U.S. Department
of Transportation
Federal Highway Administration

400 Seventh St., S.W.
Washington, D.C. 20590

September 2, 2005

In Reply Refer To: HSA-10/CC-94

Mr. Steve L. Brown
President
Trinity Highway Safety Products Division
P.O. Box 568887
Dallas, Texas 75356-8887

Dear Mr. Brown:

In his August 10, 2005, letter to Mr. Richard Powers, Mr. Don Johnson requested Federal Highway Administration (FHWA) acceptance of a modified version of your ET-Plus guardrail terminal named the ET-Plus 31. The modifications noted below were needed to match the ET-Plus terminal, which was originally tested with standard W-beam guardrail, to the Midwest Guardrail System (MGS). The MGS barrier was formally accepted as an National Cooperative Highway Research Program (NCHRP) Report 350 test level 3 (TL-3) barrier on March 1, 2005, (acceptance letter B-133). To verify the crashworthiness of the modified ET-Plus, the Texas Transportation Institute conducted the following two tests, which are described in that agency's July 2005 report, "NCHRP Report 350 Testing of the ET-Plus for 30-inch High W-Beam Guardrail":

- Report 350 test 3-30 (TTI Test 220601-2)
- Report 350 test 3-35 (TTI Test 220601-1)

To match the MGS barrier design, the following modifications, shown in Enclosure 1, were made to the original ET-Plus terminal:

1. The guardrail height was raised to 787 mm (31 inches) throughout the terminal length.
2. The depth of each offset block (beginning at post 3) was increased to 305 mm (12 inches).
3. The upper section of the Hinged Breakaway Anchor post was modified to accommodate the increased guardrail height.
4. A 3.8-m (12.5-ft) long W-beam rail, with anchor bracket holes, was used between posts 1 and 3. A special 2.86-m (9.375-ft) W-beam section begins at post 3 and results in a splice located midway between posts 4 and 5. Standard W-beam

sections with holes punched on 0.95 m (3.125 ft) centers are then used from mid-span of posts 4 and 5 and beyond. The terminal proper ends at post 7 (the first standard line post) making its total length 11.43 m (37.5 ft).

5. Ground-line weakening holes in the SYTP are located 810 mm (31.875 inches) from the top of each post. Since the overall post length is unchanged, each SYTP post is embedded approximately 1020 mm in the ground.
6. Modified SYTP posts are used for post positions 2 through 6.
7. Standard W6 x 8.5 line posts are used at post 7 and beyond.

The NCHRP Report 350 requires up to seven crash tests to determine the adequacy of a traffic barrier terminal at TL-3. However, since the original designs for attachment to standard W-beam guardrail have proven to be crashworthy, only those tests that are likely to be affected by the design changes noted above are considered necessary. You successfully completed test 3-30 (head-on test with the 820-kg car) and test 3-35 (20-degree impact with the pickup truck at post 3). Summary sheets for each of these tests are shown in Enclosure 2 to this letter.

The modifications described above are acceptable and the ET-Plus 31 may be considered a TL-3 design that can be used on the National Highway System (NHS) when connected to the MGS barrier. While the barrier itself is non-proprietary, your terminal is proprietary and remains subject to the conditions stated in Title 23, Code of Federal Regulations, Section 635.411 when used on Federal-aid highway projects, except exempt, non-NHS projects.

Sincerely yours,

/original signed by/

John R. Baxter, P.E.
Director, Office of Safety Design
Office of Safety

2 Enclosures

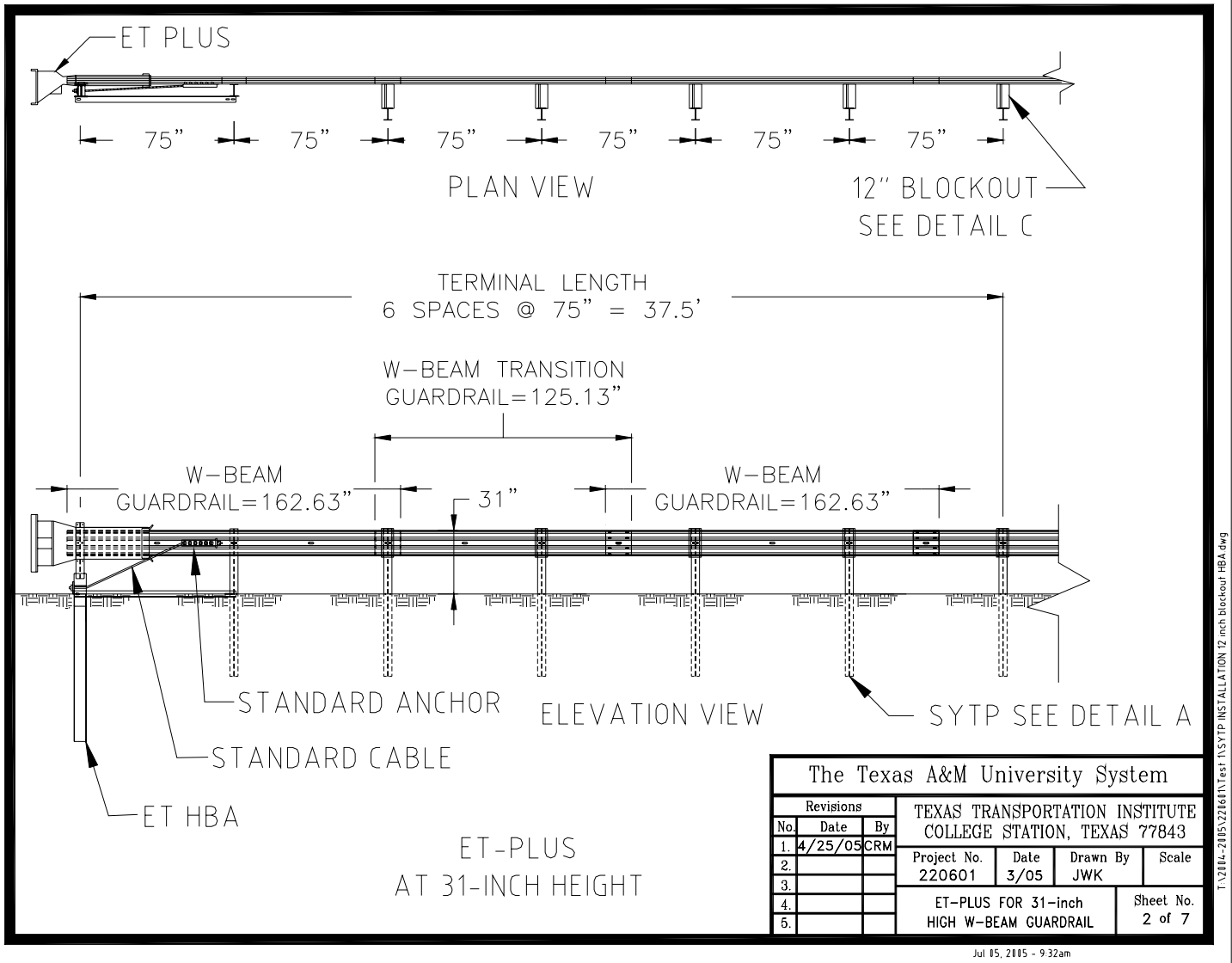
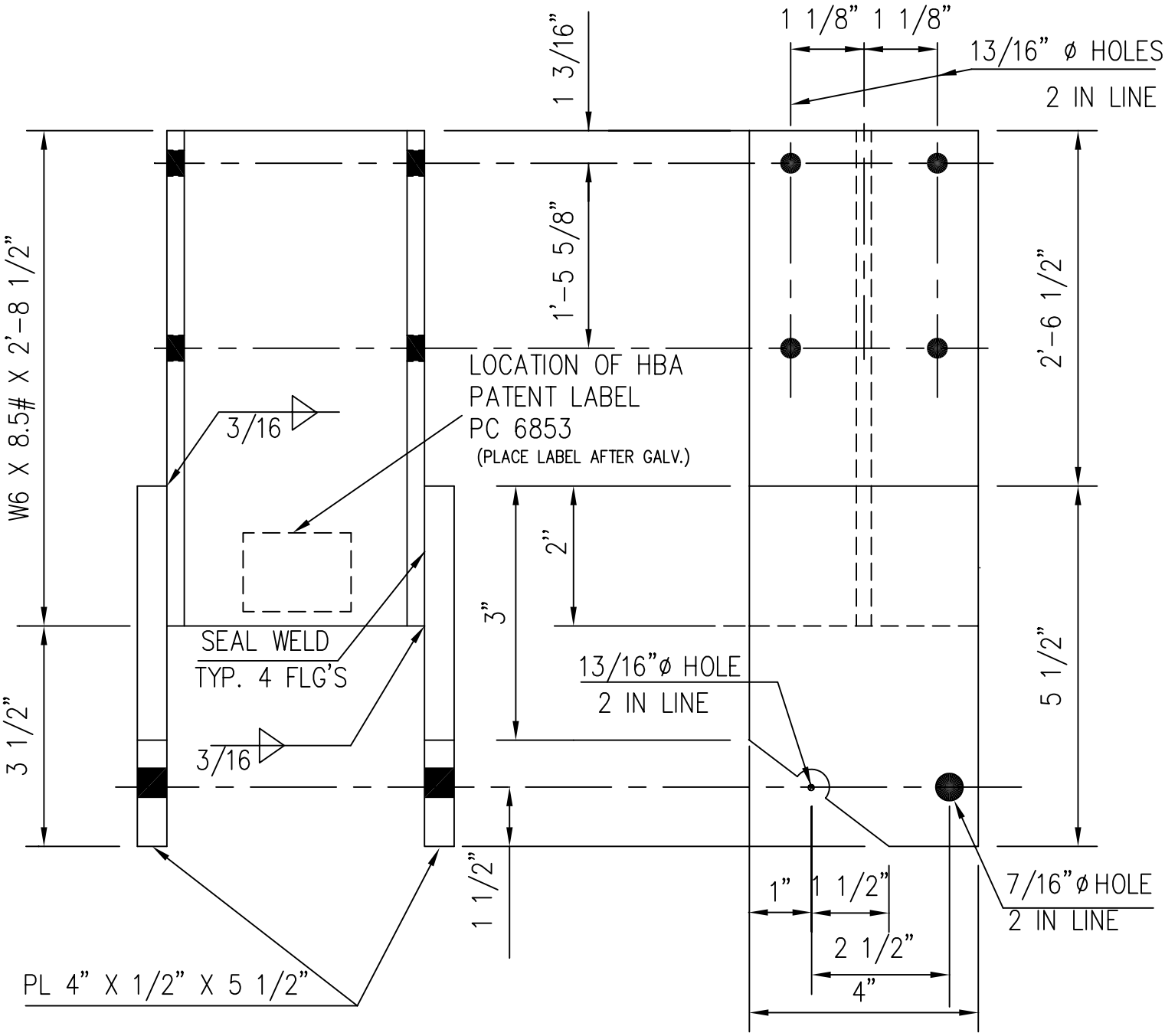


Figure 2. Details of the ET-PLUS for 787 mm (31-inch) high W-beam guardrail (upstream terminal).



ET-PLUS [31" GUARDRAIL]

APPROX. SHPG. WT.; 31.8 #

MK	BY	DATE	REVISION

ITEM CLASS:

MATERIAL: A-36 | FINISH A-123

TRINITY INDUSTRIES, INC.
HIGHWAY SAFETY PRODUCTS
2525 STEMMONS FREEWAY. DALLAS, TX 75207

BREAKAWAY POST TOP # 1
x 3'-0" [31" GUARDRAIL]

DRAWN: E.A.S.	CHKD: B.S.	SCALE: N.T.S.	DATE: 08/15/2005
DRAWING NO: 49398			REV. 0

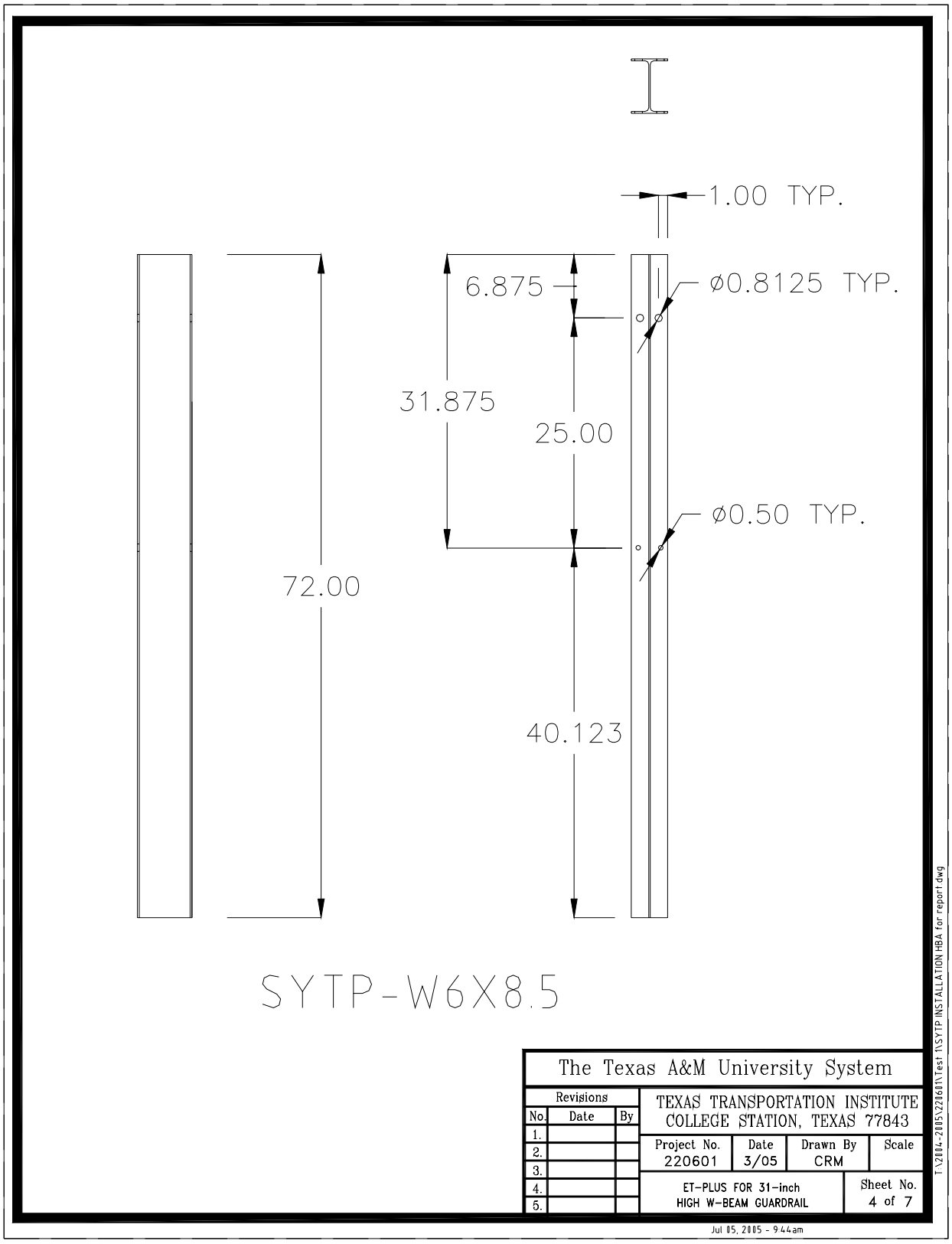
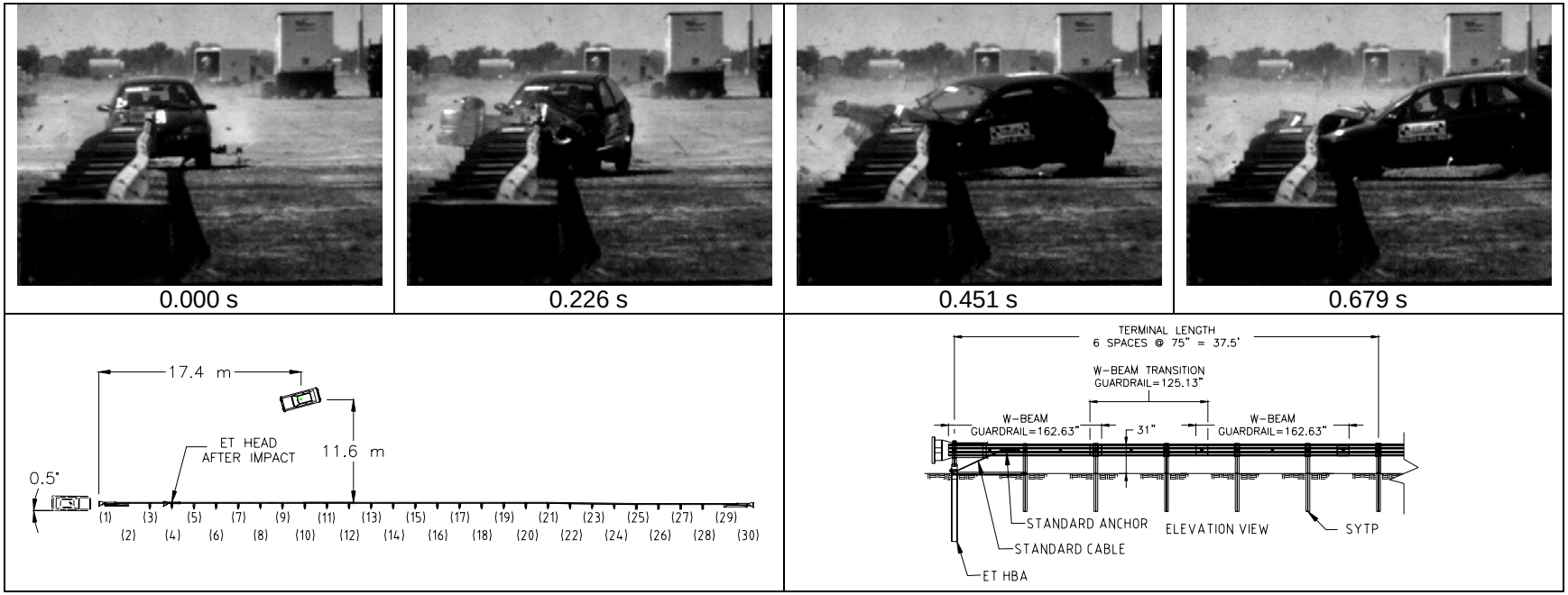


Figure 4. Details of the ET-PLUS for 787 mm (31-inch) high W-beam guardrail (SYTP post).



General Information

Test Agency	Texas Transportation Institute
Test No.	220601-2
Date	05-27-2005

Test Article

Type	Terminal
Name	ET-31
Installation Length (m)	70.5
Material or Key Elements	ET-PLUS Head on HBA Posts with SYTP Posts and 787 mm high W-beam
Soil Type and Condition	Standard Soil, Dry

Test Vehicle

Type	Production
Designation	2000P
Model	1998 Geo Metro
Mass (kg)	
Curb	810
Test Inertial	820
Dummy	77
Gross Static	897

Impact Conditions

Speed (km/h)	101.8
Angle (deg)	0.5

Exit Conditions

Speed (km/h)	N/A
Angle (deg)	N/A

Occupant Risk Values

Impact Velocity (m/s)	
Longitudinal	8.3
Lateral	0.3
THIV (km/h)	30.1
Ridedown Accelerations (g's)	
Longitudinal	-14.0
Lateral	4.3
PHD (g's)	14.3
ASI	0.92
Max. 0.050-s Average (g's)	
Longitudinal	-10.7
Lateral	3.3
Vertical	2.4

Test Article Deflections (m)

Dynamic	5.44
Permanent	5.40
Working Width	0.36

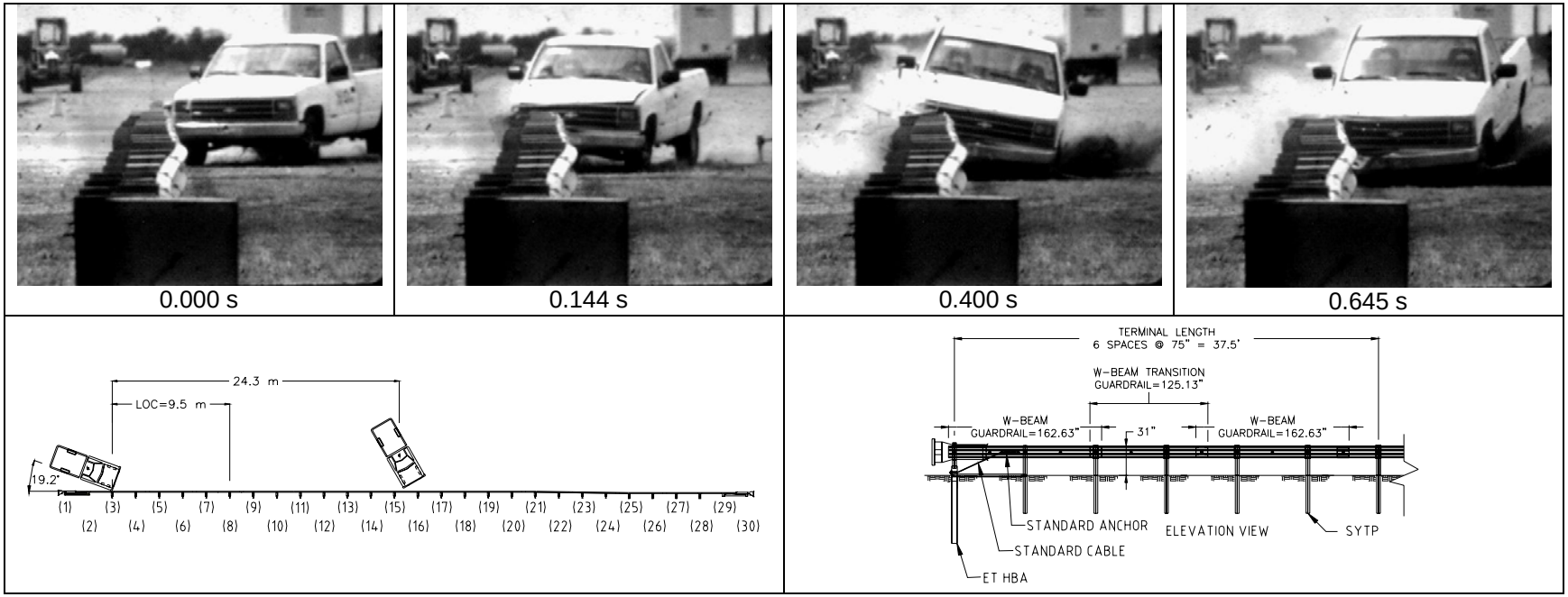
Vehicle Damage

Exterior	
VDS	12FD3
CDC	12FDEW3
Max. Exterior Vehicle Crush (mm)	420
Interior	
OCDI	FS0000000
Max. Occupant Compartment Deformation (mm)	0

Post-Impact Behavior

(during 1.0 sec after impact)	
Max. Yaw Angle (deg)	140
Max. Pitch Angle (deg)	7
Max. Roll Angle (deg)	-15

Figure 22. Summary of results for *NCHRP Report 350* test 3-30 on the ET-PLUS for 787 mm (31-inch) high W-beam guardrail.



General Information

Test Agency	Texas Transportation Institute
Test No.	220601-1
Date	05-05-2005

Test Article

Type	Terminal
Name	ET-31
Installation Length (m)	70.5
Material or Key Elements	ET-PLUS Head on HBA Posts with SYTP Posts and 787 mm high W-beam
Soil Type and Condition	Standard Soil, Dry

Test Vehicle

Type	Production
Designation	2000P
Model	1992 Chevrolet 2500 Pickup Truck
Mass (kg)	
Curb	1912
Test Inertial	2031
Dummy	No dummy
Gross Static	2031

Impact Conditions

Speed (km/h)	100.5
Angle (deg)	19.2

Exit Conditions

Speed (km/h)	N/A
Angle (deg)	N/A

Occupant Risk Values

Impact Velocity (m/s)	
Longitudinal	8.7
Lateral	4.6
THIV (km/h)	31.1
Ridedown Accelerations (g's)	
Longitudinal	-11.5
Lateral	-6.5
PHD (g's)	11.9
ASI	0.83
Max. 0.050-s Average (g's)	
Longitudinal	-7.7
Lateral	-4.6
Vertical	-3.6

Test Article Deflections (m)

Dynamic	0.94
Permanent	0.26
Working Width	0.68

Vehicle Damage

Exterior	
VDS	01RFQ3
CDC	01RFEW3
Max. Exterior Vehicle Crush (mm)	530
Interior	
OCDI	FS0000000
Max. Occupant Compartment Deformation (mm)	0

Post-Impact Behavior

(during 1.0 sec after impact)	
Max. Yaw Angle (deg)	-16
Max. Pitch Angle (deg)	21
Max. Roll Angle (deg)	-16

Figure 15. Summary of results for *NCHRP Report 350* test 3-35 on the ET-PLUS for 787 mm (31-inch) high W-beam guardrail.