February 6, 2004

Refer to: HSA-10/CC-47B

Barry D. Stephens, P.E.
Senior Vice President of Engineering
ENERGY ABSORPTION Systems, Incorporated
03617 Cincinnati Avenue
Rocklin, CA 95765

Dear Mr. Stephens:

Mr. Michael S. Griffith, in his April 21, 2003, letter to you (Acceptance Letter CC-47A), accepted the use of a six-unit TRITON water-filled barrier array for use as an end treatment for 4-m long temporary concrete barrier segments with a non-typical connection between each segment. In your January 8, 2004, letter to Mr. George Ostensen, you requested acceptance of the same terminal design for use with 3-m and longer concrete barrier segments connected with a standard pin and loop design. To support this request, you also sent copies of E-TECH Testing Services, Incorporated, January 2004 report entitled "NCHRP Report 350 Crash Test Results for the TRITON Concrete End Treatment System, Final Report #229 Revision A" and a videotape of the test you conducted.

The design, shown as Enclosure 1, consists of five TRITON barrier segments filled with water and set 178 mm off the ground on plastic support pedestals. The sixth and lead segment is inverted and left empty. It is installed 130 mm above the ground and connected to the first water-filled segment by a metal bracket. The rearmost segment is pinned to a foam-filled steel transition section (Enclosure 2) that is itself pinned to the first of two unanchored, 3-m long concrete barrier segments. Based on prior discussions with Mr. Richard Powers of my staff, it was mutually agreed beforehand that one test would be sufficient to assess the crashworthiness of TRITON Concrete End Treatment System (TCETS) when used as a crash cushion to shield the end of 3-m long temporary concrete barrier segments.

Test 3-44 was conducted with the center of the pickup truck aimed at the center of the first concrete barrier segment. The test vehicle came to rest with its severely bent frame straddling one of the displaced concrete barrier segments. Enclosure 3 is the data summary sheet for the test.

Like other water-filled plastic crash cushions designed to shield the approach end of temporary concrete barrier, TCETS has no redirectional capability and can result in excessive occupant risk, excessive passenger compartment intrusion and possible penetration into the area behind the
barrier proper when impacted near its rearmost corner. Because TCETS is a non-redirecting crash cushion, National Cooperative Highway Research Program (NCHRP) Report 350 evaluation criteria pertaining to occupant impact velocity (OIV) and ridedown accelerations are

waived for test 3-44. As can be seen on the test summary sheet, the OIV in your test was 12.3 m/sec, higher than the 12 m/s permissible for all other crash cushion tests. You noted also the occupant compartment deformation was 272 mm, significantly higher than the generally accepted limit of 150 mm, but that it was in a location where "it would not be life-threatening." As noted in Mr. Griffith's earlier acceptance letter, occupant compartment intrusion likely to cause serious occupant injury is a subjective factor (as are allowable vehicular roll, pitch and yaw angles), so I am again willing to consider TCETS acceptable for use on the National Highway System (NHS) with unanchored pin and loop concrete barrier segments of any length. However, it should be used only at locations where high-speed impacts are unlikely, penetration behind the barrier is acceptable, and use of a redirecting impact attenuator is not feasible for reasons other than cost or convenience.

You also requested that the TL-2 TRITON attenuator design, originally accepted for use with TRITON barrier, be considered acceptable for use with freestanding temporary concrete barrier. The TL-2 design is similar to the TL-3 version, but does not use plastic support pedestals to elevate the TRITON segments. Your request for acceptance was based on the assumption that the results of test 3-44 at 70 km/h would be no worse than those seen in the 100-km/h test. Although this assumption appears logical, there remains a possibility that, given less kinetic energy, the concrete barrier will not be displaced as readily as in the high-speed test and could result in greater occupant risk at the reduced impact speed. The reported ridedown acceleration for this test with your NEAT crash cushion with the first concrete segment anchored to the ground was 28 g's. As previously noted, NCHRP Report 350 evaluation criteria do not require that occupant risk limits be met in test 3-44. Accordingly, I am willing to accept use of the TL-2 TCETS design on the NHS but only at locations where expected impact speeds are below 45 mph. It is not acceptable for use on high-speed NHS routes.

Sincerely yours,

(original signed by John R. Baxter)

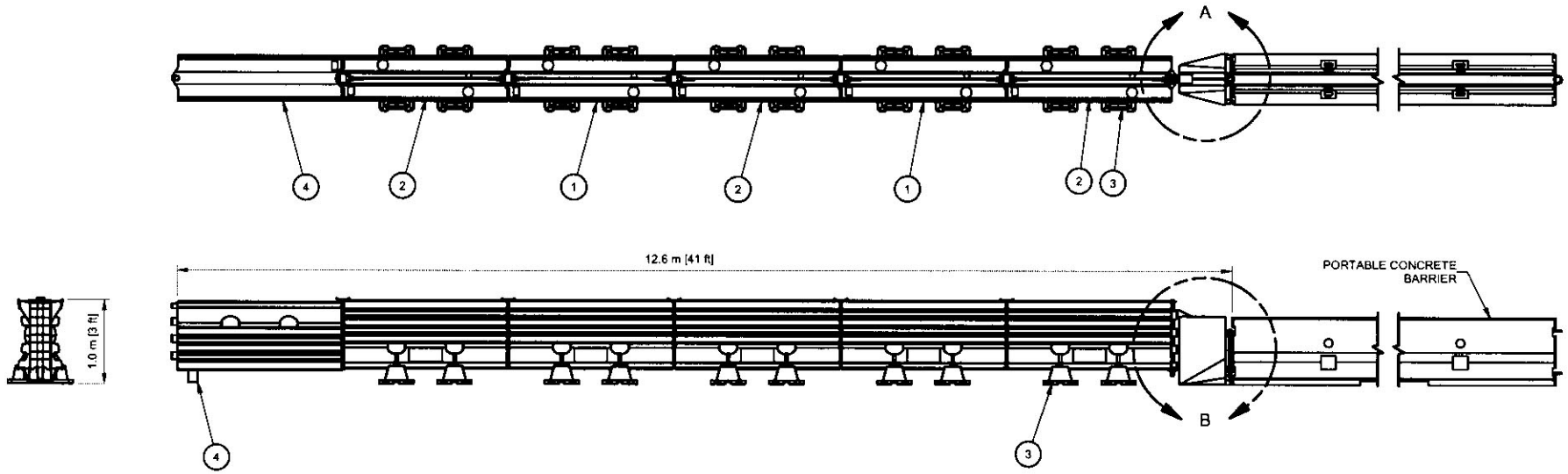
John R. Baxter, P.E.
Director, Office of Safety Design
Office of Safety

3 Enclosures

THE DEPICTED TRITON CONCRETE END TERMINAL PLUS TRANSITION IS A NARROW, NON-REDIRECTIVE, GATING CRASH CUSHION. IT HAS BEEN CRASH TESTED FOLLOWING THE GUIDELINES IN NCHRP 350 TL-3 (100 km/h). IT'S IMPACT PERFORMANCE IS SIMILAR TO A SAND-FILLED INERTIAL BARREL ARRAY. AS A CONSEQUENCE, CARE MUST BE USED IN IT'S APPLICATION IN THE FIELD. IT IS RECOMMENDED THE TRITON CONCRETE END TERMINAL ONLY BE USED TO PROTECT PORTABLE (UNANCHORED) CONCRETE BARRIER AT SITES WHERE THE CHANCE OF HIGH ANGLE, HIGH SPEED IMPACTS IS LOW. WHEN THESE TYPES OF ANGLED IMPACTS MAY OCCUR, A REDIRECTIVE CRASH CUSHION, SUCH AS THE QUADGUARD SYSTEM, SHOULD BE INSTALLED INSTEAD.

PARTS LIST

ITEM	STOCK NO.	DESCRIPTION	QTY.
1	3595020-0100	BARRIER SECTION ASSY,TRI,ORANGE	2
2	3595020-0000	BARRIER SECTION ASSY,TRI,WHITE	3
3	3595351-0000	TRITON TL-3 KIT	10
4	3595361-0000	END TREATMENT,TRITON,TL-3	1
5	2795403-0000	TRANSITION,TRITON,PCMB	1
6	2795401-0000	PIN,TRITON TRANSITION,G	1
7	2708313-0000	WASHER,BAR,1/4X3 1/2X4,G	1
8	2701361-0000	BOLT,HX,1/2X3,G2,G	1
9	2704011-0000	NUT,HX,1/2,G	1
10	2701044-0000	BOLT,HX,1 1/4X22,G	1
11	2715055-0000	WASHER,BAR,3/8X3 3/4X5,G	2
12	2708732-0000	WASHER,FLAT,1 1/2 SAE,G	2
13	2704571-0000	NUT,HX,1 1/4,G	1



ASSEMBLY NO. 3595500-0000

REFERENCES

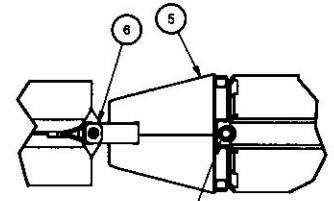
BARRIER SECTION ASSY,TRI	3595020-0000
TRITON TL-3 KIT	3595351-0000
END TREATMENT,TRITON,TL3	3595361-0000

DRAWN: D. Kohfeld	DATE: 4/11/2003
DESIGNED: J. Welch	DATE: 4/10/2003
CHECKED: KM	DATE: 4/17/2003
APPROVED: JBW	DATE: 4/17/2003
FILE: 3595500-0000.idw	
NEXT ASSEMBLY	

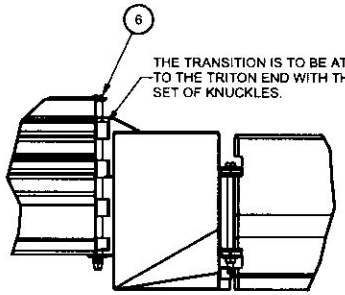
ENERGY ABSORPTION SYSTEMS, INC.
ENGINEERING AND RESEARCH DEPARTMENT

TRITON CONCRETE END TREATMENT (PIN & LOOP PCMB)

SCALE	DRAWING	SHEET	REV
1=50	3595500-0000	1 of 2	



DETAIL A
SCALE 1 / 25



DETAIL B
SCALE 1 / 25

ASSEMBLY NO. 3595500-0000

DRAWN: D. Kohfeld	DATE: 4/11/2003	
DESIGNED: J. Welch	DATE: 4/10/2003	
CHECKED: KM	DATE: 4/17/2003	
APPROVED: JBW	DATE: 4/17/2003	
FILE: 3595500-0000.idw		
NEXT ASSEMBLY:		

ENERGY ABSORPTION SYSTEMS, INC.
ENGINEERING AND RESEARCH DEPARTMENT

TRITON CONCRETE END TREATMENT

SCALE	DRAWING	SHEET	REV
1=25	3595500-0000	2 of 2	


t = 0.000 sec

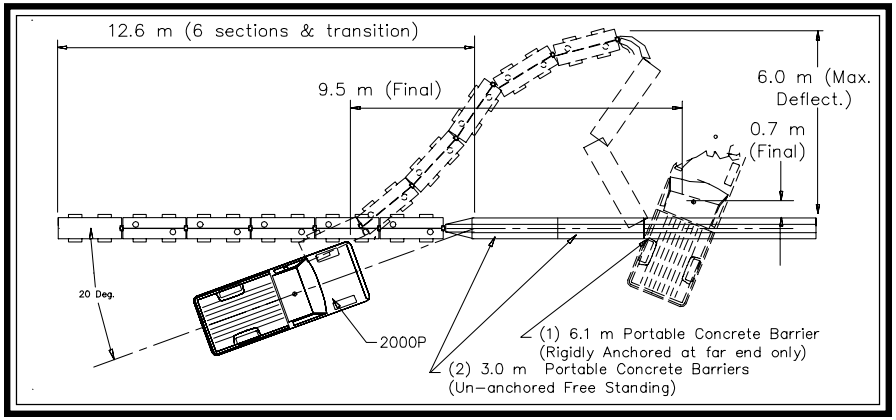

t = 0.280 sec

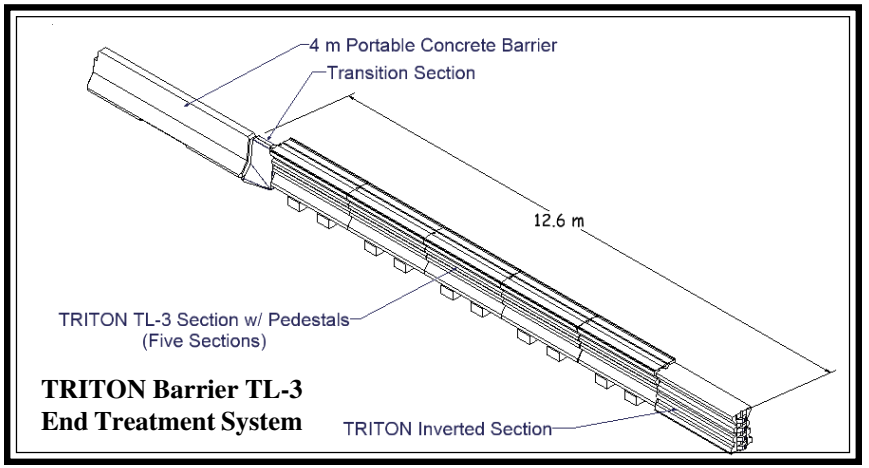

t = 0.560 sec


t = 0.840 sec


t = 1.120 sec


t = final





General Information

Test Agency	E-TECH Testing Services, Inc.
Test Designation	NCHRP 350 Test 3-44 (Modify)
Test No.	01-7605-008
Date	11/13/03

Test Article

Type	Energy Absorption Systems, Inc.
	TRITON BARRIER Concrete
	End Treatment System
Installation Length	12.6 m - (6) Sections
Size and/or dimension and material of key elements	1981 mm Section
	Length, 178 mm Pedestal Height
	Polyethylene Plastic with
	transition to (2) 3.0 m unanchored
	CMB and 6.1 m anchored CMB
Foundation and Anchoring	Dry concrete, unanchored

Test Vehicle

Type	Production Model
Designation	2000P
Model	1992 GMC C-2500
Mass (kg)	
Curb	1873
Test inertial	2000
Dummy	N/A
Gross Static	2000

Impact Conditions

Speed (km/h)	99.7
Angle (deg)	20
Impact Severity (kJ)	766.5

Exit conditions

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

Occupant Risk Values	Primary*	Secondary
Impact Velocity (m/s)		
x-direction	12.5*	12.3
y-direction	4.1*	3.6
Ridedown Acceleration (g's)		
x-direction	-16.1*	-18.9
y-direction	-120.2*	-11.4
European Committee for Normalization (CEN) Values		
THIV (km/h)	47.9	46.1
PHD (g's)	120.6	20.1
ASI	3.6	1.5
Post-Impact Vehicular Behavior (deg - rate gyro/film)**		
Maximum Roll Angle	-54.9/-55	-55.0
Maximum Pitch Angle	22.9/75	22.9
Maximum Yaw Angle	-28.7/-55	-29.1

Test Article Deflections (m)

Dynamic	6.0
Permanent	6.0

Vehicle Damage (Primary Impact)

Exterior	
VDS	LFQ-5
CDC	11LDEN4
Interior	
VCDI	AS1020000
Maximum Deformation (mm)	272

* Spurious signal on primary accelerometer due to floorboard buckle.
** Gyro measurements relative to bed, film measurements relative to cab.

Figure 1. Summary of Results - TRITON Barrier TL-3 End Treatment System Test 01-7605-008

E-TECH Testing Services, Inc.
3617 B Cincinnatti Avenue
Rocklin, CA 95765
PHONE (916) 645-8188
FAX (916) 645-3653