February 13, 2009

In Reply Refer To: HSSD/CC-47D

Mr. Barry D. Stephens, P.E.
Senior Vice President of Engineering
Energy Absorption Systems, Inc.
3617 Cincinnati Avenue
Rocklin, CA 95765

Dear Mr. Stephens:

This letter is in response to your request for the Federal Highway Administration (FHWA) acceptance of a roadside safety system for use on the National Highway System (NHS).

Name of system: Mod. TRITON Concrete End Treatment ACZ-350™ System
Type of system: Non-redirecting barrier terminal
Test Level: NCHRP Report 350 TL-3
Testing conducted by: E-TECH Testing Services
Date of request: December 17, 2008

You requested that we find this system acceptable for use on the NHS under the provisions of National Cooperative Highway Research Program (NCHRP) Report 350 “Recommended Procedures for the Safety Performance Evaluation of Highway Features.”

Requirements
Roadside safety systems should meet the guidelines contained in the NCHRP Report 350. The FHWA Memorandum “Identifying Acceptable Highway Safety Features” of July 25, 1997, provides further guidance on crash testing requirements of longitudinal barriers.

Description
The ACZ-350™ System is designed to perform as a narrow, non-redirecting crash cushion to shield the blunt ends of both permanent and variable length portable concrete median barrier (P/CMB), as well as crashworthy steel median barrier systems such as the Vulcan Barrier.

The ACZ-350™ System consists of a sheet metal nose, four water-filled plastic shell segments, and a steel transition pinned together to act as an end treatment. The nose is constructed of light gauge steel and connects directly to the front-most water filled segment. Each of the four water filled segments is equipped with an external, top-mounted steel stiffener which is rigidly fixed to each respective segment. The front two water filled segments do not contain an internal steel frame or external, side-mounted laminated steel straps. In contrast, the next (or last) two water
filled Triton segments are equipped with an internal steel frame as well as external side-mounted steel laminated straps. A heavy duty non-crushable steel transition completes the system by connecting the last water filled segment to the blunt end of the downstream barrier, be it P/CMB or Vulcan barrier. The total length of the ACZ-350™ System is 9.6 meters (31’-7”). In bi-directional traffic applications, there are no rigid exposed vehicle snag points for traffic traveling from the reverse direction.

**Crash Testing**

You requested acceptance of the ACZ-350™ System based on the successful results of three NCHRP Report 350 crash tests. The first was Test 3-40 in which an 820C compact car impacted the unit head-on, and with the vehicle offset at w/4. The second test was Test 3-41 in which a 2000P pickup truck impacted the unit head-on. The third test was a modification of Test 3-44 in which a 2000P vehicle impacts the side of the system at 20 degrees with the centerline of the vehicle aligned with the centerline of the rigid hazard. The NCHRP Report 350 states that the intent of Test 3-44 is “…to evaluate the ability of the cushion to safely stop a large passenger car prior to a life-threatening impact with the corner of the hazard object being shielded.” Aligning the centerline of the impacting vehicle at the center of the shielded concrete barrier is clearly the critical impact point for the ACZ-350 design and the impact conditions are essentially the same as Test 3-38 for redirecting crash cushions. Report 350 acknowledges that test 3-38 “would be difficult to pass for a nonredirective crash cushion”, and thus does not require that the nominal limiting occupant impact velocities and ridedown accelerations be achieved. However, we recognize your newly designed ACZ-350™ System is a nonredirective crash cushion that meets the occupant impact velocities and ridedown accelerations with reported values of 10.5 m/s and 18.4 g’s while the impacting vehicle showed no evidence of penetration, climbing or vaulting.

We agree with your conclusions that Tests 3-42 and 3-43 do not require retesting. There has been no significant change in system shape, system height or component weights between the original TRITON CET and the ACZ-350. Individual system sections near the front of the system are designed to articulate in the same fashion as the TRITON Concrete End Treatment. This articulation will allow the errant vehicle to pass through the system as expected for a gating system. Based on these design principals we believe the new ACZ-350™ system will behave with similar results as the TRITON Concrete End Treatment when tested to 3-42 and 3-43 criteria.

**Findings**

Based upon the results of the reported Tests 3-40, 3-41, and 3-44, and the discussions above, the FHWA concludes the ACZ-350™ System is acceptable for use on the NHS to act as a narrow, non-redirecting gating crash cushion for permanent and portable concrete median barrier of varying individual lengths as well as steel barrier such as Vulcan. It is acceptable for use on the NHS under the range of conditions tested, when such use is acceptable to a highway agency. The cushion should be used in locations where side impacts are unlikely, penetration behind the barrier is acceptable for angled nose impacts, and where the use of a redirective crash cushion is not feasible for reasons other than cost or convenience.
Please note the following standard provisions that apply to the FHWA letters of acceptance:

- This acceptance is limited to the crashworthiness characteristics of the systems and does not cover their structural features, nor conformity with the Manual on Uniform Traffic Control Devices.
- Any changes that may adversely influence the crashworthiness of the system will require a new acceptance letter.
- Should the FHWA discover that the qualification testing was flawed, that in-service performance reveals unacceptable safety problems, or that the system being marketed is significantly different from the version that was crash tested, we reserve the right to modify or revoke our acceptance.
- You will be expected to supply potential users with sufficient information on design and installation requirements to ensure proper performance.
- You will be expected to certify to potential users that the hardware furnished has essentially the same chemistry, mechanical properties, and geometry as that submitted for acceptance, and that it will meet the crashworthiness requirements of the FHWA and the NCHRP Report 350.
- To prevent misunderstanding by others, this letter of acceptance is designated as number CC-47D and shall not be reproduced except in full. This letter and the test documentation upon which it is based are public information. All such letters and documentation may be reviewed at our office upon request.
- The ACZ-350™ System is a patented product and considered proprietary. If proprietary systems are specified by a highway agency for use on Federal-aid projects, except exempt, non-NHS projects, (a) they must be supplied through competitive bidding with equally suitable unpatented items; (b) the highway agency must certify that they are essential for synchronization with the existing highway facilities or that no equally suitable alternative exists; or (c) they must be used for research or for a distinctive type of construction on relatively short sections of road for experimental purposes. Our regulations concerning proprietary products are contained in Title 23, Code of Federal Regulations, Section 635.411.
- This acceptance letter shall not be construed as authorization or consent by the FHWA to use, manufacture, or sell any patented system for which the applicant is not the patent holder. The acceptance letter is limited to the crashworthiness characteristics of the candidate system, and the FHWA is neither prepared nor required to become involved in issues concerning patent law. Patent issues, if any, are to be resolved by the applicant.

Sincerely yours,

David A. Nicol
Director, Office of Safety Design
Office of Safety

Enclosures
Figure 6
### General Information

| Test Agency | E-TECH Testing Services, Inc. |
| Test Designation | NCHRP 350 Test 3-44 modified |
| Test No. | 01-4317-003 |
| Date | 12/4/08 |

### Test Article

| Type | Energy Absorption System ACZ - 350 System |
| Installation Length | 9.0 m - (4) segment total, pinned and freestanding w/ steel nose |
| Material and key elements | Polylethylene plastic segments (4 water filled), first two w/o frame and steel side straps, last two with, 14 ga hollow steel nose, transition to (3) 3 m freestanding PCMB with last section anchored |
| Foundation Type and Condition | Portland Cement Concrete, clean and dry, unanchored |

### Impact Conditions

| Speed (km/h) | 96.4 |
| Angle (deg) | 20 |
| Impact Severity (kJ) | 717.0 |

### Exit Conditions

| Speed (km/h) | N/A |
| Angle (deg - veh. c.g.) | N/A |

### Occupant Risk Values

| Impact Velocity (m/s) | 10.5 |
| x-direction | 10.5 |
| y-direction | 6.9 |
| Ridedown Acceleration (g's) | -18.4 |
| x-direction | -18.4 |
| y-direction | -12.0 |

### European Committee for Normalization (CEN) Values

| THV (km/h) | 43.3 |
| PHD (g's) | 31.0 |
| ASI | 1.8 |

### Post-Impact Vehicular Behavior (deg - rate gyro)

| Maximum Roll Angle | -17.5 |
| Maximum Pitch Angle | 24.9 |
| Maximum Yaw Angle | -59.5 |

### Test Article Deflections (m)

| Dynamic | 1.7 |
| Permanent | 1.7 |

### Vehicle Damage (Primary Impact)

| Exterior |
| VDS | FL-4 |
| CDC | 11FLEW4 |
| Interior |
| VCDI | ASI020000 |
| Maximum Deformation (mm) | 195 |

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**Figure 11. Summary of Results - ACZ - 350 System Test 01-4317-003**
ACZ - 350 System Crash Test Results - 10 of 60

Figure 1. Summary of Results - ACZ - 350 System Test 01-4317-002
Figure 6. Summary of Results - ACZ - 350 System Test 01-4317-001

General Information

Test Agency: E-TECH Testing Services, Inc.
Test Designation: NCHRP 350 Test 3-41
Test No.: 01-4317-001

Date: 10/30/08
Test Article Type: ACZ - 350 System
Installation Length: 9.0 m - (4) segment total, pinned and freestanding w/ steel nose
Material and key elements: Polyethylene plastic segments (4 water-filled), first two w/ frame and steel side straps, last two w/ 14 ga hollow steel nose, transition to (3) 3 m freestanding PCMB with last section anchored
Foundation Type and Condition: Segments Length x Width x Height: (2021 mm x 533 mm x 813 mm)
Portland Cement Concrete, clean and dry, unanchored

Impact Conditions

Speed (km/h): 98.3
Angle (deg): 0
Impact Severity (kJ): 744.0
Exit conditions
Speed (km/h): N/A
Angle (deg - veh. c.g.): N/A

Occupant Risk Values
Impact Velocity (m/s):
- x-direction: 9.9
- y-direction: -0.3
Ridedown Acceleration (g's):
- x-direction: -11.1
- y-direction: -5.7

European Committee for Normalization (CEN) Values
THV (km/h): 35.6
PHD (g's): 11.2
ASI: 0.9

Post-Impact Vehicular Behavior (deg - rate gyro)
Maximum Roll Angle: -7.6
Maximum Pitch Angle: 20.0
Maximum Yaw Angle: -39.2

Test Article Deflections (mm)
Dynamic: N/A
Permanent: 5.4

Vehicle Damage (Primary Impact)
Exterior
VDS: FD-4
CDC: 12FDEW4
Interior
VCDI: N/A
Maximum Deformation (mm): 14