Mr. James R. Keaton  
Vice President of Sales and Marketing  
Barrier Systems, Inc.  
180 River Road  
Rio Vista, CA  94571-1208  

Dear Mr. Keaton:  

In your August 31 letter, you provided design and test information on two versions of a new redirective crash cushion called the TAU-II, and requested the Federal Highway Administration's (FHWA) approval of these units as NCHRP Report 350 test level 2 (TL-2) and test level 3 (TL-3) devices, respectively. The design and test information was contained in three reports prepared by Safe Technologies, Inc.: “NCHRP Report 350 Crash Test Results TAU-II Redirective, Non-Gating Crash Cushion,” dated August 15, 2001, “NCHRP Report 350 Crash Test Results TAU-II Redirective, Non-Gating Crash Cushion – Addendum 1,” dated August 31, 2001, and “NCHRP Report 350 Crash Test Results TAU-II Redirective, Non-Gating Crash Cushion – Test Level 2,” also dated August 31, 2001. Test data, including videos, were submitted on CD-ROMs and the crash tests themselves were also submitted in VHS format.

The TAU-II is a redirective crash cushion designed to shield the ends of median barriers and similar narrow fixed objects. It consists of Type A and Type B expendable Energy Absorbing Cartridges (EACs) separated by steel diaphragms within a framework of Thrie-beam rail panels. The EACs are made from black cross link polyethylene. To accommodate side impacts, two steel cables are attached to the bottom of the diaphragms and anchored at the front and rear of the unit. The effective length of the TL-3 system is 8.2 m with a height of 929 mm and a width of 889 mm. Type A cartridges are used in the first three bays and Type B cartridges are used in the remaining five bays. The TL-2 unit is similar in height and width, but is only 4.7 m long and uses one Type A EAC in the first (nose) bay and Type B EACs in the remaining 3 bays. Both units are bolted to inserts epoxied in holes drilled into 254-mm thick reinforced concrete pads. Enclosure 1 consists of drawings that show the layouts and selected components of both the TL-2 and TL-3 designs.

For the 8-bay TL-3 unit, the full compliment of tests recommended in NCHRP Report 350 was successfully conducted. Enclosure 2 includes the test summary sheets for these tests (Tests 3-30, 3-31, 3-32, 3-33, 3-36, 3-37, 3-38, and 3-39). Since the shorter TL-2 unit is comprised of the same components, only those tests directly affected by the length of the TAU-II were deemed necessary, i.e., the head-on and
angled tests into the nose of the unit (Tests 2-30, 2-31, 2-32, and 2-33). Because test 2-33 repeats test 2-32 (with the 2000-kg pickup truck in lieu of the 820-kg car) it was also considered unnecessary since the small car test is more critical for a device like the TAU-II. The summary sheets for tests 2-30, 2-31, and 2-32 are shown in Enclosure 3.

You also provided drawings of transition designs to use when the TAU-II is installed in a narrow median or other locations where reverse direction impacts are a possibility. The drawings for the transitions from a median barrier to the TAU-II shown in Enclosure 4 are acceptable. The connection to a rigid concrete median barrier is a standard design and the transitions from metal beam median barriers are similar to guardrail to bridge rail transitions that have been successfully tested in the past. Therefore, none of these designs require additional testing.

Based on staff review of the information you provided, I agree that that the 4-bay TAU-II and the 8-bay TAU-II, as tested, meet the appropriate NCHRP Report 350 evaluation criteria for TL-2 and TL-3 redirective crash cushions, respectively, and may be used on the National Highway System when such use is acceptable to the contracting agency. Since the TAU-II is a proprietary crash cushion, its use on Federal-aid projects, except exempt, non-NHS projects, is subject to the conditions listed in Title 23, Code of Federal Regulations, Section 635.411.

Sincerely yours,

(Original signed by Frederick G. Wright, Jr.)

Frederick G. Wright, Jr.
Program Manager, Safety

4 Enclosures
WOOD SPACER BLOCKS (OR THE PROPER DIMENSIONS) MAY BE SUBSTITUTED FOR THE DETAILLED STEEL BLOCKS.

TRANSITION BLOCKOUTS AND SPACERS IN ACCORDANCE WITH NEVADA DOT SPEC A-280 AND NEVADA DOT SPEC R-84.3.

TRANSITION SPACING IS IN ACCORDANCE WITH CALL-TRANS SPEC A78 AND NEVADA DOT SPEC R-84.3.
Figure 11. Summary of Results Test #TAD32

General Information
Test Agency: SAFE TECHNOLOGIES, INC.
Test Designation: NCHRP Report 350 2-32 (Head On Angled)
Test No: STI Test #TAD32
Date: 8/27/2001

Test Article
Type: Barrier Systems, Inc.
Installation Length: 4.3 meters (8 bay system)
Size and/or dimension and material of key elements:
Height 929 mm, Width 889 mm,
Mass 913 kg / 4 bay system

Test Vehicle
Type: Production Model
Model: 1989, Ford Festiva

Mass (kg)
Curb: 785.5
Test Inertial: 824
Dummy(s): 75
Gross Static: 900

Impact Conditions
Speed (km/h): 70
Angle (deg): 15
Impact Severity (kJ): 155.9

Exit Conditions
Speed (km/h): 10.8 km/h (6.7 mph)
Angle (deg): Recoil

Occupant risk Values
Impact Velocity (m/s)
x-direction: 11.2
y-direction: 0.6
Ridedown Acceleration (g's)
x-direction: -11.1
y-direction: 6.5
THIV (m/s):
PHD (g's): 11.2
ASI: 1.07

Test Article Deflection (mm)
Dynamic: 129
Permanent: 43

Vehicle Damage
Exterior
VDS: FC-1
CDC: 12FYEW1
Interior
OCDI: AS0000000

Post-Impact Vehicular behavior (deg - gyro @ c.g.)
Maximum Roll Angle: 2.6
Maximum Pitch Angle: -6.8
Maximum Yaw Angle: -37.3
Figure 6. Summary of Results Test #TAD31
Figure 1. Summary of Results Test #TAD30
**Figure 1. Summary of Results Test TAD14**

### General Information
- **Test Agency**: SAFE TECHNOLOGIES, INC.
- **Test Designation**: NCHRP Report 350 3-39 (Reverse Hit)
- **Test No.**: STI Test #TAD14
- **Date**: 7/3/2001

### Test Article
- **Type**: TAU Redirective, Non-Gating, Crash Cushion
- **Installation Length**: 8.2 meters (8 bay system)
- **Size and/or dimension and material of key elements**: Height 929 mm, Width 889 mm, Mass 1383 kg / 8 bay system

### Test Vehicle
- **Type**: Production Model
- **Designation**: 2000P
- **Model**: 1988, Chevrolet Scottsdale 2500 3/4 Ton Pickup
- **Mass (kg)**
  - Curb: 1857
  - Test Inertial: 1974
  - Dummy(s): n/a
  - Gross Static: 1974

### Impact Conditions
- **Speed (km/h)**: 98.5
- **Angle (deg)**: 20
- **Impact Severity (kJ)**: 86.3

### Exit Conditions
- **Speed (km/h)**: 62.2 (38.6 mph)
- **Angle (deg)**: 1.3

### Occupant risk Values
- **Impact Velocity (m/s)**
  - x-direction: 4.4
  - y-direction: -6.2
- **Ridedown Acceleration (g’s)**
  - x-direction: -9.8
  - y-direction: 13.9
  - THIV (m/s): 6.9
  - PHD (g’s): 16.8
  - ASI: 1.08

### Test Article Deflection (mm)
- **Dynamic**: 460
- **Permanent**: 168

### Vehicle Damage
- **Exterior**
  - VDS: LD-4
- **Interior**
  - OCDI: AS0103100

**Post-Impact Vehicular behavior (deg - gyro @ c.g.)**
- Maximum Roll Angle: -11.3
- Maximum Pitch Angle: -6.2
- Maximum Yaw Angle: 16.3
General Information

Test Agency................................. SAFE TECHNOLOGIES, INC.
Test Designation......................... NCHRP Report 350 3-38 (CIP)
Test No...................................... STI Test #TAD15
Date......................................... 7/6/2001

Test Article

Type................................. Barrier Systems, Inc.
Installation Length.................. 8.2 meters (8 bay system)
Size and/or dimension and material of key elements........ Height 929 mm, Width 889 mm,
Mass 1383 kg / 8 bay system

Test Vehicle

Type..................................... Production Model
Designation.............................. 2000P
Model...................................... 1990, Chevrolet Cheynne 2500
Mass (kg)
Curb....................................... 2003
Test Inertial............................ 1965
Dummy(s)................................. n/a
Gross Static............................ 1965

Impact Conditions

Speed (km/h)............................ 97.2
Angle (deg)............................. 20
Impact Severity (kJ).................. 83.9

Vehicle Damage

Exterior
VDS........................................ LFQ-3
CDC............................................ 11FLEE3
Interior
OCDF........................................ AS1113100

Impact Conditions

Speed (km/h)............................ 97.2
Angle (deg)............................. 20
Impact Severity (kJ).................. 83.9
Exit Conditions

Speed (km/h)............................ 81.7 (50.8 mph)
Angle (deg)............................. 12

Occipant risk values

Impact Velocity (m/s)
x-direction............................... 3.7
y-direction............................... -5.5
Ridedown Acceleration (g's)
x-direction............................... -10.8
y-direction............................... 17.6
THIV (m/s)............................... 5.9
PHD (g's)................................. 18.5
ASI........................................... 1.07

Test Article Deflection (mm)

Dynamic................................. 479
Permanent............................... 117

Figure 6. Summary of Results Test #TAD15
### General Information

**Test Agency**: SAFE TECHNOLOGIES, INC.
**Test Designation**: NCHRP Report 350 3-37 (LON)
**Test No.**: STI Test #TAD16
**Date**: 7/9/2001

**Test Information**

**Type**: Barrier Systems, Inc.
**Installation Length**: 8.2 meters (8 bay system)
**Size and/or dimension and material of key elements**: Height 929 mm, Width 889 mm, Mass 1383 kg / 8 bay system

**Test Article**

**Type**: TAU Redirective, Non-Gating, Crash Cushion
**Model**: 1989, GMC Sierra 3/4 Ton Pickup

**Test Vehicle**

**Type**: Production Model
**Designation**: 2000P
**Mass (kg)**
- Curb: 1864
- Test Inertial: 1973
- Dummy(s): n/a
- Gross Static: 1973

**Impact Conditions**

- **Speed (km/h)**: 97.9
- **Angle (deg)**: 20
- **Impact Severity (kJ)**: 85.3

**Impact LON**
- At 20 deg @ 97.9 km/h

**Impact LON at 20 deg**
- Permanent Lateral Deflection = 48 mm
- Dynamic Lateral Deflection = 477 mm

**Exit Conditions**

- **Speed (km/h)**: 77.7 (48.2 mph)
- **Angle (deg)**: 8

**Occupant risk Values**

- **Impact Velocity (m/s)**
  - x-direction: 2.2
  - y-direction: 4.8
- **Ridedown Acceleration (g's)**
  - x-direction: -11.5
  - y-direction: -13.8
- **THIV (m/s)**: 4.9
- **PHD (g's)**: 14.4
- **ASI**: 1.09

**Test Article Deflection (mm)**

- Dynamic: 477
- Permanent: 48

**Vehicle Damage**

**Exterior**
- VDS: RFQ-3
- CDC: 01RFEW2

**Interior**
- OCDI: AS0000000

**Post-Impact Vehicular behavior (deg - gyro @ c.g.)**

- Maximum Roll Angle: 13.1
- Maximum Pitch Angle: 6.2
- Maximum Yaw Angle: 150.7

---

**Figure 11. Summary of Results Test #TAD16**
### General Information

<table>
<thead>
<tr>
<th>Test Agency</th>
<th>SAFE TECHNOLOGIES, INC.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Designation</td>
<td>NCHRP Report 350 3-36 (LON)</td>
</tr>
<tr>
<td>Test No</td>
<td>STI Test #TAD17</td>
</tr>
<tr>
<td>Date</td>
<td>7/10/2001</td>
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### Test Article

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<th>Type</th>
<th>Barrier Systems, Inc. TAU Redirective, Non-Gating, Crash Cushion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installation Length</td>
<td>8.2 meters (8 bay system)</td>
</tr>
<tr>
<td>Size and/or dimension and material</td>
<td>Height 929 mm, Width 889 mm, Mass 1383 kg / 8 bay system</td>
</tr>
</tbody>
</table>

### Test Vehicle

<table>
<thead>
<tr>
<th>Type</th>
<th>Production Model</th>
</tr>
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<tr>
<td>Designation</td>
<td>820C</td>
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<tr>
<td>Model</td>
<td>1989, Ford Festiva</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>Mass (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Curb</td>
</tr>
<tr>
<td>Test Inertial</td>
</tr>
<tr>
<td>Dummy(s)</td>
</tr>
<tr>
<td>Gross Static</td>
</tr>
</tbody>
</table>

### Impact Conditions

<table>
<thead>
<tr>
<th>Speed (km/h)</th>
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</thead>
<tbody>
<tr>
<td>97</td>
</tr>
</tbody>
</table>

### Exit Conditions

<table>
<thead>
<tr>
<th>Speed (km/h)</th>
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</thead>
<tbody>
<tr>
<td>84 (52.2 mph)</td>
</tr>
<tr>
<td>Angle (deg)</td>
</tr>
<tr>
<td>3</td>
</tr>
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</table>

### Occupant risk Values

<table>
<thead>
<tr>
<th>Impact Velocity (m/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>x-direction</td>
</tr>
<tr>
<td>y-direction</td>
</tr>
<tr>
<td>Ridedown Acceleration (g's)</td>
</tr>
<tr>
<td>x-direction</td>
</tr>
<tr>
<td>y-direction</td>
</tr>
<tr>
<td>THIV (m/s)</td>
</tr>
<tr>
<td>PHD (g's)</td>
</tr>
<tr>
<td>ASI</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Impact Severity (kJ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>19.7</td>
</tr>
</tbody>
</table>

### Vehicle Damage

<table>
<thead>
<tr>
<th>Exterior</th>
</tr>
</thead>
<tbody>
<tr>
<td>VDS</td>
</tr>
<tr>
<td>CDC</td>
</tr>
<tr>
<td>OCDI</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Interior</th>
</tr>
</thead>
<tbody>
<tr>
<td>VDS</td>
</tr>
<tr>
<td>CDC</td>
</tr>
<tr>
<td>OCDI</td>
</tr>
</tbody>
</table>

### Post-Impact Vehicular behavior (deg - gyro @ c.g.)

<table>
<thead>
<tr>
<th>Maximum Roll Angle</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
</tr>
<tr>
<td>Maximum Pitch Angle</td>
</tr>
<tr>
<td>1.3</td>
</tr>
<tr>
<td>Maximum Yaw Angle</td>
</tr>
<tr>
<td>-24.9</td>
</tr>
</tbody>
</table>

---

Figure 16. Summary of Results Test #TAD17
General Information

Test Agency: SAFE TECHNOLOGIES, INC.
Test Designation: NCHRP Report 350 3-3 (Head On)
Test No.: STI Test #TAD29
Date: 8/10/2001

Test Article
Type: Barrier Systems, Inc.
TAU-II Redirective, Non-Gating, Crash Cushion
Installation Length: 8.2 meters (8 bay system)
Size and/or dimension and material of key elements:
Height 929 mm, Width 889 mm, Mass 1383 kg / 8 bay system

Test Vehicle
Type: Production Model
Designation: 2000P
Model: 1989, GMC Sierra
3/4 Ton Pickup
Mass (kg):
Curb: 1908
Test Inertial: 1982
Dummy(s): n/a
Gross Static: 1982

Impact Conditions
Speed (km/h): 96.5
Angle (deg): 15
Impact Severity (kJ): 712.4

Exit Conditions
Speed (km/h): 9.72 (6.0 mph)
Angle (deg): 70

Occupant risk Values
Impact Velocity (m/s):
x-direction: 8.6
y-direction: 0.4
Ridedown Acceleration (g's):
x-direction: -8.6
y-direction: 3.4
THIV (m/s): 8.7
PHD (g's): 8.7
ASI: 0.63

Test Article Deflection (mm)
Dynamic: 375
Permanent: 127

Vehicle Damage
Exterior
VDS: FC-1
CDC: 12FDEW1
Interior
OCDI: AS0000000

Post-Impact Vehicular behavior (deg - gyro @ c.g.)
Maximum Roll Angle: 7.1
Maximum Pitch Angle: -5.4
Maximum Yaw Angle: -168.7

Figure 31. Summary of Results Test #TAD29
Figure 1. Summary of Results Test #TAD34
**Figure 26. Summary of Results Test #TAD28**

| Permanent Lateral Deflection | = 24 mm |
| Dynamic Lateral Deflection | = 151 mm |

**Impact at 0 deg @ 98.3 km/h**

<table>
<thead>
<tr>
<th>Impact Conditions</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed (km/h)</td>
<td>98.3</td>
</tr>
<tr>
<td>Angle (deg)</td>
<td>0</td>
</tr>
<tr>
<td>Impact Severity (kJ)</td>
<td>734.6</td>
</tr>
</tbody>
</table>

**Exit Conditions**

| Speed (km/h) | n/a |
| Angle (deg)  | n/a |

**Occupant risk Values**

<table>
<thead>
<tr>
<th>Impact Velocity (m/s)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>x-direction</td>
<td>8.2</td>
</tr>
<tr>
<td>y-direction</td>
<td>0.1</td>
</tr>
<tr>
<td>Ridedown Acceleration (g's)</td>
<td></td>
</tr>
<tr>
<td>x-direction</td>
<td>-18</td>
</tr>
<tr>
<td>y-direction</td>
<td>-3</td>
</tr>
<tr>
<td>THIV (m/s)</td>
<td>8.2</td>
</tr>
<tr>
<td>PHD (g's)</td>
<td>18.2</td>
</tr>
<tr>
<td>ASI</td>
<td>1.21</td>
</tr>
</tbody>
</table>

**Test Article Deflection (mm)**

| Dynamic               | 151 |
| Permanent             | 24  |

**Test Vehicle**

| Model                  | 1989, Chevrolet Scottsdale 2500 3/4 Ton Pickup |
| Test Article           | Barrier Systems, Inc. TAU Redirective, Non-Gating, Crash Cushion |
| Installation Length    | 8.2 meters (8 bay system) |
| Size/Dimension and Material | Height 929 mm, Width 889 mm, Mass 1383 kg / 8 bay system |

**Vehicle Damage**

| Exterior               | VDS: FC-3 |
| CDC                   | 12FDEW3  |
| Interior              | OCDI: AS0000000 |

<table>
<thead>
<tr>
<th>Post-Impact Vehicular behavior (deg - gyro @ c.g.)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Roll Angle</td>
<td>-5.7</td>
</tr>
<tr>
<td>Maximum Pitch Angle</td>
<td>-3.2</td>
</tr>
<tr>
<td>Maximum Yaw Angle</td>
<td>-12.9</td>
</tr>
</tbody>
</table>
Figure 21. Summary of Results Test #TAD26
Figure D-8

NOTE:
THICKNESS OF WELD TO BE EQUAL TO THE THINNER OF 2 PIECES BEING JOINED. WELD TO BE ALL AROUND UNLESS OTHERWISE NOTED.

SCALE: HALF

The information herein is proprietary to Barrier Systems Inc. and shall not be disclosed, duplicated or used otherwise without the express written approval of Barrier Systems Inc.

TITLE: FRONT CABLE ANCHOR

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Standard Text/Line

Fractional

MODEL

REV.
B010248-PD
1

B010249
20

2

1

0.5

1

1.5

7

12

17.5

1
Figure D-5