



U.S. Department
of Transportation
**Federal Highway
Administration**

Memorandum

Subject: INFORMATION: Acceptance of NCHRP Report 350
Test Level 2 (TL-2) Guardrail Terminal

From: Dwight A. Horne *Dwight A. Horne*
Director, Office of Highway Safety Infrastructure

Date: December 21, 1999

**Reply to
ATTN:** UMHS CC62

To: Mr. Dale E. Wilken
Director, Eastern Resource Center (HRC-EA)

In your December 3 letter, you requested formal acceptance of the Vermont Agency of Transportation's G1-d W-beam guardrail terminal at NCHRP Report 350 test level 2 (TL-2). You sent a videotape copy of the tests that were conducted on the G1-d design. A copy of the Texas Transportation Institute's May 8, 1998, test report entitled "Testing and Evaluation of the Vermont W-Beam Guardrail Terminal for Low Speed Areas" by Arnold, Menges, and Butler was previously sent to my staff for informational purposes.

The G1-d terminal consists of a 3.8 meter W-beam rail section shop-bent to a 4.9 meter radius. The first post is offset 1473 mm from the tangent line of the guardrail proper, post 2 is at the midpoint of the curved section, and post 3 is at the tangent line of the barrier length of need. A steel rod which connects to the w-beam rail at post 3 and to a concrete anchor block between posts 2 and 3 provides the tensile strength needed to redirect vehicles impacting at or downstream from post 3. These and other design details are shown in Attachment 1.

Three tests were considered adequate to certify the G1-d as a TL-2 design and the test summaries are shown in Attachment 2. Since the terminal is classified as gating, the angle tests at the nose were considered redundant, as was a head-on impact with the 2000-kg pickup truck. Based on staff review of these tests, we agree that the G1-d meets the evaluation criteria for a TL-2 terminal and it may be used on the National Highway System (NHS) at locations where anticipated impact speeds are not expected to exceed 70 km/h. The G1-d must be installed on level terrain and with the full 1500 mm offset as shown on Vermont's plan sheet. Since it is a gating design, a reasonable recovery area behind and beyond the terminal is also needed wherever practicable.

Because the occupant impact velocity and ridedown accelerations were very near the maximum values recommended in Report 350 in test 2-3-1, this terminal design has essentially no reserve capacity. To increase this capacity and to reduce the cost of the G1-d, the State may wish to replace the current anchorage system with the standard breakaway design that is used on the trailing end of the barrier not exposed to traffic. This modification would eliminate the concrete

anchor, steel rod/turnbuckle assembly, and the anchor rod connector. It would also eliminate the hard spot in the design that resulted in the high impact velocity and ridedown accelerations noted in test 2-34. No additional testing would be required should the Vermont Agency of Transportation elect to make this change. Please call Mr. Richard Powers at (202) 366-1320 if you have any questions regarding this recommended design modification.

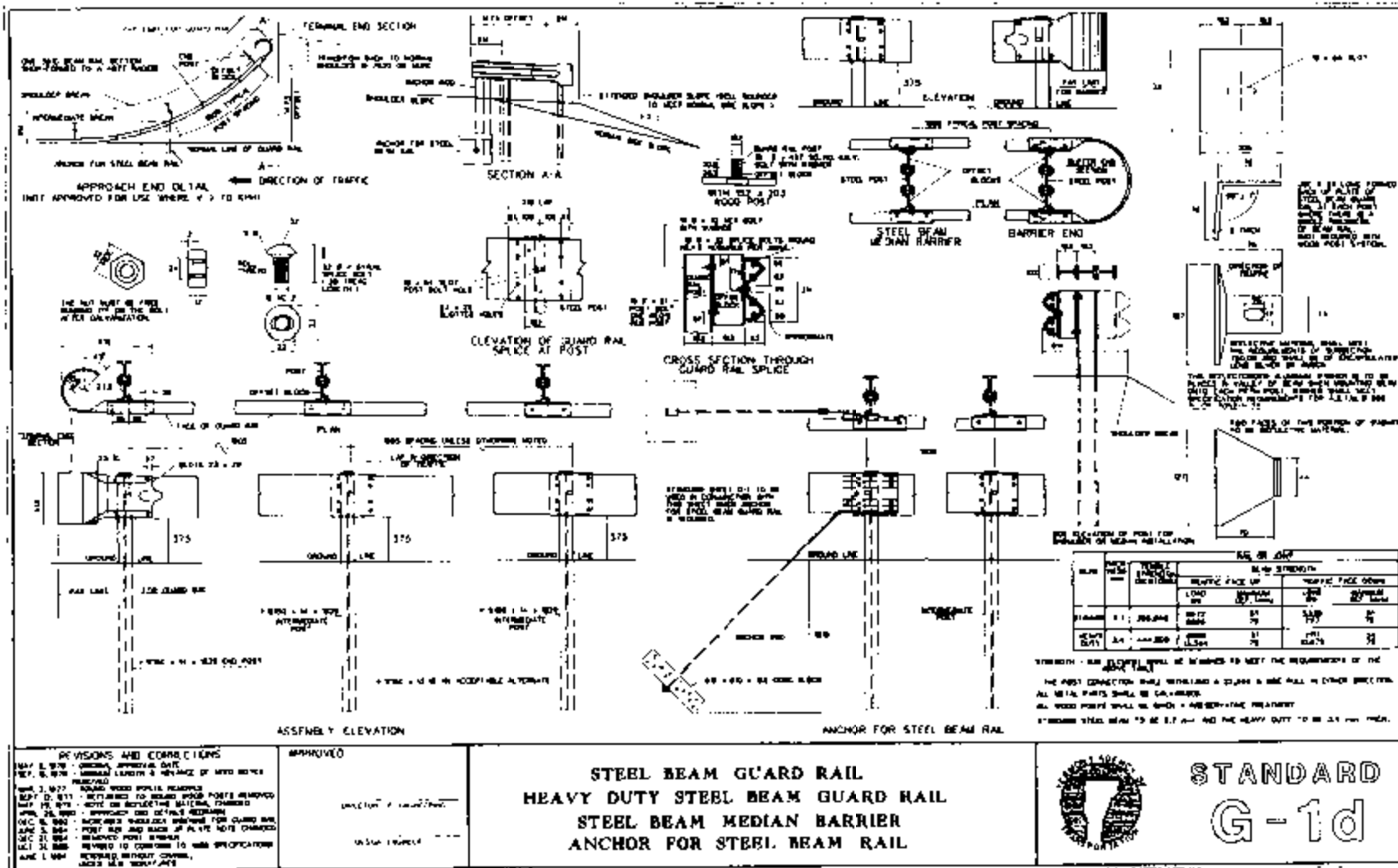
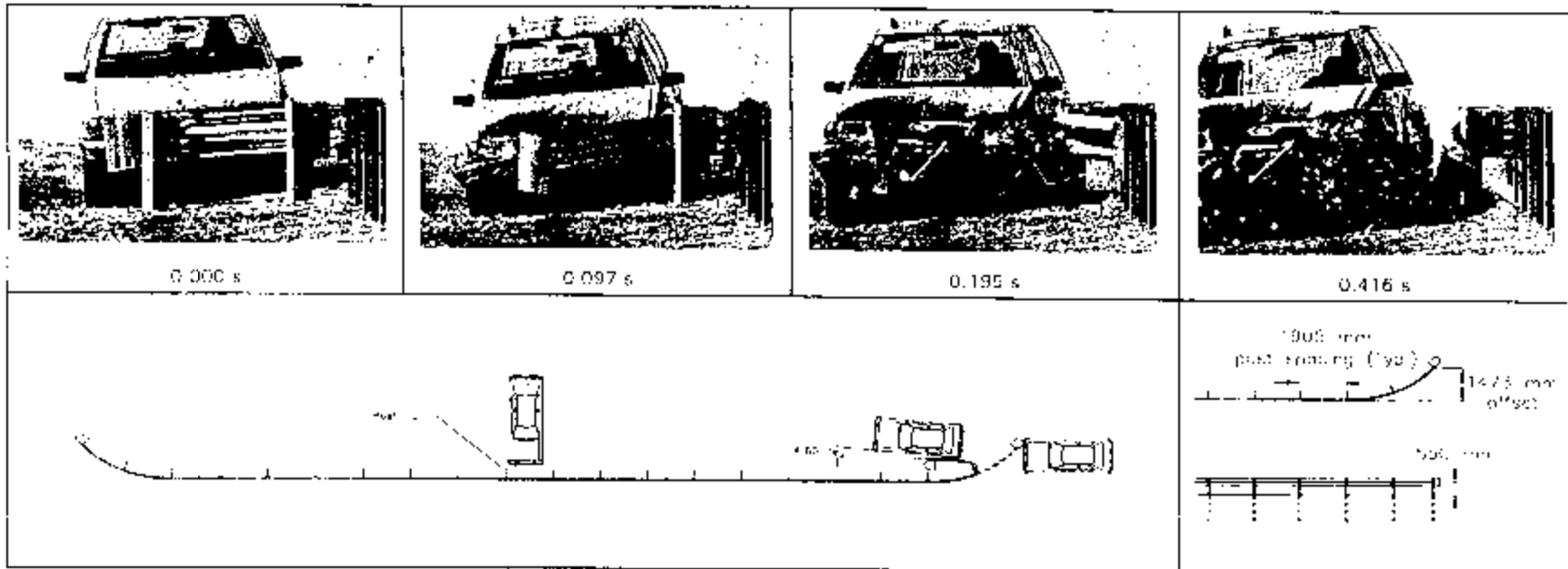
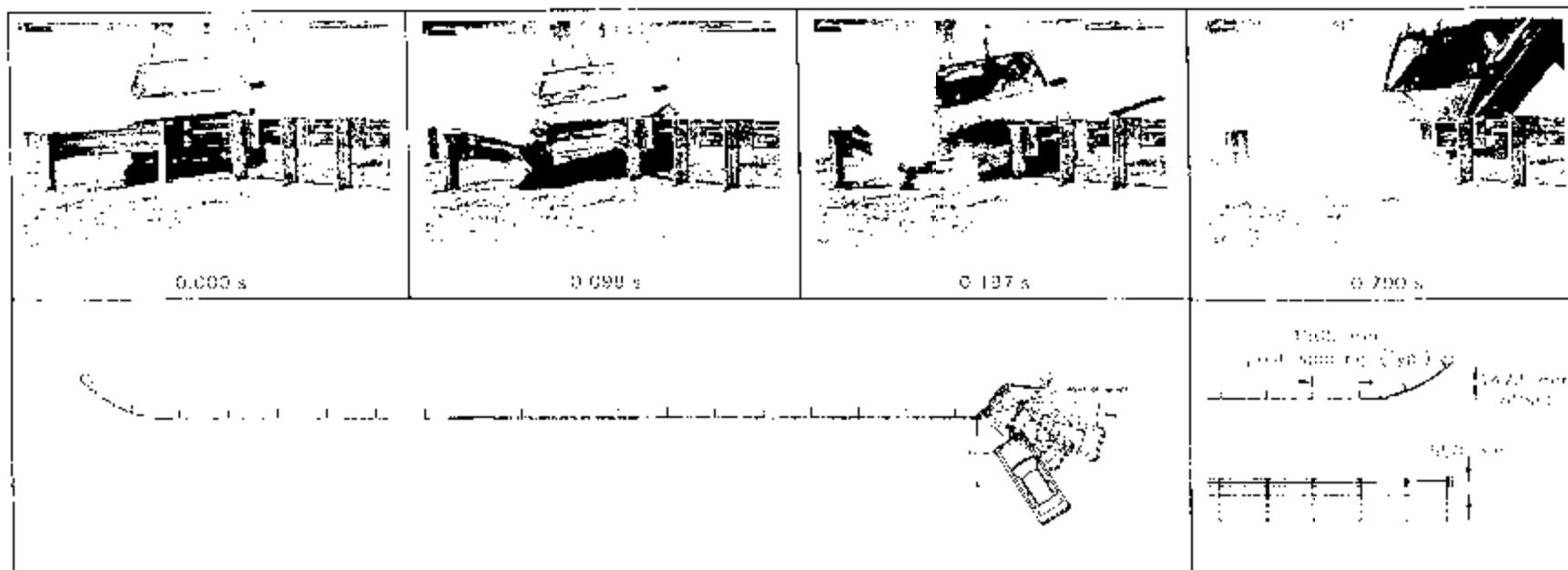


Figure 1. Details of the Vermont terminal installation.



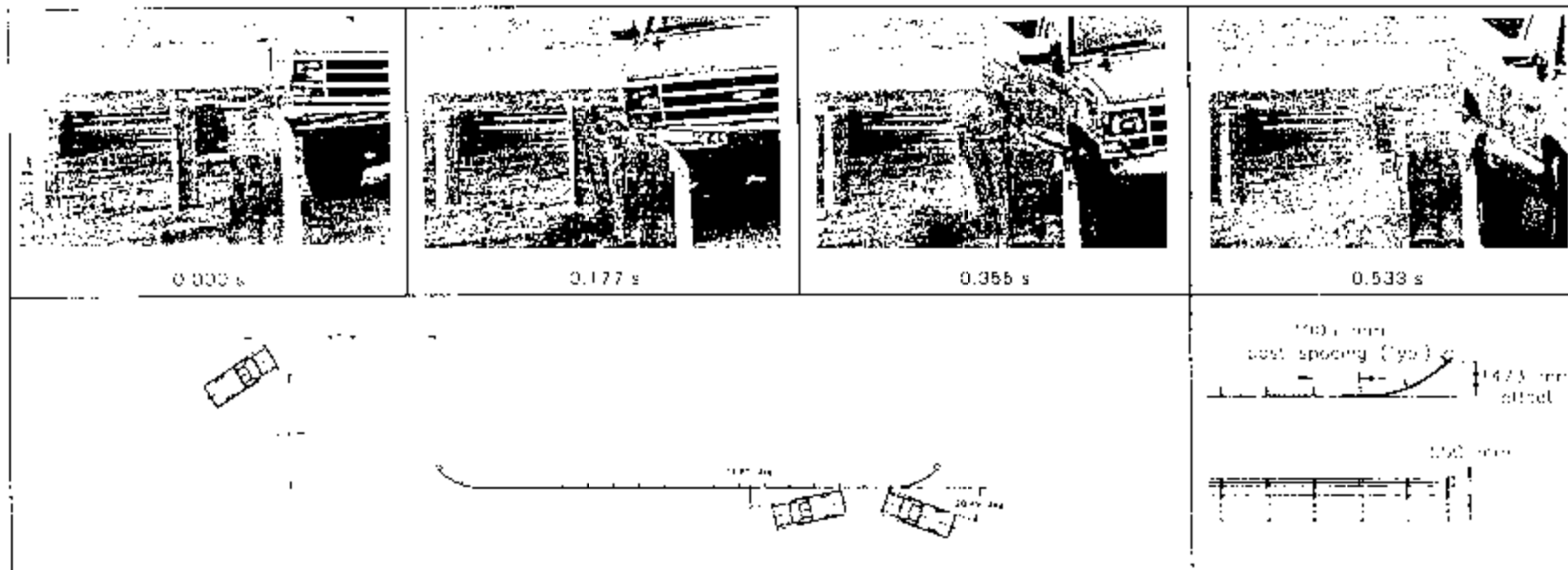
General Information		Impact Conditions		Test Article Deflections (mm)	
Test Agency	Texas Transportation Institute	Speed (km/h)	69.97	Dynamic	gated through
Test No.	473080-2	Angle (deg)	0.0	Permanent	gated through
Date	08/14/97				
Test Article		Exit Conditions		Vehicle Damage	
Type	Terminal	Speed (km/h)	45.98	Exterior	
Name	Vermont G-1d	Angle (deg)	4.60	VDS	12FDZ
Installation length (m)	37.6			CDC	12FDLW2
Size and/or dimension and material of key elements	W-beam guardrail on W150x14 steel posts with 1.47 m offset flare	Occupant Risk Values		Maximum Exterior Vehicle Crush (mm)	255
Soil Type and Condition	Standard soil dry	Impact Velocity (m/s)		Interior	
		x direction	5.98	DCDI	15000000
		y direction	No contact	Max. Occ. Compartment Deformation (mm)	0
Test Vehicle		Hedestown Accelerations (g's)		Post Impact Behavior (during 1.0 s after impact)	
Type	Production	x direction	-3.66	Max. Roll Angle (deg)	-10.4
Designation	820C	y direction	N/A	Max. Pitch Angle (deg)	7.9
Model	1991 Ford Festiva	Max. 0.050 s Average (g's)		Max. Yaw Angle (deg)	10.2
Mass (kg) Curb	826	x direction	6.73		
Test inertial	820	y direction	1.43		
Dummy	76	z direction	-3.10		
Gross Static	896				

Figure 16. Summary of results for test 473080-2.



General Information		Impact Conditions		Test Article Deflections (in)	
Test Agency	Texas Transportation Institute	Speed (km/h)	71.41	Dynamic	N/A
Test No.	473080-3	Angle (deg)	17.76	Permanent	0.26
Date	09-09/97				
Test Article		Exit Conditions		Vehicle Damage	
Type	Terminal	Speed (km/h)	6.11	Exterior	
Name	Veripost G 1st	Angle (deg)	39.76	VOS	11ED31
Installation Length (m)	37.5			CDC	11ED31W3
Size and/or dimensions and material of key elements	W-beam guardrail on W150x14 steel posts with 1.47 m offset flare	Occupant Risk Values		Maximum Exterior	
Soil Type and Condition	Standard soil, dry	Impact Velocity (m/s)		Vehicle Crush (mm)	270
Test Vehicle		x direction	11.30	Interior	
Type	Production	y direction	3.34	CCDI	45001000H
Designation	820C	Ride-down Accelerations (g/s)		Max. Occ. Compartment Deformation (mm)	47
Model	1991 Ford Festiva	x direction	-19.63		
Mass (kg) Comp.	805	y direction	2.48	Post-Impact Behavior	
Test Journal	820	Max. OCCS-Average (g/s)		(Using 1.0 s after impact)	
Identify	76	x direction	16.37	Max. Roll Angle (deg)	11.4
Gross Stab.	890	y direction	4.72	Max. Pitch Angle (deg)	-28.2
		z direction	2.22	Max. Yaw Angle (deg)	31.8

Figure 23. Summary of results for test 473080-3.



General Information		Impact Conditions		Test Article Deflections (in)	
Test Agency	Texas Transportation Institute	Speed (km/h)	69.77	Dynamic	0.35
Test No.	473080-4	Angle (deg)	20.49	Permanent	0.01
Date	11/05/97				
Test Article		Exit Conditions		Vehicle Damage	
Type	Turned	Speed (km/h)	54.26	Exterior	
Name	Vermont 3' x 4'	Angle (deg)	17.65	VDS	01RF02
Installation Compliance	3/7.5			ODC	011RFK2 & 01RDLW2
Size and/or dimension		Occupant Risk Values		Maximum Extensor	
Material of key elements	W-beam galvanized on W150x14 steel posts with 1.42 m offset flare	Impact Velocity (m/s)		Vehicle Crush (mm)	330
Surf. Type and Condition	Standard soil, dry	x direction	3.16	Interior	
Test Vehicle		y direction	3.80	OCC1	19C050000
Type	Production	Roll-over Accelerations (g's)		Max. Occ. Compart. Deformation (mm)	0
Description	2000P	x direction	-2.43		
Model	1991 Chevrolet 2500 pickup	y direction	5.69	Post-impact Behavior	
Mass (kg) Corb	1967	Max. 0.050 s Average (g's)		During 1.0 s after impact:	
Test frontal	2000	x direction	-2.17	Max. Roll Angle (deg)	9.6
Dummy	No dummy	y direction	3.86	Max. Pitch Angle (deg)	-2.1
Gross Stab.	2000	z direction	1.46	Max. Yaw Angle (deg)	26.6

Figure 29. Summary of results for test 473080-4.