 5]

REAR UNDERRIDE PROTECTION;
TRUCKS AND TRAILERS

Notice of Proposed Rule Making

The proposed test requirement has been altered to take into account these objections and suggestions. It is now proposed that the face of the test block be a rectangle 4 inches high and 12 inches wide, and that its height for the test be uniformly set with its lower edge 16 inches from the ground. The vehicle would be required to meet the strength requirement at all points out to the outermost test points on the vehicle. All specific configurational requirements would be eliminated, and the vehicle could meet the strength requirement with whatever components are in position to contact the test block.

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Test programs conducted by both the NHTSB and concerned industries indicated that the 75,000-pound test force was unnecessarily large. The proposed requirement has been changed to 50,000 pounds in accordance with those findings.

S5. Test procedure.

S5.1 Place the vehicle, loaded to its curb weight, on level ground, restrained to prevent forward, upward or lateral motion. The means used to restrain the vehicle must not inhibit forward movement of the portions tested relative to the rest of the vehicle.

S5.2 Prepare a test block of rigid material with a plane surface in the form of a rectangle 4 inches high and 12 inches wide ("the surface").

S5.3 Position the test block at a point between the outermost positions specified in S4.1, so that—

(a) The surface is vertical and facing in the direction of forward travel of the vehicle;

(b) The lower 12-inch edge of the surface is horizontal and 16 inches from the ground; and

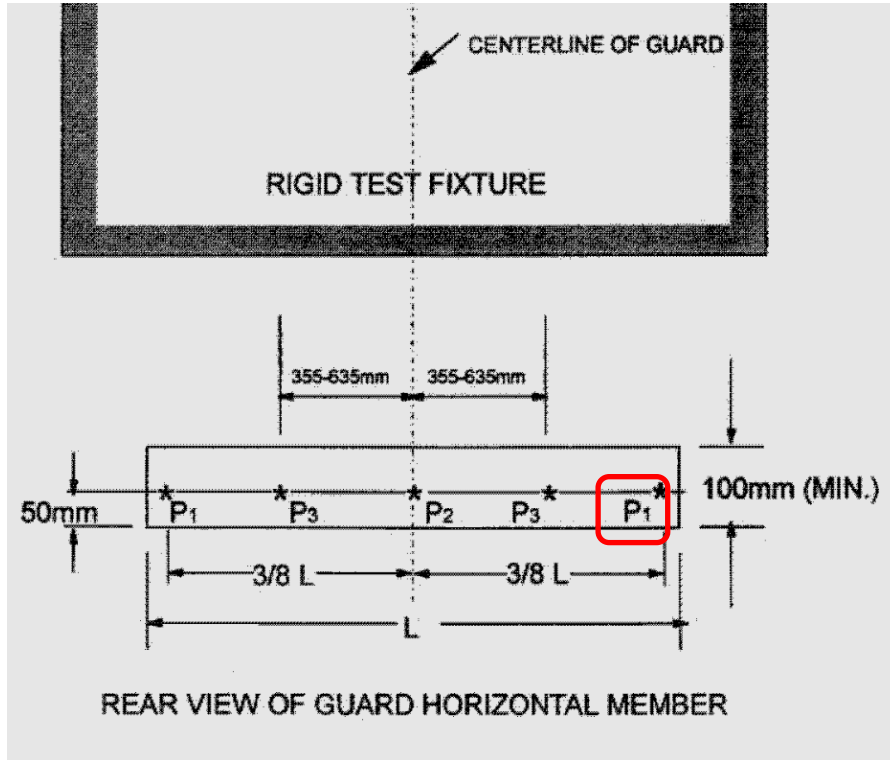
(c) The surface is in contact with the rear of the vehicle.

S5.4 Apply a forward static force of 50,000 pounds to the test block. Maintain the force for 15 seconds. Restrain the block from lateral, vertical, or rotational movement throughout the test.

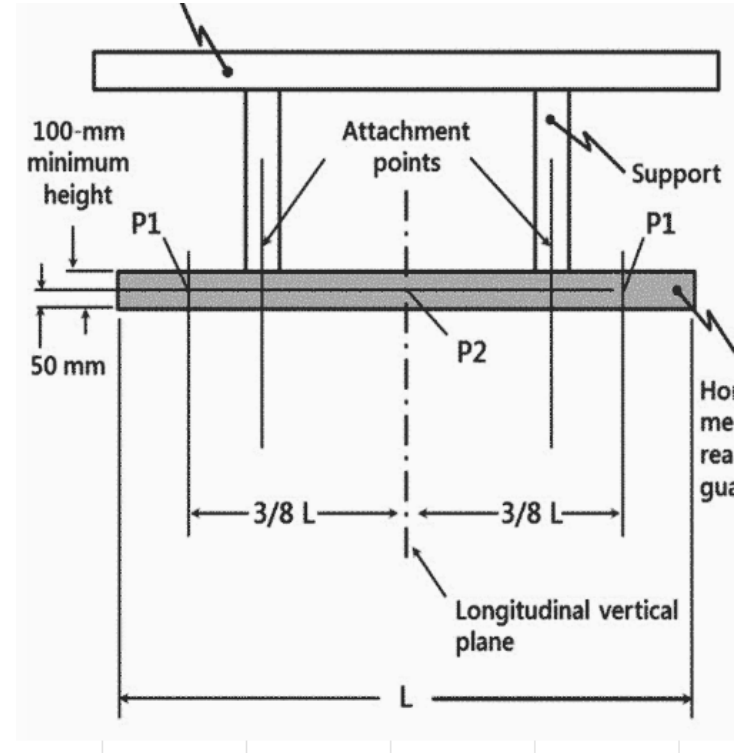
[F.R. Doc. 70-10663; Filed Aug. 13, 1970; 8:48 a.m.]

Rear Guard Performance Standards 1998, 2023

FMVSS 223 (1998)



FMVSS 223 (2022)



Rear Guard Standards 1970, 1993, 2022

ANPRM 1970	Location	Load (min)	Load (min)	Depth	Depth	Energy (min)	Energy (min)	~Force (min)	~Avg Force (min)
Rear Underride	(see diagram)	(kn)	(lb)	(mm)	(in)	(kJ)	(ftlb)	(N)	(lb)
	All Points*	220000	50000	381	15	42.4	31250	110000	25000
	To Outer Edge								
FMVSS 223	Location	Load (min)	Load (min)	Depth	Depth	Energy (min)	Energy (min)	Avg Force (min)	Avg Force (min)
	(see diagram)	(kn)	(lb)	(mm)	(in)	(kJ)	(ftlb)	(N)	(lb)
	P1	50.0	11363.6	125.0	4.9	NA	NA		
	P2	50.0	11363.6	125.0	4.9				
	Distributed	350.0	79545.5	125.0	4.9	20.0	14751.2	160000.0	36363.6
Old FMVSS 223	Location	Load (min)	Load (min)	Depth	Depth	Energy (min)	Energy (min)	Avg Force (min)	Avg Force (min)
	(see diagram)	(kn)	(lb)	(mm)	(in)	(kJ)	(ftlb)	(N)	(lb)
	P1	50.0	11363.6	125.0	4.9	NA	NA		
	P2	50.0	11363.6	125.0	4.9	NA	NA		
	P3	100.0	22727.3	125.0	4.9	5.7	4167.2	45200.0	10272.7
IIHS 2018	Location	Load (min)	Load (min)	Depth	Depth	Energy (min)	Energy (min)	Avg Force (min)	Avg Force (min)
Quasi Static	(see diagram)	(kn)	(lb)	(mm)	(in)	(kJ)	(ftlb)	(N)	(lb)
	Outside edge	100.0	22727.3	75.0	3.0	10.0	7375.6	80000.0	18181.8

How Strong is Strong Enough?

35 mph Crash Summary

Force = mass x acceleration

$$F_{avg} = ma_{avg} = m(\Delta v / \Delta t) = m(dv/dt)$$

Average crash pulse (time) = 0.150s (150) ms

Delta v = 35-0 mph (51.3 ft/sec)

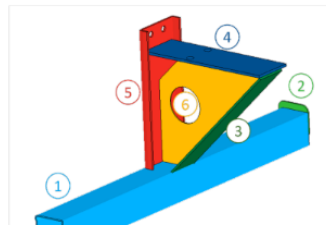
Mass = 3500 lb (108.7 slug) - midsized sedan

Force (avg, lb) = ma = m($\Delta v / \Delta t$) = 108.7 x (51.3/0.150) = 37,175

Force peak \approx 37,175/.707 = **52,581 lb** FMVSS 223 GUARD @ P1: **11,300 lb**

Rear Guard Weight

Elemance | Aim 2.2: Modify Guards to minimally comply with FMVSS 223 : Wabash

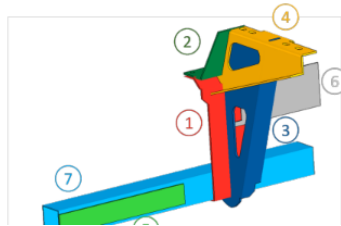


Wabash	Quasi-Static Response				Mass (kg)
	P1 Force (kN)	P2 Force (kN)	UDL Force (kN)	UDL Energy (kJ)	
Baseline	135.8	125.4	394.7	32.1	54.4
Minimally Compliant					
FMVSS Req.	≥50	≥50	≥350	≥20	N/A

Baseline Weight (lb)

120 lb

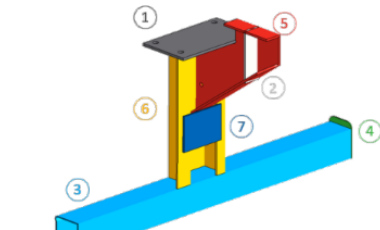
Elemance | Aim 2.2: Modify Guards to minimally comply with FMVSS 223 : Manac



Wabash	Quasi-Static Response				Mass (kg)
	P1 Force (kN)	P2 Force (kN)	UDL Force (kN)	UDL Energy (kJ)	
Baseline	172.5	83.3	356.2	36.8	84.8
Minimally Compliant	157.1	52.5	351.9	33.3	75.7
FMVSS Req.	≥50	≥50	≥350	≥20	N/A

187 lb / No PCI

Elemance | Aim 2.2: Modify Guards to minimally comply with FMVSS 223 : Great Dane



Wabash	Quasi-Static Response				Mass (kg)
	P1 Force (kN)	P2 Force (kN)	UDL Force (kN)	UDL Energy (kJ)	
Baseline	120.5	149.4	441.7	36.6	69.4
Minimally Compliant	67.2	77.0	350.4	29.4	52.5
FMVSS Req.	≥50	≥50	≥350	≥20	N/A

153 lb

✓ PCI Prevented
 ✗ PCI Not Prevented

Guard Model		PCI Dynamic Response			Quasi-Static Response				Mass (kg)
		FW	50%	30%	P1 Force (kN)	P2 Force (kN)	UDL Force (kN)	UDL Energy (kJ)	
Manac	Baseline	✓	✓	✓	172.5	83.3	356.2	36.8	84.8
	Minimally Compliant	✓	✓	✓	157.1	52.5	351.9	33.3	75.7
	Strengthened- Midsize								
Wabash	Baseline	✓	✓	✗	135.8	125.4	394.7	32.1	54.4
	Minimally Compliant	✓	✓	✗	79.6	68.5	350.4	25.6	38.9
	Strengthened- Midsize	✓	✓	✓	295.7	243.8	928.1	68.0	75.8
Great Dane	Baseline	✓	✓	✗	120.5	149.4	441.7	36.6	69.4
	Minimally Compliant	✓	✓	✗	67.2	77.0	350.4	29.4	52.5
	Strengthened- Midsize	✓	✓	✓	192.1	277.3	495.4	42.8	101.1
FMVSS No. 223 Requirement					≥50	≥50	≥350	≥20	N/A

35 mph 30% Overlap
 Added Weight (lb)

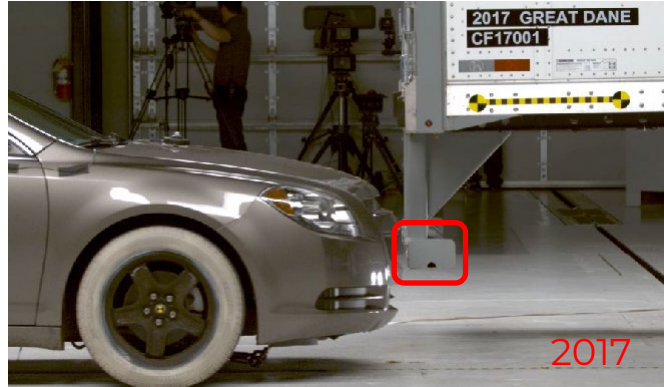
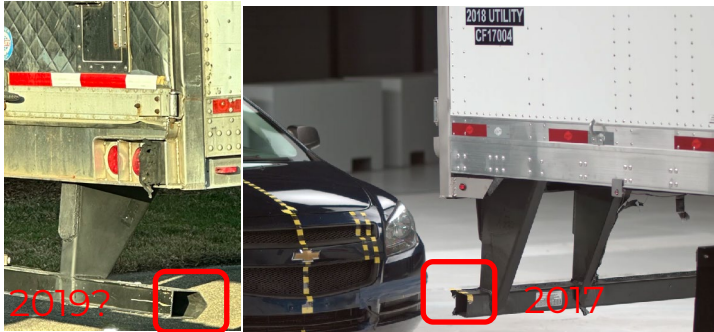
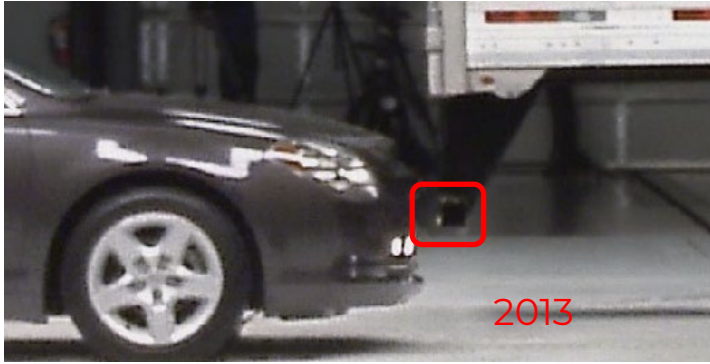
-20 lb / No PCI

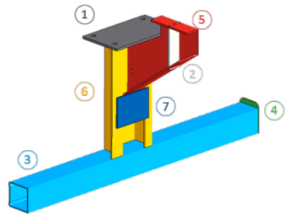
+47 lb / No PCI

+70 lb / No PCI

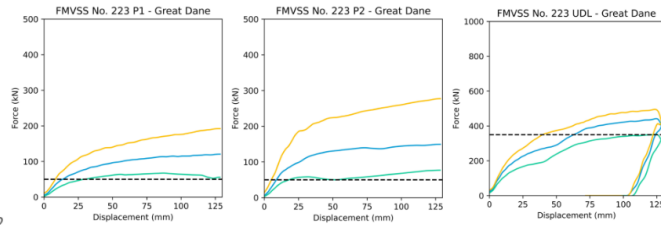
32 lb Additional / ~13,000 lb Empty Weight = **0.25%**

+32 lb Average





Wabash	Quasi-Static Response				Mass (kg)
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Baseline	120.5	149.4	441.7	36.6	69.4
Minimally Compliant	67.2	77.0	350.4	29.4	52.5
Strengthened	192.1	277.3	495.4	42.8	101.1
FMVSS Req.	≥50	≥50	≥350	≥20	N/A



Geometry = strength w/o weight (Great Dane 2017, UTM 2019?)

Retrofit (2007 GD / 2002 UTM)

Why did Elemance thicken horizontal to **0.28"** in lieu of geometry?

While safety is paramount, it is also important for fleets to avoid adding weight to their trailers. Lane notes that with traditional materials, such as conventional steels, the design Wabash chose would have added a significant amount of weight. But, he says, Wabash used specialty high-strength steel in their RIG-16 design that actually reduced the overall trailer weight by more than 100 lbs.

NOT REVIEWED FOR SECTION 508 COMPLIANCE

Pre 2017

Square 4" x 0.185" x 95" = 1520 in² / 10.56 ft² / ~ 80 lb

2017-Current (Retrofit to 2002 UTM 2007 GD)

Rectangular 4x8" x 95" = 2280 in² / 15.83 ft² / ~120 lb (Utility ~100 lb)

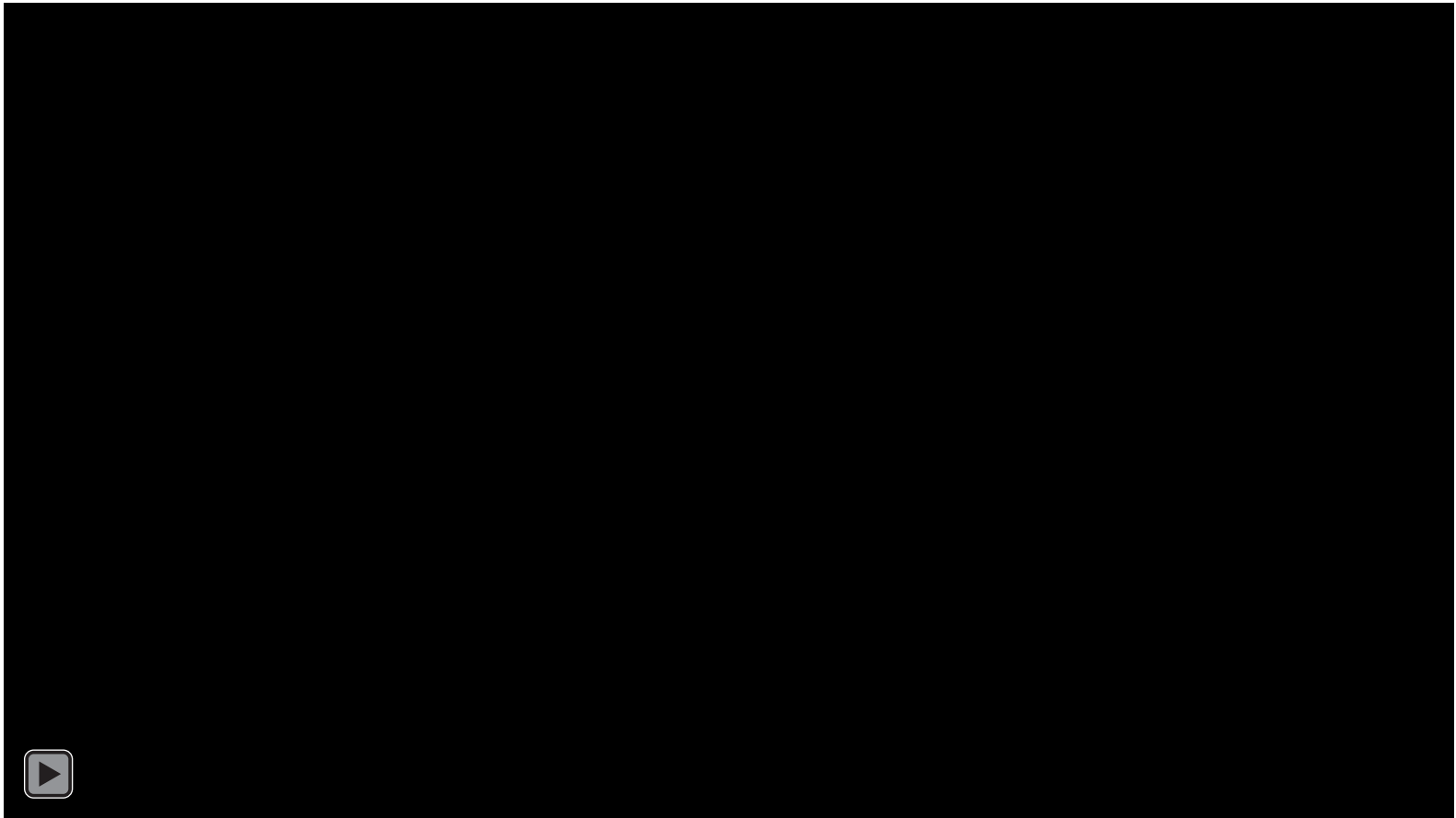
Added weight: **~40 lb**

Increased horizontal strength: **~4x**

RIG Retrofit 39 mph 30% Overlap Test (2012 Chevy Impala)

Bolt on aluminum RIG Retrofit: ~140 lb total

Weld on Steel RIG Retrofit: 60 lb total



*Collision **Safety** Consulting PLLC*