December 24, 1998

Mr. Darryl E. Durgin  
Deputy Commissioner  
Chief Engineer  
Minnesota Department of Transportation  
395 John Ireland Boulevard  
Saint Paul, Minnesota 55155-1890  

Dear Mr. Durgin:


Our review indicated that the ELT that was tested to the NCHRP Report 350 criteria is essentially the same design as the ELT that was developed and tested in the late 1980's under NCHRP Report 230 criteria. The only changes made were the replacement of post number 7 (originally a standard line post) with a fifth wooden CRT post, and a 25 mm extension in the offset distance (from 635 mm to 660 mm) at post number 2. The latter change is reflected in the enclosed drawings (Enclosure 1), and we suggest that the drawings be updated to show clearly the use of CRT posts at post locations 3 through 7.

The NCHRP Report 350 recommends up to seven tests for a gating, redirective terminal. We agreed prior to testing that the angle hits on the nose of the ELT (tests 3-32 and 3-33) and the reverse direction test (3-39) could be waived as they have been with similarly flared terminal designs. We also agreed that earlier tests run on the Report 230 ELT, RBCT-13 (test 3-30) and RBCT-19 (test 3-34), need not be repeated if they met the test parameters now required in the NCHRP Report 350. The researchers reviewed the earlier tests and we concur in their finding that both of these small car tests essentially conformed to the current NCHRP Report 350 tests and that neither test need be repeated.

The summary results of the new tests that were run, tests 3-31 and 3-35, are enclosed as Enclosure 2.
Based on our review of the information you submitted, we find that the ELT, with the modifications listed above, meets the acceptance criteria for an NCHRP Report 350 Test Level 3 (TL-3) W-beam guardrail terminal and is acceptable for use on the National Highway System (NHS) if requested by a transportation agency. However, since the pickup truck rode on the rail for approximately 45 m in the end-on test, each barrier installation terminated with an ELT should have a length of need sufficiently long to prevent an impacting vehicle from reaching a shielded fixed-object hazard that is directly behind the guardrail. This recommendation is also noted in the research report. Because all of the line posts in the test installation were timber posts and the W-beam was near its breaking point, the ELT should not be used with steel line posts without an additional test. Because several of the line posts failed at the ground line as the truck slid on top of the rail, the ELT and the guardrail installation it anchors should be installed in a strong soil, as tested. We noted also that the ELT was installed and tested using straight sections of W-beam rail that are forced against the posts resulting in some kinking of the rail elements. We believe this kinking is beneficial in that it allows the rail to collapse more readily in an end-on hit. Consequently, shop-curved sections should not be used without further testing.

Finally, we wish to emphasize the necessity and importance of the grading around the terminal that is shown in your standard drawing. As with all gating terminals, impacting vehicles may travel some distance behind and beyond the ELT in an end-on hit so this area needs to be clear of hazards and relatively traversable. You may also wish to revise your standard drawing to show appropriate reflectorization on the nose of the ELT and, as noted above, to show that posts 3 through 7 are CRT posts and post 8 and all downstream posts must be standard timber line posts.

Sincerely yours,

(Original signed by Dwight A. Horne)

Dwight A. Horne
Chief, Federal-Aid and Design Division

2 Enclosures
Acceptance Letter CC-56
NOT APPROVED

BREAKAWAY CABLE TERMINAL (ELT)

DEPARTMENT OF TRANSPORTATION
STATE OF MINNESOTA

INSTALLATION DETAILS FOR GUARDRAIL END TREATMENT

REFERENCE DATE: 11-6-98

M83229F

SPECIFICATION REFERENCE SHEET 1 OF 4

NOTES:
2. ECCENTRIC LOADER BCT - PAY ITEM LENGTH IS 11.4 METERS.
3. LENGTH-OF-NEED BEGINS 3.8 Meters from BCT NOSE.
4. TANGENT GUARDRAIL SHOWN, SEE CHAPTER 10 IN ROAD DESIGN MANUAL FOR PARABOLIC flare APPLICATIONS.

NOTE: ALL DIMENSIONS ARE IN MILLIMETERS, EXCEPT AS NOTED.
**Nose Details**

**TOP VIEW**

- **Post A**
- **Steel Plate Washer**
- **Trim Corner of Post to Clear Weld**

**SIDE VIEW**

- **Eccentric Loader Assembly**
- **Corrugated Steel Pipe**

**PLATE BEAM**

- **M16 x 2.5 Hex Bolt and Nut**
  - 560 mm long which passes thru end splice bolt slots of plate beam, 45 mm x 75 mm rectangular washer and 45 mm O.D. washers on top and bottom.

**SOIL PLATE**

- **M20 x 2.5 Hex Bolt & Nut with 2 Washers Each**
  - 250 mm long.

**Elevation - Nose Assembly**

- **BEARING PLATE**
- **SOIL PLATE**
- **STEEL TUBE**
- **BCI Cable Assembly**
- **Two M20 x 2.5 x 205 mm Hex Head Bolts & Nuts with 2 Washers Each**

**Plan View**

- **Strut and Yoke Assembly**
  - Shown legs down, for opposite hand, install legs up.

**Notes:**

- Corrugated Steel Pipe as per Spec. 3226.
- Structural Steel as per Spec. 3306, unless otherwise noted.
- Galvanize structural steel as per Spec. 3592 & 3594 after fabrication, unless otherwise noted.

**Note:** All dimensions are in millimeters, except as noted.
Enclosure 1 (3 of 4)

CABLE TERMINAL

25 mm DIA.
4 HOLES

WE MEASURED ON OUTER
CIRCUMFERENCE

610 mm DIA.
X 16 GAGE
CUMULATED
STEEL PIPE
WITH ANNULAR
CORRUGATIONS

CORRUGATED STEEL PIPE

510
300
250
88 mm x 330 mm
SLOT (FOR
PLATE BEAM)

STRUCTURAL TUBE

TS 12 x 4 x 3/16

88
130
150

30 mm DIA.
2-HOLES

125 mm x 330 mm
SLOT FOR
PLATE BEAM

TOP VIEW

Steel Plate
4 REQUIRED

STANDARD
PLATE
NO.

M8329F

NOTE:
ALL DIMENSIONS ARE IN
MILLIMETERS, EXCEPT AS NOTED.

STANDARD
PLATE
NO.

SPECIFICATION
REFERENCE
2554

BREAKAWAY CABLE TERMINAL (ELT)

ECCENTRIC LOADER

ANGLE

20 mm DIA.
2 HOLES

STEEL PLATE
(4 REQUIRED)

50
100

20 mm DIA.
2 HOLES

STEEL PLATE WASHER

208
250

YOKES
12 REQUIRED

TOP VIEW
SIDE VIEW

NOTE:
DO NOT USE FLAME CUTTING FOR THESE OPENINGS.
Figure 18. Summary of results for test 473390-2, NCHRP Report 350 test 3-31.
**General Information**
- **Test Agency**: Texas Transportation Institute
- **Test No.**: 473390-1
- **Date**: 09/07/98

**Test Article**
- **Type**: Terminal
- **Name**: Minnesota ELT
- **Installation Length (m)**: 57.1
- **Material or Key Elements**: 1.2 m Flared W-beam guardrail on wooden posts spaced 1.9 m

**Soil Type and Condition**: Standard Soil, Dry

**Test Vehicle**
- **Type**: Production
- **Designation**: 2000P
- **Model**: 1994 Chevrolet 2500 pickup truck
- **Mass (kg)**:
  - Curb: 2071
  - Test inertial: 2000
  - Dummy: No dummy
  - Gross Static: 2000

**Impact Conditions**
- **Speed (km/h)**: 102.1
- **Angle (deg)**: 21.0

**Exit Conditions**
- **Speed (km/h)**: 35.9
- **Angle (deg)**: 18.6

**Occupant Risk Values**
- **Impact Velocity (m/s)**
  - x-direction: 7.3
  - y-direction: 4.5
  - THV (km/h): 24.4

**Ride-down Accelerations (g's)**
- x-direction: 9.7
- y-direction: 9.0
- PHD (g's): 12.8
- ASI: 0.78
- Max 0.050-s Average (g's)
  - x-direction: -6.0
  - y-direction: -5.2
  - z-direction: 7.5

**Test Article Deflections (in)**
- **Dynamic**: 0.99
- **Permanent**: 0.64

**Vehicle Damage**
- **Exterior**: VDS, 01:FREG2, DB:87:EW3
- **Maximum Exterior**: 0.99
- **Vehicle Crush (mm)**: 440

**Interior**
- ODI: RF0104000
- **Maximum Occ. Compartment Deformation (mm)**: 62

**Post-Impact Behavior**
- (crumpl 1.0 s after impact)
  - Max. Yaw Angle (deg): -45
  - Max. Pitch Angle (deg): -5
  - Max. Roll Angle (deg): -5

Figure 10. Summary of results for test 473390-1. NCHRP Report 350 test 3-35.