INFORMATION HANDOUT

MATERIALS INFORMATION

ALTERNATIVE CRASH CUSHION SYSTEMS
CRASH CUSHION
(TYPE QUADGUARD II)
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**Note:** This manual and the standard drawings with their reference drawings in PDF format are also contained on the CD included on the inside back cover of this manual.

**Important Introductory Notes**

Proper installation of the QuadGuard II System is essential to assure maximum performance. Take the time to review the installation instructions and product limitations thoroughly before performing the necessary work. Do not attempt to install any crash cushion without the proper plans and installation manual from the manufacturer.

**Note:** The drawing package provided with the QuadGuard II System should take precedence over the drawing package provided in this manual. These drawings are for reference only and may not be up to date.

If you need additional information, or have questions about the QuadGuard II System, please call Energy Absorption Systems’ Customer Service Department at (888) 323-6374.

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The QuadGuard II System is a highly efficient, redirective, non-gating crash cushion for hazards ranging in width from 610 mm to 3200 mm (2’ to 10.5’). It consists of crushable, energy-absorbing cartridges surrounded by a framework of Quad-Beam™ panels.

The QuadGuard II System utilizes two types of cartridges in a “staged” configuration to address both lighter cars and heavier, high center-of-gravity vehicles. Its modular design allows the system length to be tailored to the design speed of a site. Refer to Table A on page 9 to determine the appropriate length system for a given design speed.

**How to Determine Left/Right**

To determine left from right when ordering parts, stand in front of the system facing the hazard as shown in Figure 1. Your left is the system’s left and your right is the system’s right.

**Counting the Number of Bays**

One bay consists of one cartridge, one diaphragm, and two fender panels. The nose section is not considered a bay, though there is a cartridge in the nose of each system. Note that this means there will always be one more cartridge in the system than the number of bays in the system. To determine number of bays, count fender panels on one side, see Figure 1 (5 bay System shown).

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**Figure 1**

System Orientation
QuadGuard® II System

System Overview (cont’d.)

Measuring the Width
The QuadGuard II System is available in seven nominal widths:

- 610 mm [24”]
- 760 mm [30”]
- 915 mm [36”]
- 1219 mm [48”]
- 1755 mm [69”]
- 2285 mm [90”]
- 3200 mm [126”] Min. 6 Bays required for this width.

The nominal width of a system with tension strut backup is the width between side panels behind the backup (see Figure 2).

The nominal width of a system with concrete backup is the width of the concrete backup at location shown in Figure 3.

The outside width of the system is approximately 150 mm [6"] to 230 mm [9"] wider than the nominal width. The width of the system is not the same as the width of the backup.

Figure 2
Width of System with Tension Strut Backup

Figure 3
Width of System with Concrete Backup

Crash Performance
The 5 bay QuadGuard II System has successfully passed the NCHRP 350, Test Level 3 tests with both the light car and pickup truck at speeds up to 100 km/h (62 mph) at angles up to 20 degrees.

During head-on impacts, the QuadGuard II System telescopes rearward and crushes to absorb the energy of impact. When impacted from the side, it safely redirects the vehicle back toward its original travel path and away from the hazard.

Return Goods Policy
Before returning any goods for credit please contact Energy Absorption Systems Inc. Customer Service Department at 1-888-323-6374 or your local distributor for proper instructions.
QuadGuard® II System

QuadGuard® II System
General Specifications

I. GENERAL

All QuadGuard II Systems are designed and manufactured by Energy Absorption Systems, Incorporated, of Chicago, Illinois.

II. DESCRIPTION OF SYSTEM

A. General

The QuadGuard II System consists of energy absorbing cartridges surrounded by a framework of steel Quad-beam guardrail, which can telescope rearward during head-on impacts. The QuadGuard II System has a center monorail, which will resist lateral movement during side angle impacts, and a backup, which will resist movement during head-on impacts. The nose consists of a steel nose wrap and an energy-absorbing cartridge. Transitions are available and may be required depending on site conditions.

B. Component Descriptions

1. A bay describes a section of the QuadGuard II System consisting of an energy absorbing cartridge, a diaphragm, two fender panels and fasteners.

   a. There are two types of cartridges, referred to as Type I and Type II. The front portion of the system is fitted with Type I cartridges. The rear of the system is fitted with Type II cartridges. The outside of each cartridge is fabricated from a weather resistant plastic. The actual quantity of each is determined by the system design speed.

   b. The diaphragms are made from 10 gauge, steel Quad-Beam sections. Two support legs are welded to the Quad-Beam. Ski-shaped plates are welded to the bottom of the support legs. The diaphragms are designed to lock onto, and be guided by a ground-mounted, center monorail support structure. (The 24”, 30”, 36 and 48” wide systems require the use of monorail stabilizer plates bolted between the diaphragm and rail guide.

   c. The fender panels are fabricated from 10 gauge steel Quad-Beam sections. The rear of each fender panel (the panel end furthest from the nose of the assembled system) is tapered to help maximize performance during wrong-way, redirective impacts. Each fender panel is drilled and slotted in accordance with the manufacturer’s specifications so that when assembled in the field, the front end (the end closest to the nose of the assembled system) is bolted to a diaphragm or hinge plate (depending on width of system) by means of 5/8” bolts. The rear of each Quad-beam fender panel overlaps the next rearward fender panel and is connected to the diaphragm or hinge plate of the next bay by means of a bolt and “mushroom” washer. The bolt fits through the long horizontal slot in the forward fender panel. This permits the movement, front to back, of one set of fender panels relative to the panels in the underlying, next rearward bay. For QuadGuard II Systems, the mushroom bolt assembly is held in place by a compression spring, which allows limited separation of the fender panels during an impact.
QuadGuard® II System

QuadGuard® II System

General Specifications (cont’d.)

2. The monorail support structure is made of steel and is to be anchored per manufacturer’s instructions, to a specified concrete pad. The monorail prevents lateral movement, vertical movement and overturning of the diaphragms during design impacts.

3. The nose section contains a nose cover and an energy absorbing cartridge and is not counted as a bay. The nose cover is made from 14 ga. steel, powder-coated to resist weathering. The nose attaches to the front diaphragm. Standard color is yellow.

4. The backup is made of steel and is attached to concrete or an integral tension strut framework, and is available in nominal widths of 610 mm [24"], 762 mm [30"], 915 mm [36"], 1219 mm [48"], 1753mm [69"], 2286mm [90"] and 3200 mm [126"].

5. Several transition panels are available as required by site conditions including: Quad-Beam to Safety Barrier, Quad-Beam to Thrie-Beam, Quad-Beam to W-Beam, and Quad-Beam End Shoe. Contact Energy Absorption Systems, Inc. for specific applications.

C. Material Specifications

1. Metal work is fabricated from either M1020 Merchant Quality or ASTM A-36 steel. After fabrication, metal work is galvanized in accordance with ASTM A-123. All welding is done by or under the direction of a certified welder.

2. The system is assembled with galvanized fasteners. All bolts, nuts, and washers are Commercial Quality “American National Standard” unless otherwise specified.

III. PERFORMANCE CRITERIA

A. For head-on impacts into the nose, a QuadGuard® II System shall be specified which is capable of meeting the occupant risk criteria as recommended in NCHRP 350. For vehicles weighing between 820 and 2000 kg [1,810 and 4,410 lbs], the theoretical impact velocity of a hypothetical front seat passenger against the vehicle’s interior (calculated from vehicle acceleration and 600mm [24"] forward displacement) shall be less than 12m/s [39.4 ft/sec], and the vehicle’s highest 10 millisecond average acceleration subsequent to the instant of the hypothetical passenger impact shall be less than 20 G’s.

B. The QuadGuard II System is capable of redirecting 2000 kg [4,410 lbs] vehicles which impact the sides of the system at speeds up to 100 km/h [62 mph] at angles of 20° (angles measured from system’s longitudinal centerline). The QuadGuard II System is capable of redirecting 820 kg [1,810 lbs] vehicles, which impact the sides of the system at speeds up to 100 km/h [62 mph] at angles of 15°. (See Test Criteria below.)

C. The QuadGuard II System is designed and constructed so there is no solid debris from the system which can create a hazard on the roadway after either head-on or side angle design impacts.

IV. TEST CRITERIA

The QuadGuard System has been fully tested per the recommended criteria set forth in National Cooperative Highway Research Program (NCHRP) Report 350, 1993, Test Level 3 for redirective, non-gating terminals and crash cushions.

V. DESIGN AND SELECTION CRITERIA


B. Installation of the QuadGuard II System attenuators shall be accomplished in accordance with the recommendations of Energy Absorption Systems, Incorporated.
QuadGuard® II System
QuadGuard® II CZ System
General Specifications

I. GENERAL
All QuadGuard II CZ Systems are designed and manufactured by Energy Absorption Systems, Incorporated, of Chicago, Illinois.

II. DESCRIPTION OF SYSTEM
A. General
The QuadGuard II CZ System consists of energy absorbing cartridges surrounded by a framework of steel Quad-beam® guardrail which can telescope rearward during head-on impacts. The QuadGuard II CZ System has a center monorail which will resist lateral movement during side angle impacts and a backup which will resist movement during head-on impacts. The nose consists of a steel nose wrap and an energy-absorbing cartridge. Transitions are available and may be required depending on site conditions.

The QuadGuard II CZ System is available in 3 to 9 bay lengths and nominal widths of 610 mm [24"], 762 mm [30"], 915 mm [36"] and 1219 mm [48"].

B. Component Descriptions
1. A bay describes a section of the QuadGuard II CZ System consisting of an energy absorbing cartridge, a diaphragm, two fender panels and fasteners.
   a. There are two types of cartridges, referred to as Type I and Type II. The front portion of the system is fitted with Type I cartridges. The rear of the system is fitted with Type II cartridges. The outside of each cartridge is fabricated from a weather resistant plastic. The actual quantity of each is determined by the system design speed.
   b. The diaphragms are made from 10 gauge, steel Quad-beam sections. Two support legs are welded to the Quad-beam. Ski-shaped plates are welded to the bottom of the support legs. The diaphragms are designed to lock onto and be guided by a ground-mounted, center monorail support structure.
   c. The fender panels are fabricated from 10 gauge steel Quad-beam sections. The rear of each fender panel (the panel end furthest from the nose of the assembled system) is tapered to help maximize performance during wrong-way, redirective impacts. Each fender panel is drilled and slotted in accordance with the manufacturer’s specifications so that when assembled in the field, the front end (the end closest to the nose of the assembled system) is bolted to a diaphragm by means of 5/8” bolts. The rear of each Quad-beam fender panel shall overlap the next rearward fender panel and be connected to the diaphragm of the next bay by means of a bolt and “mushroom” washer. The bolt fits through the long horizontal slot in the forward fender panel. This permits the front to back movement, of one set of fender panels relative to the panels in the underlying, next rearward bay.
2. The nose section shall contain a nose cover and an energy-absorbing cartridge and is not counted as a bay. The nose cover is made from 14 ga. steel, powdercoated to resist weathering. The nose shall attach to the front diaphragm. Standard color is yellow.
3. The monorail support structure is made of steel and be anchored per manufacturer’s instructions, to specified concrete pad or asphalt roadway. The monorail shall prevent lateral movement, vertical movement and overturning of the diaphragms during design impacts.
4. The backup is made of steel and be attached to an integral tension strut framework, and is available in nominal widths of 610 mm[24"], 760 mm[30"], 915 mm[36"] and 1219 mm [48"].
5. Optional Plate - The monorail backup section and the monorail extension section are available welded to steel plate sections. The plates shall be anchored per manufacturer’s instructions, to a specified concrete pad or asphalt roadway.
QuadGuard® II System

QuadGuard® II CZ System

General Specifications (cont’d.)

a. The monorail backup section is 3 bays long on a 10mm x 1.07m x 4.16m [3/8” x 3’6” x 13’7-5/8’'] plate. The backup and monorail are welded to the plate. The backup monorail section is available in normal widths of 610 mm [24’’], 760 mm [30’’], 915 mm [36’’] and 1219 mm [48”].

b. The monorail extension section is 3 bays long and can be added as required to the monorail backup section to make 4 to 9 bays systems. The plate of a monorail extension section is 10mm x 1.07m x 2.74m [3/8” x 3’6” x 9’’]. The monorail extension sections shall prevent lateral movement, vertical movement and overturning of the diaphragms during design impacts.

6. Several transition panels are available as required by site conditions including: Quad-beam to Safety Barrier, Quad-beam to Thrie-beam, Quad-beam to W-beam, and Quad-beam End Shoe. Transitions may be necessary to minimize potential vehicle snag conditions. Contact Energy Absorption Systems, Inc. for specific applications.

C. Material Specifications

1. Metal work is fabricated from either M1020 Merchant Quality or ASTM A-36 steel. After fabrication, metal work is galvanized in accordance with ASTM A-123. All welding is done by or under the direction of a certified welder.

2. The system is assembled with galvanized fasteners. All bolts, nuts, and washers are Commercial Quality "American National Standard" unless otherwise specified.

III. PERFORMANCE CRITERIA

A. The QuadGuard II CZ System is capable of redirecting 820 to 2000 kg [1,810 to 4,410 lbs] vehicles which impact the sides of the system at speeds up to 100 km/h [62 mph] at angles of 20 degrees for both right-way and wrong-way impacts (angles measured from system’s longitudinal centerline). (See Test Criteria below.)

B. For head-on impacts into the nose, a QuadGuard II CZ is capable of meeting the occupant risk criteria as recommended in NCHRP 350. For vehicles weighing between 820 and 2000 kg [1,810 and 4,410 lbs], the theoretical impact velocity of a hypothetical front seat passenger against the vehicle’s interior (calculated from vehicle acceleration and 610mm [24’’] forward displacement) shall be less than 12m/ s [39.4 ft/sec]. The vehicle’s highest 10 millisecond average acceleration subsequent to the instant of the hypothetical passenger impact shall be less than 20 G’s.

C. The QuadGuard II CZ System is designed and constructed so there is no solid debris from the system which can create a hazard on the roadway after either head-on or side angle design impacts.

IV. TEST CRITERIA

The five bay QuadGuard II CZ System has been tested per the recommended criteria set forth in National Cooperative Highway Research Program (NCHRP) Report 350, 1993, Test Level 3 for redirective, non-gating terminals and crash cushions.

V. DESIGN AND SELECTION CRITERIA


B. Installation of the QuadGuard II CZ System attenuators shall be accomplished in accordance with the recommendations of Energy Absorption Systems, Incorporated.
QuadGuard® II System

QuadGuard II System Design Criteria

Establish Basic System Specifications
The specification of a QuadGuard II System for a particular site must always include system width and system length.

1) Specification of System Width
The QuadGuard II System is available in five nominal widths:
- 610 mm [24”]
- 760 mm [30”]
- 915 mm [36”]
- 1019 mm [40”]
- 1225 mm [48”]
- 1372 mm [50”]
- 1755 mm [69”]
- 2285 mm [90”]
- 3200 mm [126”]

As a general rule, selection of the narrowest width that adequately shields the hazard is recommended.

2) Specification of System Length
System length is specified by the number of bays the system includes. The number of bays required is a function of the design speed of the roadway.

Choose a Backup Structure for the System
Two backup designs are available. The Tension Strut backup and the concrete backup. Both types are appropriate for use on grade or deck.

Special Site Conditions
Contact Energy Absorption Systems Customer Service Department if you would like assistance with your application. You will need to answer the following questions:

1. Are curbs, islands or elevated objects (delineators or signs) present at the site? What height and width are they? All curbs and elevated objects over 100 mm [4”] high should be removed. If possible, curbs under 100 mm [4”] high should be removed approximately 15 m [50’] in front of the QuadGuard® System, and as far back as the system’s backup. Any curbs that must remain should be 100 mm [4”] maximum and be mountable.

2. If the installation site is a gore area, (place where two roads diverge), what is the angle of divergence?

3. What is the general geometry of the site, including the roadway for 150 m [500’] in front, so traffic patterns can be visualized?

4. Is there an existing barrier? When there is an existing guardrail or median barrier at the site, the backup of the QuadGuard II System should tie into it when possible.

5. Will there be traffic approaching from the rear of the system? Is the system in a two-way traffic situation, with traffic going in opposite directions on either side of the system? Or, is the system on the side of the road in a location where cross over traffic is a concern? If so, a Transition from the back of the system to the hazard is necessary to prevent vehicle snagging (see Page 15).

6. Are there any other unique features at the site that may affect positioning or performance of the QuadGuard II System? (See next section).

Other Factors That May Affect Your Design:
1. The existence of drain inlets.
2. Junction boxes or other appurtenances located near the hazard.
3. Insufficient space for the length preferred.
4. The location and movement of expansion joints.

If these or any other special site conditions exist, please contact Energy Absorption Systems Customer Services Department before proceeding with your design. For Customer Service call: 1-888-323-6374.
QuadGuard® II System

QuadGuard II System Design Criteria (cont’d.)

This chart represents the modified versions of the QG II length relative to impact speed, and is based on the capacity of the system using a 2000 kg [4400 lb] Pickup truck.

<table>
<thead>
<tr>
<th># of Bays</th>
<th>Model #</th>
<th>Vehicle Speed kph [mph]</th>
<th>TYPE I Cartridge Qty.</th>
<th>TYPE II Cartridge Qty.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1*</td>
<td>QG240__</td>
<td>40 [25]</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>QG270__</td>
<td>70 [44]</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>3*</td>
<td>QG280__</td>
<td>80 [50]</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>4*</td>
<td>QG290__</td>
<td>90 [56]</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>QG2100__</td>
<td>100 [62]</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>6*</td>
<td>QG2105__</td>
<td>105 [65]</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>7*</td>
<td>QG2110__</td>
<td>110 [68]</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>8*</td>
<td>QG2115__</td>
<td>115 [71]</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>9*</td>
<td>QG2120__</td>
<td>120 [75]</td>
<td>4</td>
<td>6</td>
</tr>
</tbody>
</table>

Table A - Speed Chart For Narrow Systems

<table>
<thead>
<tr>
<th># of Bays</th>
<th>Model #</th>
<th>Vehicle Speed kph [mph]</th>
<th>TYPE I Cartridge Qty.</th>
<th>TYPE II Cartridge Qty.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
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<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3*</td>
<td>QG270__</td>
<td>70 [44]</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>4*</td>
<td>QG280__</td>
<td>80 [50]</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>QG2100__</td>
<td>100 [62]</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>6*</td>
<td>QG2105__</td>
<td>105 [65]</td>
<td>4</td>
<td>3</td>
</tr>
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<td>7*</td>
<td>QG2110__</td>
<td>110 [68]</td>
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<td>4</td>
</tr>
<tr>
<td>8*</td>
<td>QG2115__</td>
<td>115 [71]</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>9*</td>
<td>QG2120__</td>
<td>120 [75]</td>
<td>4</td>
<td>6</td>
</tr>
</tbody>
</table>

Table B - Speed Chart For Wide Systems

*System capacity estimated through calculation.

Impact conditions which differ from those described in the NCHRP 350 test matrix for non-gating, redirecting crash cushions may result in different crash results than those encountered in testing.

Furthermore, impacts in excess of TL-3 impact severity, or the existence (at the site of the installation) of curbs or cross slopes in excess of 8%, may yield crash performance which does not meet NCHRP 350 evaluation criteria relative to structural adequacy, occupant risk and vehicle trajectory factors.

Model Number Description

- NOMINAL WIDTH OF THE SYSTEM AT BACKUP
- QUADGUARD® II
- DESIGN SPEED (km/h)

Figure 4  
Model Number Key

For Customer Service Call  
1-888-32-ENERG
QuadGuard® II System

QuadGuard System Design Criteria (cont’d.)

Key
1 Cartridge
2 Diaphragm
3 Quad Beam Fender Panel
4 Nose Cover
5 Monorail
6 Backup

Plan & Elevation (Five bay System with Tension Strut backup Shown)

Figure 5
QuadGuard® II System

QuadGuard II cz Design Criteria

The portable compact crash cushion for construction zones. The QuadGuard II cz is available in the same narrow sizes as permanent systems.

A wise choice...

because the Construction Zone QuadGuard (QuadGuard II cz) provides the same lifesaving efficiency and features of the permanent QuadGuard II System. The QuadGuard II cz is designed to redirect vehicles hitting the system along the side. After a typical design speed head on impact the majority of the system can be used again. The system can usually be repaired by pulling it back into place and replacing the Nose and Cartridges. (Depending on the foundation a QuadGuard II cz may need to be reset after impact.)

because the QuadGuard II cz is easy to transport. The system can be pre-assembled away from the job site. When the need arises, the QuadGuard II cz, can be positioned at the impact site with the aid of a 2 ton lifting device.

because installation of the QuadGuard II cz usually requires little site preparation. Both the lifting platform and steel backup are integral parts of the QuadGuard II cz so the installation of anchor bolts is usually all that is necessary.

because the QuadGuard II cz may be permanently installed on a prepared site. When there is no longer a need for temporary site protection, or when the construction job is finished, the QuadGuard II cz can be permanently installed.

because the QuadGuard II cz is crush efficient. Cartridges offer exceptional energy absorbing efficiency. With variable design lengths systems can be tailored to meet your design criteria. The QuadGuard II cz offers the best size/efficiency ratio of any impact attenuator. Thus, the shortest system possible for a given design speed can be installed. This increases driver decision distance and reduces the likelihood of the system being hit.

because the QuadGuard II cz meets your needs for temporary protection at most construction sites. Whether it be the end of unfinished median barriers, bridge piers, temporary or permanent safety walls, light posts, or numerous other types of hazards. As with the permanent QuadGuard II System, the system size should be chosen so that the width and length are no larger than necessary.

The QuadGuard II cz must be properly anchored. Refer to Page 12 for the recommended anchorage for various foundations.

Table C  QuadGuard II cz on a Plate Model Numbers

<table>
<thead>
<tr>
<th>NUMBER OF BAYS</th>
<th>NOMINAL WIDTH</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>610 mm [24&quot;]</td>
</tr>
<tr>
<td>2</td>
<td>QZ27024P</td>
</tr>
<tr>
<td>5</td>
<td>QZ210024P</td>
</tr>
</tbody>
</table>

Model Number Description

QUADGUARD II CZ (CONSTRUCTION ZONE)

DESIGN SPEED (km/h)

PLATE/MONORAIL SECTIONS

WIDTH OF THE BACKUP (610 mm [24"], 760 mm [30"], 915 mm [36"], 1219 mm [48") )
QuadGuard® II System

QuadGuard II cz Foundation Specifications

Foundation Specifications

The QuadGuard cz may be installed on any of the following Foundations using the specified anchorage:

A: Concrete Pad

Foundation: 150 mm [6"] minimum depth
Portland Cement Concrete (P.C.C.)
Anchorage: MP-3® with 180 mm [7"] studs
140 mm [5.5"] embedment

Note: 18” Anchors are supplied with the QuadGuard cz. If another substrate is encountered, please call customer service to discuss options.

B: Asphalt over P.C.C.

Foundation: 75 mm [3"] minimum Asphalt Concrete (A.C.) over 75 mm [3"] minimum (P.C.C.)
Anchorage: MP-3 with 460 mm [18"] studs
420 mm [16.5"] embedment

C: Asphalt over Subbase

Foundation: 150 mm [6"] minimum (A.C.) over 150mm [6in] minimum Compacted Subbase (C.S.)
Anchorage: MP-3 with 460 mm [18"] studs
420 mm [16.5"] embedment

D: Asphalt Only

Foundation: 200 mm [8"] minimum (A.C.)
Anchorage: MP-3 with 460 mm [18"] studs
420 mm [16.5"] embedment

A. C. (Asphalt Concrete)

AR-4000 A. C.
(per ASTM D3381 ’83) .75" Maximum,
Medium (Type A or B) aggregate
Sieve Size Operating Range (%) Passing
1” 100
3/4” 95-100
3/8” 65-80
No. 4 49-54
No. 8 36-40
No. 30 18-21
No. 200 3-8

P.C.C. (Portland Cement Concrete)

Stone aggregate concrete mix
4000 psi minimum compressive strength
(Sampling per ASTM C31-84
or ASTM C42-84a, testing per ASTM C39-84)

C.S. (Compacted Subbase)

150 mm [6"] minimum depth 95% compaction
Class 2 aggregate
Sieve Size Moving Average % Passing
3” 100
2 1/2” 90-100
No. 4 40-90
No. 200 0-25

For Customer Service Call
1-888-32-ENERG
QuadGuard® II System

General Installation Information

Required Tools

Documentation
- Manufacturer’s Installation Manual
- Manufacturer’s Drawing Package

Cutting equipment
- Rebar Cutting Bit
- 22 mm (7/8”) Concrete Drill Bits (*Two Fluted)
- Grinder, Hacksaw or Torch (optional)
- Drill Motor
- Drill Bits: 1/16” through 7/8”

* Energy Absorption Systems recommends using two fluted drills to achieve optimum tensile strength when installing the MP-3 anchoring system.

Hammers
- Roto Hammer
- Sledgehammer
- Standard Hammer

Wrenches
- Heavy Duty Impact Wrench
- Standard adjustable wrench
- 1/2” drive sockets: 7/16”, 9/16”, 11/16”, 3/4”, 15/16”, 1 1/8”, 1 1/4”
- Deep Sockets: 5/16”, 1 1/4”
- Ratchet and attachments for the above sockets
- Breaker Bar: 1/2” x 24”
- Torque Wrench: 200 ft-lbs.
- Crescent Wrench: 300 mm [12”]
- Allen Wrench: 3/8”
- Impact Wrench: 1/2”
- Open End Wrench: 7/16”

Personal protective equipment
- Safety Glasses
- Gloves

Miscellaneous
- Traffic Control Equipment
- Lifting and Moving Equipment (A lifting device is preferred although a forklift can be used.) Minimum 5,000 lb. capacity required.
- Compressor (100 psi) and Generator (5 KW)
- Long Pry Bar
- Drift Pin 300 mm [12”]
- Center Punch
- Tape Measure 7.5 m (25’)
- Chalk Line
- Concrete Marking Pencil
- Nylon bottle brush for cleaning 7/8” drilled holes
- Rags, Water, and Solvent for Touch-up

Note: The above list of tools is a general recommendation. The actual number of tools required will depend on specific site conditions and the complexity of the installation.
QuadGuard® II System

Transitioning

Quad-Beam End Shoe Transition Panel
The Quad-Beam End Shoe Panel transitions the Quad-Guard II System to vertical faced concrete structures whether it is a concrete backup or concrete barrier wall, see Page 15. An Extended End Shoe is also available. In cases where the corners of the hazard are not chamfered it may be necessary to add wheel deflectors to the structure in order to prevent wheel snagging.

Quad-Beam to Guardrail Transition Panel (W-beam and Thrie-Beam)
The Quad-Beam to W-beam and Quad-Beam to Thrie-Beam Transition Panels transition the QuadGuard II System to new and existing runs of standard guardrail, see Page 15.

Quad-Beam to Safety Barrier Transition Panel
There are several options available when transitioning the QuadGuard II System to safety shape barrier depending on the shape and position of the barrier.

When transitioning to barriers with a “New Jersey” style profile, the 4” offset transition panel is most commonly used, see Page 15. For transitioning to barriers that are in line with the side of the system, use transition assembly 354018L or R. For transitioning a wide system to barrier that runs parallel to the centerline of the system, transition assembly 354042L or R is used. A 9” offset transition panel is also available for transitioning to barriers that are in line with the side of the system.

When transitioning to Single Slope style barriers and parapets, 6” and 8” offset transition panels are available. For transitioning a wide system to barrier that runs parallel to the centerline of the system, a 6” offset panel is available.

How do you determine the transition panel offset?
The Transition Panel Offset is determined by measuring the distance between the face of the barrier and the top edge of the backup diaphragm at 32” above ground level, see Figure 7. Remember, when installing the QuadGuard II System that the correct transition panel offset must be achieved in order for the offset bracket to nest between the barrier and transition panel ensuring proper performance of the transition.
Transitioning (cont’d.)

Transition Panel Types
If a system is placed in a location where traffic will be approaching from the rear, a transition panel is necessary. Figures 8, 9, 10 & 11 show the standard panel types. There are variations for each panel type. The specific panel needed will depend on system and site conditions. Therefore, it is important to send site specific data to the customer service department for a recommendation for exact panel needed for your application.

Figure 8
Quad-Beam to Safety Barrier (NJ Shape) Transition Panel

Figure 9
Quad-Beam to Thrie-Beam Transition Panel

Figure 10
Quad-Beam to W-Beam Transition Panel

Figure 11
Quad-Beam End Shoe Transition Panel
QuadGuard® II System

Site Preparation

Establish Required System Footing

Note that the system must be anchored. MP-3 polyester anchor bolts will be supplied for all required anchorages in concrete. Refer to QuadGuard II Installation Manual, or MP-3 kits for detailed installation instructions.

1) Is the system to be placed on existing concrete?

Existing concrete - Concrete must be at least 150 mm [6"] thick, reinforced 28 MPa [4000 psi] Portland cement concrete (P.C.C.), or 200 mm [8"] thick non-reinforced 28 MPa [4000 psi] P.C. Concrete Roadway, measuring at least 3.66 m [12'-0"] wide by 15.24 m [50'-0"] long. The concrete should be in good condition and be free of major cracks.

New concrete - If existing concrete does not meet these criteria, a new concrete pad must be placed to properly secure the system. See concrete pad details supplied with the system.

2) Is there a cross slope at the installation site?

Cross slope exists - If there is a cross slope of more than 8% (5 deg.), or if the cross slope varies (twists) more than 2% (1 deg.) over the length of the system, a concrete leveling pad may be required. (See Figure 12)

No Cross slope - No additional action is required.

General Maintenance and Repair

The QuadGuard II System is considered to be reusable. After most design impacts, you can expect to reuse 65 - 70% of the system. The system must be inspected after each impact and must be pulled out to its original length. Depending on the impact, components may get damaged and need replacement.

Estimated time for Maintenance

An experienced two person crew with the proper tools and spare parts should be able to complete the work in one to 3 hours depending on the damage done to the system.

Life Expectancy

Environment

Except due to impact damage, it is anticipated that the cartridges will survive in a highway environment for a period ranging from 10 to 15 years from the date of installation.

Impacts

Life expectancy is also dependent on the impacts. This includes:

1. The number of impacts
2. The severity of the impacts
3. The temperature at the time of the impacts

Systems must be inspected after each impact. Any cartridge that is crushed or otherwise damaged should be replaced and the system should be pulled out to its original length.

IMPORTANT: After an impact, always follow the “Post-Impact Instructions” in the maintenance and repair section of the installation manual.

Recycling Information

When parts need to be replaced, it is recommended that the old parts be recycled as follows:

Steel should be sold as scrap to a local metal recycler.
Plastic from the cartridges should be sold to a plastic recycler if available. If a recycler is unavailable, dispose of the material as plastic refuse.

Figure 12
Cross-Slope

The 5 bay QuadGuard II System has been tested and evaluated per the recommendations of the NCHRP 350 Guidelines* for Test Level 3 (TL-3) terminals and crash cushions. These tests typically evaluate product performance by closely simulating actual impacts involving a typical range of vehicles on roadways, from lightweight cars (approx. 820 kg [1800 lb.]) to full size pickup trucks (approx. 2000 kg [4400 lb.]). A product can be certified for various speed levels.

- TL-1: 50 km/h [31.10 mph]
- TL-2: 70 km/h [43.49 mph]
- TL-3: 100 km/h [62.13 mph]

These tests are not designed to represent the performance of products when impacted by every vehicle type or every impact condition.

Energy Absorption Systems, Inc. does not represent nor warrant that the results of these controlled tests show that vehicle impacts with the products in other conditions would necessarily avoid injury to person(s) or property. Impacts that exceed the design capabilities of the product may not result in acceptable crash performance as outlined in NCHRP Report 350, relative to structural adequacy, occupant risk and vehicle trajectory. Energy Absorption Systems, Inc. expressly disclaims any warranty or liability for injury or damage to persons or property resulting from any impact, collision, or harmful contact with products, other vehicles, or nearby hazards or objects by any vehicle, object or person, whether or not the products were installed by or under the direction of Energy Absorption Systems, Inc. or by third parties.

Impact conditions which differ from those described in NCHRP 350 test matrix for non-gating, redirecting crash cushions may result in different crash results than those encountered in testing. Furthermore, impacts in excess of TL-3 impact severity, or the existence (at the site of the installation) of curbs or cross slopes in excess of 8% may yield crash performance which does not meet NCHRP 350 evaluation criteria relative to structural adequacy, occupant risk and vehicle trajectory factors.

The QuadGuard II System was designed to be installed, delineated, and maintained in accordance with State and Federal guidelines. It is important to select the most appropriate product configuration for a site. The customer should be careful to properly select, install and maintain the product. Careful evaluation of the site geometry, vehicle population type, speed, traffic direction and visibility are some of the elements that require evaluation in the proper selection of a safety appurtenance. For example, curbs could cause unsafe vehicle trajectory.

After an impact occurs, the product should be restored to its original condition as soon as possible. When a reusable safety product is struck, it is still necessary to restore the product to its original length and inspect all the components for damage and repair and/or replace components as necessary.

*Copy may be obtained from:
Transportation Research Board
National Research Council
2101 Constitution Avenue, N.W.
Washington, D.C. 20418
NOTES:
1. IN COMPLIANCE WITH THE AASHTO 2002 ROADSIDE DESIGN GUIDE, MANUFACTURER RECOMMENDS REMOVAL OF ALL CURBS AND ISLANDS TO ENSURE PROPER IMPACT PERFORMANCE.
2. PROVISION SHALL BE MADE FOR REAR FENDER PANELS TO SLIDE REARWARD UPON IMPACT.
3. 150 [6.00] MIN. REINFORCED MPa [4000 PSI] P.C. CONCRETE PAD OR 200 [8.00] MIN. NON-REINFORCED MPa [4000 PSI] P.C. CONCRETE ROADWAY, MEASURING AT LEAST 3.66 m [12'-0"] WIDE BY 15.24 m [50'-0"] LONG.
4. SEE THE QUADGUARD II SYSTEM PRODUCT MANUAL FOR A DESCRIPTION OF ITS IMPACT PERFORMANCE CHARACTERISTICS AND DESIGN LIMITATIONS BEFORE PLACING A SYSTEM AT A GIVEN SITE. INFORMATION AND COPIES OF ABOVE MANUAL ARE AVAILABLE BY CALLING CUSTOMER SERVICE DEPARTMENT AT (888) 323-6374.
5. WHERE NECESSARY, THE CUSTOMER SHALL SUPPLY AN ADEQUATE TRANSITION FROM THE QUADGUARD II SYSTEM TO THE OBJECT BEING SHIELDED.
6. UNITS OF MEASUREMENT ARE MILLIMETERS [INCHES] UNLESS OTHERWISE NOTED.
7. BACKUP, MONORAIL, AND NOSE ASSEMBLIES ARE NOT INCLUDED IN MODEL NUMBER, ORDER SEPARATELY.
8. THE QUADGUARD II HAS BEEN FULLY TESTED TO NCHRP 350.

REFERENCES:

D. Kohfeld
M. Buehler
KRM
R. Brougher

EH PROJECT

IN REF BOX SHIM KIT WAS (RAIL GUIDE) (ECO2663) 2/26/09 A WWL STT MJB
REPLACED 2 BAY TABLE WITH 9 BAY TABLE 6/8/09 B DDS JME RCB

REVIEW

Date: 2/20/09

A: 18 QG2CBCVR-U.idw

REVISION HISTORY

10/29/08 QG210524

10/29/08 QG28024

10/29/08 QG29024

10/29/08 QG210530

10/29/08 QG210536

10/29/08 QG211024

10/29/08 QG211524

10/29/08 QG211536

10/29/08 QG211548

10/29/08 QG211048

10/29/08 QG211036

10/29/08 QG210036

10/29/08 QG28036

10/29/08 QG29036

10/29/08 QG211030

10/29/08 QG210030
### QUADGUARD II® SYSTEM

**NOTES:**
1. In compliance with the AASHTO 2002 Roadside Design Guide, Manufacturer recommends removal of all curbs and islands to ensure proper impact performance.
2. Provision shall be made for rear fender panels to slide rearward upon impact. 762 [30.00] min.
4. See the "QUADGUARD II® System Product Manual" for a description of its impact performance characteristics and design limitations before placing a system at a given site. Information and copies of above manual are available by calling customer service department at (888) 323-6374.
5. Where necessary, the customer shall supply an adequate transition from the QUADGUARD II® System to the object being shielded.
6. Units of measurement are millimeters [inches] unless otherwise noted.
7. Backup, monorail, and nose assemblies are not included in model number, order separately.
8. The QUADGUARD II® System has been tested to NCHRP 350.

### TABLE

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**REFERENCES**

- QG2T5CVR-U 1 1 B

**QUADGUARD II® SYSTEM**

**WITH TENSION STRUT BACKUP**

**REV. DATE**

- 2/26/09 A DK JME MJB
- 6/22/09 B DDS STT RCB

**DIMENSIONS**

- 1220 [48.03] [INCHES]
- 102 [4.00] [INCHES]
- 915 [36.02] [INCHES]
- 210 [8.28] [INCHES]
- 816 [32.14] [INCHES]
- 1220 [48.03] [INCHES]

**REFERENCES**

- QG2T5CVR-U.idw

**KEY**

- 1. CARTRIDGE
- 2. MONORAIL
- 3. DIAPHRAGM ASSEMBLY
- 4. NOSE ASSEMBLY
- 5. FENDER PANEL
- 6. BACKUP

**REFERENCES**

- SHLS KIT. DIAPHRAGM 35-40-07
- NOSE ASSEMBLY 35-40-07
- MONORAIL ASSY. 35-40-06
- BACKUP ASSY. 35-40-05
- CONCRETE PAD 35-40-04

**SERIAL NO.**

- EH PROJECT 35-40-00
- FENDER PANEL ASSY. 35-40-03
- CONCRETE PAD 35-40-70

**SALES ORDER**

- 35-40-01
- 35-40-02
- 35-40-04
- 35-40-70

**REV.**

- 1


**FILE**

- QG2T5CVR-U.idw
2. Provision shall be made for rear fender panels to slide rearward upon impact 762 [30.00] min.

3. Caution: The Quadguard II CZ must be correctly anchored for proper impact performance.

4. Where necessary, the customer shall supply an adequate transition from the Quadguard II system to the object being shielded.

8. The Quadguard II has been fully tested to NCHRP 350.
1. In compliance with the AASHTO 2010 Roadside Design Guide, manufacturer recommends removal of all curbs and islands to ensure proper impact performance.

2. Provision shall be made for rear fender panels to slide rearward upon impact RG (30.00 ft).

3. 150 (6.00) MIN. REINFORCED 28 MPa [4000 PSI] P.C. CONCRETE PAD OR 200 (8.00) MIN. NON-REINFORCED 28 MPa [4000 PSI] P.C. CONCRETE ROADWAY, MEASURING AT LEAST 3.66 m [12'-0"] WIDE BY 15.24 m [50'-0"] LONG.

4. See the "QUADGUARD II SYSTEM PRODUCT MANUAL" for a description of its impact performance characteristics and design limitations before placing a system at a given site. Information and copies of above manual are available by calling Customer Service Department at (888) 323-6374.

5. Where necessary, the customer shall supply an adequate transition from the QUADGUARD II system to the object being shielded.

6. Units of measurement are millimeters [inches] unless otherwise noted.

7. Backup, monorail, and nose assemblies are not included in model number, order separately.

8. The QUADGUARD II family has been fully tested to NCHRP 350.

UNIDIRECTIONAL

QUADGUARD II SYSTEM
WITH CONCRETE BACKUP

QF2BCVR-U 1 1 B

M. Buehler
JME
4/15/2009

4/14/2009

12/30/2008

D. Kohfeld

4/6/2009

NOTES:

1. IN COMPLIANCE WITH THE AASHTO 2010 ROADSIDE DESIGN GUIDE, MANUFACTURER RECOMMENDS REMOVAL OF ALL CURBS AND ISLANDS TO ENSURE PROPER IMPACT PERFORMANCE.

2. PROVISION SHALL BE MADE FOR REAR FENDER PANELS TO SLIDE REARWARD UPON IMPACT RG (30.00 ft).

3. 150 (6.00) MIN. REINFORCED 28 MPa [4000 PSI] F.C. CONCRETE PAD OR 200 (8.00) MIN. NON-REINFORCED 28 MPa [4000 PSI] P.C. CONCRETE ROADWAY, MEASURING AT LEAST 3.66 m [12'-0"] WIDE BY 15.24 m [50'-0"] LONG.

4. SEE THE "QUADGUARD II SYSTEM PRODUCT MANUAL" FOR A DESCRIPTION OF ITS IMPACT PERFORMANCE CHARACTERISTICS AND DESIGN LIMITATIONS BEFORE PLACING A SYSTEM AT A GIVEN SITE. INFORMATION AND COPIES OF ABOVE MANUAL ARE AVAILABLE BY CALLING CUSTOMER SERVICE DEPARTMENT AT (888) 323-6374.

5. WHERE NECESSARY, THE CUSTOMER SHALL SUPPLY AN ADEQUATE TRANSITION FROM THE QUADGUARD II SYSTEM TO THE OBJECT BEING SHIELDED.

6. UNITS OF MEASUREMENT ARE MILLIMETERS [INCHES] UNLESS OTHERWISE NOTED.

7. BACKUP, MONORAIL, AND NOSE ASSEMBLIES ARE NOT INCLUDED IN MODEL NUMBER, ORDER SEPARATELY.

8. THE QUADGUARD II FAMILY HAS BEEN FULLY TESTED TO NCHRP 350.

WITH CONCRETE BACKUP

QF2BCVR-U 1 1 B

M. Buehler
JME
4/15/2009

4/14/2009

12/30/2008

D. Kohfeld

4/6/2009

NOTES:

1. IN COMPLIANCE WITH THE AASHTO 2010 ROADSIDE DESIGN GUIDE, MANUFACTURER RECOMMENDS REMOVAL OF ALL CURBS AND ISLANDS TO ENSURE PROPER IMPACT PERFORMANCE.

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7. BACKUP, MONORAIL, AND NOSE ASSEMBLIES ARE NOT INCLUDED IN MODEL NUMBER, ORDER SEPARATELY.

8. THE QUADGUARD II FAMILY HAS BEEN FULLY TESTED TO NCHRP 350.
1. In compliance with the AASHTO 2002 Roadside Design Guide, manufacturer recommends removal of all curbs and islands to ensure proper impact performance.

2. Provision shall be made for rear fender panels to slide rearward upon impact.

3. See Note 7.

4. See the "QuadGuard II System Product Manual" for a description of its impact performance characteristics and design limitations before using a system at a given site. Information and copies of above manual are available by calling Customer Service Department at (888) 323-6374.

5. Where necessary, the customer shall supply an adequate transition from the QuadGuard II system to the object being shielded.

6. Units of measurement are millimeters/inches unless otherwise noted.

7. Backup, monorail, and noise assemblies are not included in model number, order separately.

8. The QuadGuard II has been fully tested to NCHRP 350 TL-3.


10. See Note 2.

11. SEE NOTE 7.
NOTE:
QUADGUARD II REQUIRES SHIM KIT.
SEE DRAWING 3540078—0000.
# PARTS LIST

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**ASSEMBLY NO. 3540078-0000**

**SHIM KIT, DIAPHRAGM, RAIL GUIDE, QG II**

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**DETAIL A**
TYPICAL BOTTOMS

---

**Shim Kit, Diaphragm, Rail Guide, QG II**

**Revision History**

- **D. Kohfeld**: 2/27/09
- **M. Buehler**: 12/30/08
- **JME**: 3/4/09
- **MJB**: 3/19/09

**Description Change**

- **Description WAS**: SHIM KIT, RAIL GUIDE, QG2 (ECO 2663) 5/27/09 A WWL STT MJB
- **Updated ITEM 1**: 7/14/09 B DKB JME RCB

**File Reference**

- 3540078-0000.idw

**Drawing Details**

- **Drawing Scale**: DRAWING
- **Drawing SHEET**: REVISION
- **Drawing FILE**: 3540078-0000

- **Drawing Created By**: JME
- **Revision Date**: 5/27/09
- **Checked By**: WWL
- **Approved By**: MJB
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*1 - YELLOW
*2 - BLACK

#### ASSEMBLY NO. 3540042-0100 (YELLOW)

- ADDED BLACK OPTION, DWG NO. WAS 3540042-0100. 4/9/09 A DK KRM MJB

- NOSE ASSY, QGII, NARROW

#### ASSEMBLY NO. 3540042-0200 (BLACK)

- ADD SHEET 2, PN 3540044-0100 & 3540044-0200. 5/22/09 B DK BK BRE
**NOTES:**

1. Dimensions are in millimeters [inches] unless otherwise noted.
2. For reference only. Use Item 1 as a template to drill holes in concrete.
3. A rebar cutting bit will likely be required to achieve proper anchor installation.
4. Studs located in upper valley will need to extend approx. 2.50 in from face of concrete in order to get nuts on. Washers may be omitted.

**REFERENCES**

**CONCRETE BACKUP, CG**

**QUADGUARD® SYSTEM**

**back-up assy, concrete, cg**

**UNI-DIRECTIONAL**

**ASSEMBLY NO. (SEE TABLE)**

**ENERGY ABSORPTION SYSTEMS, INC.**

**ENGINEERING AND RESEARCH DEPARTMENT**

**sheet 30**
CONCRETE BACKUP ASSY

TOTAL RAIL LENGTH

SEE TABLE 1, SHEET 1

VARES:
24”
30”
36” (SHOWN)

325 (10.00) (H)'

NOTES:
1. RAIL 180 (7.00) THICK, 28 WPS (4000 PS) REINFORCED CONCRETE DECK STRUCTURE
2. 150 (6.00) WPS. REINFORCED 28 WPS (4000 PS) P.C. CONCRETE PADS.
3. 200 (8.00) WPS. NON-REINFORCED CONTINUOUS 28 WPS
4. 4000 PS) P.C. CONCRETE ROADWAY. (MEASURING AT LEAST 3.8 m (12’-0") WDE BY 15.24 m (50’-0") LONG).

NOTE: MONORAIL & BACKUP ASSEMBLY MUST BE STRAIGHT TO WITHIN 13 (0.50)

PLAN
TYPICAL 8 BAY ASSEMBLY

CAUTION
40 (1.50) MAXIMUM STUD HEIGHT

ASSEMBLY NO. SEE TABLE 1 ON SHEET 1

ELEVATION
(W/CONCRETE BACKUP)

REFERENCES

QUADGUARD® SYSTEM
MONORAIL ASSY, QG II

ENERGY ABSORPTION SYSTEMS, INC.
ENGINEERING AND RESEARCH DEPARTMENT

REV.

W. Ledington 2/27/09
S. Trogser 2/28/09
M. J. Blueher 2/28/09

DATE

354075-02.dwg

CHECK

N.T.S. 35-40-75

2 of 3
### TABLE "L"

<table>
<thead>
<tr>
<th>NO. OF BAYS</th>
<th>(PAD LENGTH)</th>
<th>REBAR REQUIRED</th>
<th>YARDS OF CONCRETE [m³]</th>
<th>YARDS [YARDS]</th>
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<tr>
<td></td>
<td>m</td>
<td>m</td>
<td>m</td>
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<tr>
<td>1</td>
<td>1.60 (5' - 6&quot;)</td>
<td>9.73 (3' - 4&quot;)</td>
<td>0.37 (0.5)</td>
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<tr>
<td>2</td>
<td>2.99 (10' - 6&quot;)</td>
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<td>0.56 (0.7)</td>
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<tr>
<td>3</td>
<td>3.51 (12' - 6&quot;)</td>
<td>20.40 (13' - 6&quot;)</td>
<td>0.66 (0.9)</td>
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<td>4</td>
<td>4.42 (14' - 0&quot;)</td>
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<td>0.63 (1.1)</td>
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<td>5</td>
<td>5.33 (17' - 0&quot;)</td>
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<td>1.05 (1.4)</td>
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<td>6</td>
<td>6.25 (20' - 0&quot;)</td>
<td>36.96 (21' - 0&quot;)</td>
<td>1.21 (1.6)</td>
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<td>1.74 (2.3)</td>
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---

### SECTION A-A

- **15mm [5"] REBARS AT 610 [24.00] CENTERS**
- **28 MPa (4000 PS) STONE AGGREGATE CONCRETE 23.24 kg/m³ [145 lb/cu. ft.]**

---

### PLAN VIEW

- **610 [24.00] MIN. [REF.]**
- **76 [3.00]**
- **15mm [5"] REBAR AT 610 [24.00] CENTERS**
    - **NOTE 1:** REBAR 356 [14.00] FROM FRONT FACE OF BACKUP

---

**NOTES:**
1. CROSS SLOPE OF PAD SHALL NOT EXCEED 8% AND NOT VARY MORE THAN 2% FROM FRONT TO BACK.
2. PAD AND BELOW GRADE BACKUP BLOCK SHOULD BE TIED TOGETHER & Poured MONOLITHICALLY.
3. DIMENSIONS ARE IN mm [INCHES] UNLESS OTHERWISE NOTED.

---

**REFERENCES**

<table>
<thead>
<tr>
<th>W. Laddington</th>
<th>5/27/09</th>
</tr>
</thead>
<tbody>
<tr>
<td>S. Troyer</td>
<td>5/28/09</td>
</tr>
<tr>
<td>M.J. Ruinier</td>
<td>5/29/09</td>
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**QUADGUARD™ II SYSTEM**

**CONCRETE PAD, FOR CONC. BACKUP, QQ**

---

**CATALOG:** 1:20 35-40-77 1 of 1
NOTES:
1. WHEN TRANSITIONING QUADGUARD SYSTEM TO EXISTING BARRIER REFER TO THE TRANSITION ASSEMBLY DRAWINGS FOR PROPER USE OF SIDE PANEL PART NO. 2760541-0000.
<table>
<thead>
<tr>
<th>NO. OF BAYS</th>
<th>(PAD LENGTH) [m]</th>
<th>(PAD LENGTH) [ft]</th>
<th>REBAR REQUIRED [m³]</th>
<th>REBAR REQUIRED [YARDS³]</th>
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<td>1</td>
<td>2.74 [9' 0&quot;]</td>
<td>8.33 [24']</td>
<td>0.59 [2.0]</td>
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<td>2.74 [9' 0&quot;]</td>
<td>8.33 [24']</td>
<td>0.59 [2.0]</td>
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<tr>
<td>3</td>
<td>3.85 [12' 6&quot;]</td>
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<td>18.20 [60']</td>
<td>1.97 [6.8]</td>
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<tr>
<td>5</td>
<td>6.49 [21' 0&quot;]</td>
<td>21.25 [69']</td>
<td>2.12 [7.6]</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>6.49 [21' 0&quot;]</td>
<td>21.25 [69']</td>
<td>2.12 [7.6]</td>
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<tr>
<td>7</td>
<td>7.82 [25' 9&quot;]</td>
<td>25.66 [84']</td>
<td>2.51 [8.9]</td>
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<tr>
<td>8</td>
<td>8.23 [27' 0&quot;]</td>
<td>27.59 [90']</td>
<td>2.66 [9.3]</td>
<td></td>
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<tr>
<td>9</td>
<td>9.44 [30' 9&quot;]</td>
<td>31.03 [102']</td>
<td>2.81 [9.6]</td>
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SECTION A-A

"L" (SEE TABLE)

16mm [\#5] REBAR AT 810 [26.00] CENTERS
BEGIN 1575 [52.00] FROM REAR EDGE OF PAD

REBAR SCHEDULE

- 40 [1575] 16mm [\#5] REBARS
  - EVENLY SPACED

QUADGUARD PAD

- MINIMUM P.C. CONCRETE PAD AND ANCHOR BLOCK
- 25 kg/m² [145 Lbs/CF FT]

NOTES:
1. CROSS SLOPE OF PAD SHALL NOT EXCEED 8%, AND NOT VARY MORE THAN 2% FROM FRONT TO BACK.
2. UNITS OF MEASUREMENT ARE MILLIMETERS [INCHES] UNLESS OTHERWISE NOTED.

REFERENCES

- W. Lennarson
- S. Trager
- M. J. Bluhm
- J. D. Smith
- 354076.DWG
- D. L. Jones
- S. W. Smith

ENERGY ABSORPTION SYSTEMS, INC.
ENGINEERING AND RESEARCH DEPARTMENT

QUADGUARD® II SYSTEM CONCRETE PAD FOR TENSION STRUT BACKUP

1575 [52.00] FROM REAR EDGE OF PAD

PLACE 16mm [\#5] REBAR AT 76 [3.00] FROM EDGE FOR ALL PAD LENGTHS.
### TABLE

<table>
<thead>
<tr>
<th>NO. OF BAYS</th>
<th>&quot;L&quot; (PAD LENGTH) m</th>
<th>&quot;P&quot; m</th>
<th>REBAR REQUIRED m³ (YD³)</th>
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<tr>
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<td>4.57 (15'-0&quot;)</td>
<td>1.1 (3'-9&quot;)</td>
<td>25.50 (83'-8&quot;)</td>
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<tr>
<td>3</td>
<td>4.57 (15'-0&quot;)</td>
<td>1.1 (3'-9&quot;)</td>
<td>25.50 (83'-8&quot;)</td>
</tr>
<tr>
<td>4</td>
<td>4.57 (15'-0&quot;)</td>
<td>1.1 (3'-9&quot;)</td>
<td>25.50 (83'-8&quot;)</td>
</tr>
<tr>
<td>5</td>
<td>4.57 (15'-0&quot;)</td>
<td>1.1 (3'-9&quot;)</td>
<td>25.50 (83'-8&quot;)</td>
</tr>
<tr>
<td>6</td>
<td>4.57 (15'-0&quot;)</td>
<td>1.1 (3'-9&quot;)</td>
<td>25.50 (83'-8&quot;)</td>
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<td>25.50 (83'-8&quot;)</td>
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<td>4.57 (15'-0&quot;)</td>
<td>1.1 (3'-9&quot;)</td>
<td>25.50 (83'-8&quot;)</td>
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</tbody>
</table>

### Notes:
1. CROSS SLOPE OF PAD SHALL NOT EXCEED 8%, AND NOT VARY MORE THAN 2% FROM FRONT TO BACK.
2. TO PREVENT SLIDING DURING AN IMPACT, PAD MUST BE INSTALLED AGAINST OR TIED TO AN EXISTING STRUCTURE. OTHERWISE ADDITIONAL BELOW GRADE SUPPORTS MUST BE ADDED AS DETERMINED NECESSARY BY THE PROJECT ENGINEER.
3. UNITS OF MEASUREMENT ARE MILLIMETERS [INCHES] UNLESS OTHERWISE NOTED.

### References

| D. Stans | 5/15/96 |
| W. Programs | 3/7/96 |
| S. Troeger | 3/24/96 |
| W. Programs | 3/28/96 |

### Energy Absorption Systems, Inc.

**QUADGUARD™ System**

CONCRETE PAD, CZ, QQ

---

**Revision History**

- **3 BAY PAD WAS 12’ LONG** 08/09/96 E RH SM 3’Pt
- **CHANGED PAD WIDTH TO 1220** 11/06/96 D EM W 3’Pt
- **ADDED 3 BAY TO PAD TABLE** 6/27/96 E MK KB

**Scale:** 1:20

**Material:** 35-40-10 1 of 1

**Energy Absorption Systems, Inc.**

**Engineering and Research Department**

---

**SECTION A-A**


**NOTE:** ADD (1) 13mm [5/8"] REBAR • "P" AS NEEDED.

**SECTION B-B**

**NOTE:** ADD (1) 13mm [5/8"] REBAR • "P" AS NEEDED.
SECTION A-A
REFER TO QUADGUARD CZ ANCHORING SYSTEM INSTALLATION & SAFETY INSTRUCTIONS FOR FURTHER INFORMATION

EXAMPLE:
6 BAY QUADGUARD CZ
SCALE = 1:50

TO MOVE SYSTEM:
1. Verify monorail sections are bolted together.
2. Attach two lifting brackets each on diaphragms listed (four brackets total). See example.
3. Minimum sling length 3 meters (9 ft). Use fixed equal length slings.
4. Free unit from anchor bolts & grout prior to lifting the system. To accomplish this, start at the nose of the system and use pry bars to gradually raise the system off of the studs. Place blocks such as 2X4's under the monorail and work down the length of the unit until the unit is completely free of the studs.
5. Lift the system to new location and re-anchor.

ANCHOR SYSTEM FOR ROOF IMPACT PERFORMANCE. Use MP-3 polyester anchor system, supplied by Energy Absorption Systems, or approved equal. QuadGuard cz Systems installed on asphalt must be inspected to ensure the anchors are still properly set following each impact. Re-anchor as necessary. See drawing 35-40-06.

MONORAIL ATTACHMENT
SCALE = 1:25

QUADGUARD CZ DECAL

QUADGUARD CZ DECAL

QUADGUARD CZ DECAL

ITEMS 5 & 6 LOCATION CHART
NO. OF BAYS
ASSAMBLEY
DIAGRAM NO.
1
2
3
4
5
6
7
8
9

QUADGUARD CZ DECAL

ASSY NO. 354024*--0000

ENERGY ABSORPTION SYSTEMS INC.
ENGINEERING & RESEARCH DEPARTMENT

QuadGuard® SYSTEM
CZ ANCHOR/LIFTING KIT, QG,
(3-5 BAYS)

AS NOTED
35-40-24
1 of 2

Revisions
Date
Rev.
By
Desc/Asp/Doc.

Item x VAL 354020-0000
35/07/98
G
600 000 SP 111
354020.png

REVISED TO SHOW NOSE BELT
3/17/99
H
12.5 00 8 SP 111
354024.dwg

354024.png
NOTES:
1. MANUFACTURER RECOMMENDS USING THE MONORAIL AND BACKUP AS A TEMPLATE FOR DRILLING HOLES. HOLES LOCATIONS ARE GIVEN HERE FOR REFERENCE PURPOSES ONLY.
2. UNITS ARE MILLIMETERS.

ANCHOR BOLT LOCATIONS

QuadGuard SYSTEM
C2 ANCHOR/LIFTING KIT, QC.
(3-9 BAYS)

Revisions | Date | Rev. | By | App'd
--- | --- | --- | --- | ---
REV CHANGE TO MATCH SHEET 1 | 3/1/96 | M | GLS | SP
REV CHANGE TO MATCH SHEET 1 | 3/1/96 | H | GLS | SP

ENERGY ABSORPTION SYSTEMS, INC.
ENGINEERING AND RESEARCH DEPARTMENT

D. Staus 10/8/96
B. Burgess 10/15/96
K. Mortensen 10/15/96
S. Turner 10/15/96
### PARTS LIST

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<td>NOSE,R,WIDE,QGII,W/LOGO</td>
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<td>2760006/11010</td>
<td>BRACKET,CART SUPPORT,NOSE,QGII,B</td>
<td>1</td>
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<td>4</td>
<td>2760287/10000</td>
<td>BRACKET,CART SUPPORT,NOSE BAY,QGII,G</td>
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<td>2760006/11010</td>
<td>BOLT,HX,5/4X1/4,G</td>
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<td>2760287/10000</td>
<td>WASHER,FLAT,5/8 X 1 3/4,G</td>
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</tbody>
</table>

* 1 - YELLOW
* 2 - BLACK

---

**ASSEMBLY NO. 3540043-0000 (YELLOW)**

**ASSEMBLY NO. 3540043-0001 (BLACK)**

---

**NOSE ASSY,QGII,WIDE**

---

**ENERGY ABSORPTION SYSTEMS, INC.**

**ENGINEERING AND RESEARCH DEPARTMENT**

---

**D. Kohfeld**

4/3/2009

M. Buehler

12/30/2008

**JME**

4/9/2009

R. Brougher

4/9/2009
TWO FENDER PANEL ASSEMBLIES REQUIRED PER BAY.

NOTES:
1. UNDERLYING PANEL IS A FENDER PANEL IF ATTACHED TO A DIAPHRAGM. UNDERLYING PANEL IS A BACKUP SIDE PANEL, EXTENSION PANEL OR TRANSITION PANEL IF ATTACHED TO THE BACKUP.
2. UNITS OF MEASUREMENT ARE MILLIMETERS [INCHES] UNLESS OTHERWISE NOTED.
3. TIGHTEN NUT UNTIL IT REACHES END OF THREADS.

ASSY NO. 3540370–0000

ENERGY ABSORPTION SYSTEMS, INC.
ENGINEERING AND RESEARCH DEPARTMENT

QuadGuard – Wide System
FENDER PANEL ASSY

AS NOTED 3540370–0000 1 of 1 1

Revisions
Date | Rev | By | Rev | Date | Rev | By | Rev | Date | Rev | By | Rev | Date
--- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | ---
REMOVED ITEMS 7, 8, 10, & 11 | 07/19/00 | C | MWC | REMOVED ITEMS 7, 8, 10, & 11 | 07/19/00 | C | MWC | REVISED PLAN VIEW | 08/01/97 | P | GSO | REVISED PLAN VIEW | 08/01/97 | P | GSO | ADDED NOTE 3 | 08/26/97 | T | GSO | ADDED NOTE 3 | 08/26/97 | T | GSO
### TABLE

<table>
<thead>
<tr>
<th>NO. OF BAYS</th>
<th>(PAD LENGTH) [m]</th>
<th>(PAD LENGTH) [ft-in]</th>
<th>REBAR REQUIRED [m]</th>
<th>(REBAR REQUIRED) [ft-in]</th>
<th>YARDS OF CONCRETE IN PAD</th>
</tr>
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<tr>
<td>1</td>
<td>3.24 (10' - 8&quot;)</td>
<td>10' 8&quot;</td>
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<td>8' 2&quot;</td>
<td>1.19 (1.0)</td>
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<td>12'</td>
<td>2.82</td>
<td>9' 2&quot;</td>
<td>1.30 (1.1)</td>
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<td>15'</td>
<td>3.30</td>
<td>10' 9&quot;</td>
<td>1.55 (1.3)</td>
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<td>18' 0&quot;</td>
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<td>30'</td>
<td>6.39</td>
<td>24' 0&quot;</td>
<td>2.85 (2.6)</td>
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</table>

**NOTES:**

1. CROSS SLOPE OF PAD SHALL NOT EXCEED 8% AND NOT VARY MORE THAN 2% FROM FRONT TO BACK.
2. UNITS OF MEASUREMENT ARE MILLIMETERS [INCHES] UNLESS OTHERWISE NOTED.

---

**REFERENCES**

W. Leducington
5/27/09

T. Troeger
5/28/09

M. J. Buehrer
5/28/09

354076.000

ENERGY ABSORPTION SYSTEMS, INC.
ENGINEERING AND RESEARCH DEPARTMENT

QUADGUARD ® SYSTEM
CONCRETE PAD FOR
TENSION STRUT BACKUP

NTS 35-40-76 1 of 2
## Table

<table>
<thead>
<tr>
<th>No. of Bays</th>
<th>&quot;W&quot; (foot)</th>
<th>&quot;H&quot; (foot)</th>
<th>Rebar Required (linear ft)</th>
<th>Yards of Concrete in Pad (yd³)</th>
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<tr>
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</tbody>
</table>

**L** (see table)

- 76 [3.00] REBAR AT 610 [24.00] CENTERS
- 1575 [62.00] FROM REAR EDGE OF PAD
- PLACE 16mm [1/2] REBAR AT 76 [3.00] FROM EDGE FOR ALL PAD LENGTHS.

**FIVE 16mm [1/2] REBARS EQUALLY SPACED**

- 16mm [1/2] REBARS AT 610 [24.00] CENTERS

### Notes:

1. Cross slope of pad shall not exceed 8% and not vary more than 2% from front to back.
2. To prevent slippage during an impact, pad must be installed against or tied to an existing structure. Otherwise, additional below-grade supports must be added as determined necessary by the project engineer.
3. Units of measurement are millimeters [inches] unless otherwise noted.

### Section D-D

**28 Mpa [4000 P.S.I.] Minimum P.C. Concrete Pad and Anchor Block. 2324 kg/m³ [145 lbs/cu. ft.].**

### Additional Information

- **Quaguard System**
- Optional 8" Concrete Pad for Tension Strut Backup

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**Table of Revisions**

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<td>W. Leddington</td>
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**FILE INFORMATION**

- N76 35-40-76
- 2009076.dwg
- 35-40-76.dwg

**ENERGY ABSORPTION SYSTEMS, INC.**

**ENGINEERING AND RESEARCH DEPARTMENT**
CRASH CUSHION SYSTEM
(TYPE SCI-100GM)
Parts List:
01 - Transition 24" Concrete Block Right & Left #9433

Only need one transition for reverse direction traffic protection.

CONCRETE BLOCK, 24 INCH TRANSITION
ET-06-04
ONE OR BOTH SIDES AS REQUIRED

24" BLOCK CONCRETE BARRIER

48 [1219]

260\frac{3}{4} [6610] SYSTEM LENGTH TO BARRIER

276 [7011] CONCRETE PAD LENGTH

33\frac{1}{2} [854] END CUSHION TO END TRANS.

Bolts are 31" from front of barrier. If barrier tapers in before this, get measurement. May move the system forward no more than 6". Or you can move the system forward more and use a transition on both sides and move it forward until it is a flat surface.

Cannot be wider than 24" for this transition.

CONCRETE BLOCK, 24 INCH TRANSITION
ET-06-04
ONE OR BOTH SIDES AS REQUIRED

24" BLOCK CONCRETE BARRIER

33\frac{1}{2} [845]

CUSHION UP AGAINST CONCRETE BARRIER

LEVEL III ELEVATION
Cross Slope at Top Surface not to Exceed 1 in 10
Foundation must be a Level Plane

**Wide Hazards and Transitions may require the foundation to be longer. See Transition Drawings.**

**SPECIFICATIONS**

All reinforcing steel - straight #4 ASTM-A36

Embedment requirements:
- 6" reinforced concrete pad with anchor embedment of 5 1/2"
- 8" non-reinforced concrete pad with anchor embedment of 5 1/2"
- 3" asphalt over 3" concrete with anchor embedment of 16 1/2"
- 6" asphalt over 6" of compacted subbase with anchor embedment of 16 1/2"
- 8" asphalt with anchor embedment of 16 1/2"

The contractor shall furnish a certification for material installed to the following requirements:
- 6" reinforced concrete (PCC) sampling per ASTM C31-84, testing per ASTM C39-84
- 8" non-reinforced concrete (PCC) sampling per ASTM C31-84, testing per ASTM 39-84
- 3" asphalt over 3" concrete - Type SP 12.5 Level C or higher
- 6" asphalt over 6" of compacted subbase - same as above
- 8" asphalt (AC) - Type SP 12.5 Traffic Level C or higher
CRASH CUSHION SYSTEM
(TYPE TAU II)
NOTES:
1.) REINFORCEMENT OF SAFETY SHAPED BARRIER END MAY BE NEEDED. REFER TO BSI SPECIFICATION B010714 OR B010819 FOR FOUNDATION REQUIREMENTS.
2.) SUPPORT SPACING AND BLOCKOUTS SHOWN ARE IN ACCORDANCE WITH NEVADA DOT SPECIFICATION R-8.4.3.
3.) 4-SPACE THRIE BEAM GUARDRAIL PER AASHTO HARDWARE SPECIFICATION RTED1lb.
4.) THRIE BEAM BRIDGE SHOE PER AASHTO HARDWARE SPECIFICATION RTED1lb.
5.) RECTANGULAR GUARDRAIL WASHER PER AASHTO HARDWARE SPECIFICATION F/R03.
6.) TAU-II SYSTEM TO BE INSTALLED PER MANUFACTURER INSTRUCTIONS.
7.) OVERLAP THRIE BEAM OR BRIDGE SHOE ACCORDING TO DIRECTION OF TRAFFIC. UNDERLYING PART SHOULD BE DOWNSTREAM OF TRAFFIC AS SHOWN.

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NOTES:

1.) REFERENCE UNIVERSAL TAU-II FOUNDATION DIMENSION CHART FOR SPECIFIC SYSTEM FOUNDATION DIMENSIONS.
2.) FOUNDATION MATERIAL, SPECIFICATIONS, AND ANCHORAGE MUST BE IN ACCORDANCE WITH BSI FOUNDATION SPECIFICATIONS FOR A CONCRETE PAD. REFERENCE BSI DRAWING A040113.
3.) THE CONCRETE REINFORCEMENT SHOWN IS RECOMMENDED TO ENSURE ADEQUATE FOUNDATION INTEGRITY FOR PROPER IMPACT PERFORMANCE. VARIATIONS MAY BE REVIEWED AND DETERMINATIONS MADE AS TO EQUIVALENCE BY PROJECT ENGINEER.
4.) ALL REBAR IS #5 [15mm].
5.) IF FOUNDATION EXTENDS FROM A CONCRETE CURB, WALL, ABUTMENT, OR OTHER CONCRETE HAZARD, PLACE BACKSTOP AGAINST THE HAZARD AND SUBTRACT 10" FROM DIMENSION "L".
6.) TORQUE ANCHORS TO 120 FT-LBF (160 N·m).
7.) ANCHORING COMPOUND MUST MEET BSI SPECIFICATIONS.

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FOUNDATION SPECIFICATIONS:

THE TAU-II CRASH CUSHION SYSTEM HAS BEEN DESIGNED TO ATTACH TO CONCRETE OR ASPHALT FOUNDATIONS. USE THE ANCHORAGE SPECIFIED BELOW DEPENDING ON THE FOUNDATION AT THE JOB SITE. REFERENCE UNIVERSAL TAU-II FOUNDATION DRAWINGS FOR FURTHER DETAIL.

1.) CONCRETE PAD

2.) ASPHALT OVER SUBBASE

3.) ASPHALT ONLY

4.) ASPHALT OVER P.C. CONCRETE

MATERIAL SPECIFICATIONS

PORTLAND CEMENT CONCRETE (PCC)

STONE AGGREGATE CONCRETE MIX, 4,000 PSI [28 MPa] MINIMUM COMPRESSIVE STRENGTH (SAMPLING PER ASTM C31-84 OR ASTM C494-84A, TESTING PER ASTM C39-84)

ASPHALTIC CONCRETE (AC)

AR-4000 A.C. (PER ASTM D3208-83) .75" MAXIMUM, MEDIUM, TYPE A OR B AGGREGATE

COMPACTED SUBBASE (DGA)

6 IN. [150 mm] MINIMUM DEPTH, 95% COMPACITION, CLASS 2 AGGREGATE

SCALE: FULL

DATE: 01/09/04

INIT: GAD

REV: 01

TITLE: FOUNDATION SPECIFICATIONS

MODEL: A040113

REV: A

A SEE ECN 00589

REV. CHANGES DATE BY REQ'D NEXT ASSY. ITEM

6/01/04 6/01

Standard Tolerance
Angular ± 1/2°
Fractional ± 1/16

Dec. XXX± .010
Dec. XX± .020