Important: These instructions are to be used only in conjunction with the assembly, maintenance, and repair of QuadGuard® II systems. These instructions are for standard assembly specified by the appropriate highway authority only. In the event the specified system assembly, maintenance, or repair would require a deviation from standard assembly parameters, contact the appropriate highway authority engineer. This system has been accepted for use by the Federal Highway Administration for use on the national highway system under strict criteria utilized by that agency. Energy Absorption Systems representatives are available for consultation if required.

This Manual must be available to the worker overseeing and/or assembling the product at all times. For additional copies, contact Energy Absorption Systems at (888) 323-6374 or download from websites below.

The instructions contained in this Manual supersede all previous information and Manuals. All information, illustrations, and specifications in this Manual are based on the latest QuadGuard® II system information available to Energy Absorption Systems at the time of printing. We reserve the right to make changes at any time. Please contact Energy Absorption Systems to confirm that you are referring to the most current instructions.
# Table of Contents

Customer Service Contacts .......................................................................................................... 3  
Important Introductory Notes ........................................................................................................ 3  
Recommended Safety Rules for Assembly .................................................................................. 4  
Safety Symbols ............................................................................................................................. 5  
Warnings and Cautions .................................................................................................................. 5  
Limitations and Warnings .............................................................................................................. 6  
System Overview .......................................................................................................................... 7  
Recommended Tools .................................................................................................................... 8  
System Assembly for Narrow Hazards ....................................................................................... 13  
Site Preparation/Foundation ....................................................................................................... 14  
System Assembly for Wide Hazards ........................................................................................... 32  
Site Preparation/Foundation ....................................................................................................... 33  
  Transition Panel Types ............................................................................................................. 35  
MP-3® Polyester Anchoring system ............................................................................................ 51  
Horizontal Assemblies ................................................................................................................ 53  
MP-3® Assembly Cautions .......................................................................................................... 55  
Maintenance and Repair ............................................................................................................. 56  
  Inspection Frequency ................................................................................................................. 56  
  Visual Drive-By Inspection ........................................................................................................ 56  
  Walk-Up Inspection .................................................................................................................. 56  
Post-Impact Instructions ............................................................................................................. 58  
Parts Ordering Procedure ........................................................................................................... 62
Customer Service Contacts

Energy Absorption Systems (a Trinity Highway Products company) is committed to the highest level of customer service. Feedback regarding the QuadGuard® II system, its assembly procedures, supporting documentation, and performance is always welcome. Additional information can be obtained from the contact information below:

<table>
<thead>
<tr>
<th>Energy Absorption Systems:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Telephone: (888) 323-6374 (USA Only) (214) 589-8140 (USA or International)</td>
<td></td>
</tr>
<tr>
<td>E-mail: <a href="mailto:customerservice@energyabsorption.com">customerservice@energyabsorption.com</a></td>
<td></td>
</tr>
</tbody>
</table>

Important Introductory Notes

Proper assembly of the QuadGuard® II is essential to achieve performance of the system under appropriate federal and state criteria. These instructions should be read in their entirety and understood before assembling the QuadGuard® II. These instructions are to be used only in conjunction with the assembly of the QuadGuard® II and are for standard assemblies only as specified by the applicable highway authority. In the event your system assembly requires or involves deviation from standard parameters or, during the assembly process a question arises, please contact the appropriate highway authority that specified this system at this particular location for guidance. Energy Absorption Systems is available for consultation with that agency. These instructions are intended for an individual who is qualified to both read and accurately interpret them as written. They are intended for the individual who is experienced and skilled in the assembly of highway products which are specified and selected by the highway authority.

A set of product and project shop drawings will be supplied by Energy Absorption Systems. The shop drawings will be for each section of the assembly. These drawings should be reviewed and studied thoroughly by a qualified individual who is skilled in interpreting them before the start of any assembly.
Important: Read safety instructions thoroughly and follow the assembly directions and suggested safe practices before assembling, maintaining, or repairing the QuadGuard® II system. Failure to follow this warning can result in serious injury or death to workers and/or bystanders. It further compromises the acceptance of this system by the FHWA. Please keep these instructions for later use.

Warning: Ensure that all of the QuadGuard® II system Warnings, Cautions, and Important statements within the QuadGuard® II Manual are completely followed. Failure to follow this warning could result in serious injury or death in the event of a collision.

Recommended Safety Rules for Assembly

* Important Safety Instructions *

This Manual must be kept in a location where it is readily available to persons who assemble, maintain, or repair the QuadGuard® II system. Additional copies of this Manual are immediately available from Energy Absorption Systems by calling (888) 323-6374. Please contact Energy Absorption Systems if you have any questions concerning the information in this Manual or about the QuadGuard® II system. This Manual may also be downloaded directly from the websites indicated below.

Always use appropriate safety precautions when operating power equipment, mixing chemicals, and when moving heavy equipment or QuadGuard® II components. Gloves, apron, safety goggles, steel toe boots, and back protection shall be used.

Safety measures incorporating traffic control devices specified by the highway authority must be used to provide safety for personnel while at the assembly, maintenance, or repair site.
Safety Symbols
This section describes the safety symbols that appear in this QuadGuard® II Manual. Read the Manual for complete safety, assembly, operating, maintenance, repair, and service information.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>!</td>
<td>Safety Alert Symbol: Indicates Danger, Warning, or Caution. Failure to read and follow the Danger, Warning, Safety, or Caution indicators could result in serious injury or death to the workers and/or bystanders.</td>
</tr>
</tbody>
</table>

Warnings and Cautions
Read all instructions before assembling, maintaining, or repairing the QuadGuard® II system.

Warning: Do not assemble, maintain, or repair the QuadGuard® II system until you have read this Manual thoroughly and completely understand it. Ensure that all Warnings, Cautions, and Important Statements within the Manual are completely followed. Please call Energy Absorption Systems at (888) 323-6374 if you do not understand these instructions. Failure to follow this warning could result in serious injury or death in the event of a collision.

Warning: Safety measures incorporating appropriate traffic control devices specified by the highway authority must be used to protect all personnel while at the assembly, maintenance, or repair site. Failure to follow this warning could result in serious injury or death in the event of a collision.

Warning: Use only Energy Absorption Systems parts that are specified herein for the QuadGuard® II for assembling, maintaining, or repairing the QuadGuard® II system. Do not utilize or otherwise combine parts from other systems even if those systems are other Energy Absorption Systems or Trinity Highway Products systems. Such configurations have not been tested, nor have they been accepted for use. Assembly, maintenance, or repairs using unspecified parts or accessories is strictly prohibited. Failure to follow this warning could result in serious injury or death in the event of a vehicle impact with an UNACCEPTED system.

Warning: Do NOT modify the QuadGuard® II system in any way. Failure to follow this warning could result in serious injury or death in the event of a collision.

Warning: Ensure that the QuadGuard® II system and delineation used meet all federal, state, specifying agency, and local specifications. Failure to follow this warning could result in serious injury or death in the event of a collision.

Warning: Ensure that your assembly meets all appropriate Manual on Uniform Traffic Control Devices (MUTCD) and local standards. Failure to follow this warning could result in serious injury or death in the event of a collision.
Limitations and Warnings

Energy Absorption Systems, in compliance with the National Cooperative Research Highway Program 350 (NCHRP Report 350) "Recommended Procedures for the Safety Performance of Highway Safety Features", contracts with FHWA approved testing facilities to perform crash tests, evaluation of tests, and submittal of results to the Federal Highway Administration for review.

The QuadGuard® II system has been accepted by FHWA as meeting the requirements and guidelines of NCHRP Report 350* TL-1 (2 Bay narrow system), TL-2 (2 Bay narrow system and 3 Bay wide system) and TL-3 (5 Bay system). The NCHRP Report indicates that these tests typically evaluate product performance by closely simulating actual impacts involving a typical range of vehicles on our roadways, from lightweight cars (approx. 820kg [1800 lb.]) to full size pickup trucks (approx. 2000 kg [4400 lb.]) as specified by the FHWA. A product can be certified for multiple Test Levels. The QuadGuard® II has been accepted to the Test Level(s) as shown below:

- Test Level 1: 50 km/h [31 mph]
- Test Level 2: 70 km/h [44 mph]
- Test Level 3: 100 km/h [62 mph]

These FHWA directed tests are not intended to represent the performance of systems when impacted by every vehicle type or every impact condition existing on the roadway. This system is tested only to the test matrix criteria of NCHRP 350 as approved by FHWA.

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

Energy Absorption Systems 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 criteria capabilities of the product may not result in acceptable impact performance as outlined in NCHRP Report 350, relative to structural adequacy, occupant risk and vehicle trajectory. Energy Absorption Systems 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 assembled by or in the presence of Energy Absorption Systems representatives or by third parties.

The QuadGuard® II system is intended to be assembled, delineated, and maintained in accordance with specific 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, assemble, 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 an untested effect on an impacting vehicle. Before deployment of this system at any location, these issues need to be fully discussed with the appropriate highway authority planning and specifying the assembly.

After an impact occurs, the product should be restored to its original condition as soon as possible. When a potentially reusable safety product is impacted, it is still necessary to restore the product to its original length and inspect all the components as necessary.
**System Overview**

The QuadGuard® II is a potentially reusable, re-directive, non-gating crash cushion for hazards ranging in width from 610 mm to 3200 mm (24" to 126"). It consists of 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. See the QuadGuard® II Product Manual to determine the appropriate number of Bays for a given speed.

**Impact Performance**

The 5 Bay QuadGuard® II systems have successfully passed the requirements stipulated in NCHRP Report 350, Test Level 3 tests with both the light car and pickup at speeds of up to 100 km/h [62 mph] at angles up to 20 degrees.

During head-on impacts, within NCHRP Report 350 criteria, the QuadGuard® II telescopes rearward and crushes to absorb the energy of impact. When impacted from the side, within the applicable NCHRP 350 criteria, it safely redirects the vehicle back toward its original travel path and away from the hazard.
Recommended Tools

Documentation

- Manufacturer’s Assembly Manual
- Manufacturer’s Drawing Package

Cutting equipment

- Rotary Hammer Drill
- Rebar cutting bit
- Concrete drill bits – 22 mm [7/8"] (*Two Fluted)
- Grinder, Hacksaw or Torch (optional)
- Drill motor
- Drill bits 1/16” through 7/8”

*Energy Absorption Systems recommends using two fluted drill bits to achieve optimum tensile strength when applying the MP-3® anchoring system.

Hammers

- Sledgehammer
- Standard hammer

Wrenches

- Heavy duty impact wrench
- Standard adjustable wrench
- 1/2” drive sockets: 9/16", 11/16", 3/4", 15/16", 1 1/8", 1 1/4"
- 1/2” drive Deep sockets: 15/16", 1 1/4"
- 1/2” drive Ratchet and attachments
- 1/2” drive Breaker bar – 24" long
- 1/2” drive Torque wrench: 200 ft-lb
- Crescent wrench: 300 mm [12”]
- Allen wrench: 3/8”
- Impact Wrench: 1/2"

Personal Protective equipment

- Safety Glasses
- Gloves
- Apron for MP-3® application
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.
- Air Compressor (100 psi minimum) 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. Depending on specific site conditions and the complexity of the assembly specified by the appropriate highway authority, additional or fewer tools may be required. Decisions as to what tools are needed to perform the job are entirely within the discretion of the specifying highway authority and the authority's selected contractor performing the assembly of the system at the authority's specified site.
Figure 1 Plans & Elevation
(Five Bay systems with Tension Strut Backups shown, except as noted)

Key
1) Cartridge
2) Diaphragm
3) Quad-Beam™ Fender Panel
4) Nose Cover
5) Monorail
6) Backup
7) Side Panel
How to Determine Left/Right
To determine left from right when ordering parts, stand in front of the system facing the hazard. 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, two Fender Panels, etc. 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 2). Five Bay system shown.

Figure 2
System Orientation
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”] (Minimum 3 Bays Required)
- 2285 mm [90”] (Minimum 6 Bays Required)
- 3200 mm [126”]

The nominal width of a system with Tension Strut Backup is the width between Side Panels behind the Backup (See Figure 3).

The nominal width of a system with Concrete Backup is the width of the Concrete Backup at location shown in Figure 4.

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 3](image1.png) Width of system with Tension Strut Backup

![Figure 4](image2.png) Width of system with Concrete Backup
System Assembly for Narrow Hazards

610 mm [24"] MODEL NO. QG2__24

760 mm [30"] MODEL NO. QG2__30

915 mm [36"] MODEL NO. QG2__36

1219 mm [48"] MODEL NO. QG2__48

Figure 5
Narrow System and Model Numbers
Site Preparation/Foundation

A QuadGuard® II should be assembled only on an existing or freshly placed and cured concrete base (28 MPa [4000 psi] minimum). Location and orientation of the concrete base and attenuator must comply with project plans or as otherwise determined by the resident project engineer.

Recommended dimension and reinforcement specifications for new concrete foundations are provided in Energy Absorption Systems concrete foundation drawings, supplied with the system. The system may be assembled on a non-reinforced concrete roadway (minimum 200 mm [8"] thick). Deployment cross-slope shall not exceed 8% and should not twist more than 2% over the length of the system; the foundation surface shall have a light broom finish.

**Caution:** Accurate placement of all steel rebar is critical to avoid interference with the concrete anchor bolts.

![Cross-Slope Diagram](image)

**Figure 6**

Cross-Slope

**Warning:** Location of the Backup in relation to nearby objects will affect the operation of the attenuator. Upon impact, the Fender Panels telescope rearward and extend beyond the rigid Backup as much as 876.3 mm [34.5"]'). Position the Backup so that the rear ends of the last Fender Panels are a minimum of 760 mm [30"] forward of objects that would otherwise interfere with movement of the rearmost Fender Panels. Failure to comply with this requirement will result in impaired system performance offering motorists less protection and causing component damage.
Inspect Shipping

Before deploying the QuadGuard® II system, check the received parts against the shipping list supplied with the system. Make sure all parts have been received.

Assembly Procedures

Note: The Drawing Package supplied with the QuadGuard® II system must be used with these instructions for proper assembly and should take precedence over these general instructions.

1) Determine Backup & Transition Type

The QuadGuard® II system is available with a Tension Strut Backup or a Concrete Backup. See Figure 7 and 8, along with the Backup Assembly drawing, to determine which type of Backup is being deployed.

A Transition Panel or Side Panel must be used on each side of the Backup. A Side Panel is not needed when a Transition Panel is used. Several types of Transitions are available for use with the QuadGuard® II system. See Figures 9 through 14 and the Drawing Package to determine which type of Panels to attach.
Transition Panel Types

**Note:** The proper Transition Panel or Side Panel must be used for impact performance of the system. The correct Panel(s) to use will depend on the direction of traffic and what type of barrier or hazard the QuadGuard® II system is shielding. Contact the Customer Service Department prior to deployment if you have any questions.
2) **Mark System Location**

Locate the centerline of the system by measuring the proper offset from the hazard. See the Drawing Package supplied with the system. Place chalk line to mark the centerline of the system. Mark a construction line parallel to the center line and offset 165 mm [6.5"] to one side as shown in Figure 15. The edge of the Monorail will be positioned on this line.

**Note:** The concrete foundation shall comply with the project plans supplied with the system.

**Warning:** Location of system with respect to the hazard is critical and dependent on the type of Transition Panel used. See the Project Plans supplied with the system for details.

![Centerline of System and Construction Line](image)

**Figure 15**
*(Top view of concrete foundation)*
3) Anchor the Backup

A) Concrete Backup Construction (Figure 16)

Locate Backup Face Plate using the Backup Assembly drawing. Verify that any applicable Transition Panels fit properly before anchoring the Face Plate. Drill anchor holes in the Concrete Backup using the Face Plate as a template. Anchor the Face Plate to the Concrete Backup using the MP-3® Anchoring system (horizontal kit) supplied with the QuadGuard® II system (See “MP-3® Polyester Anchoring System” section on Page 51).

**Warning:** Every hole and slot in Backup and Monorail must be anchored by an MP-3® stud.

B) Tension Strut Backup Assembly (Figure 17)

Locate Tension Strut Backup and Monorail on foundation with side of Monorail on the construction line (See Figure 20 on Page 20). Verify that any applicable Transition Panels fit properly before anchoring Backup. Drill anchor holes in foundation using the Backup as template. Anchor the Backup to the concrete foundation using the MP-3® Anchoring system (Vertical kit) supplied with the QuadGuard II system (See “MP-3® Polyester Anchoring System” section on Page 51).
4) **Anchor the Monorail**

**A) Monorail Construction for Concrete Backup (Figure 19)**

Locate Monorail on foundation with side of Monorail on the construction line and rear edge of Monorail foot 10" forward of front face of Concrete Backup (See Figure 19).

Orient the Monorail so that the Monorail tongues face Backup (See Figure 19).

Drill 140 mm [5 1/2"] deep anchor holes using the Monorail as a template. Do not drill through foundation.

**Warning:** Every hole and slot in Backup and Monorail must be anchored by an MP-3® stud.

Anchor each Monorail section using the MP-3® vertical kits provided. See Figure 18 and the MP-3® Polyester Anchoring System Instructions included with this Manual. It is important to attach each segment of Monorail in alignment from the back to the front of the system (± 6 mm [1/4"]).

**Warning:** Improper alignment at the Monorail Sections will prevent proper system collapse during an impact.
**B) Monorail Construction for Tension Strut Backup (Figure 20)**

Locate Monorail on foundation with side of Monorail on the construction line and rear edge of Backup foot 4” forward of edge of foundation (See Figure 20).

Orient the Monorail so that the Monorail tongues face the Backup (See Figure 19 on Page 19).

Drill 140 mm [5 1/2"] deep anchor holes using the Monorail as a template. Do not drill through foundation.

**Warning:** Every hole and slot in Backup and Monorail must be anchored by an MP-3® stud.

Anchor each Monorail section using the MP-3® vertical kits provided. See Detail 20a and the MP-3® Polyester Anchoring System Instructions included with this Manual. It is important to attach each segment of Monorail in alignment from the back to the front of the system (± 6 mm [1/4"]).

**Warning:** Improper alignment at the Monorail splice joints will prevent proper system collapse during an impact.
5) **Attach Side Panels and/or Transition Panels to Backup Assembly**

Attach Transition Panel or Side Panel to side of Backup using 5/8" hex bolt and 5/8" rail nut (two places - top and bottom holes only). See Figure 21 and Backup Assembly drawing.

**Note:** A Side Panel is not needed when a Transition Panel is used.

**Construction tip:**

Use drift pin to align the center hole of the Panel with the center hole of the Backup before inserting the rail bolts.

---

**Figure 21**

Side Panel/Transition Panel Attachment
6) **Attach Monorail Guides**

Attach Monorail guides to Diaphragm as follows:

Insert 3/4” x 2” G8 hex bolt through Monorail guide and Diaphragm, oriented as shown in Figure 22. Secure with 3/4” lock washer and 3/4” hex nut (typical 4 places). See also Diaphragm Assembly drawing. Shims are sandwiched between the Rail Guide and Diaphragm.

Repeat process for each Diaphragm.

7) **Attach Diaphragms**

Orient a Diaphragm so that the front face of the Diaphragm shape faces toward the Nose of the system as shown in Figure 23. Slide one Diaphragm all the way to the Backup to ensure the system is able to collapse properly during impact. Once this has been verified, slide the Diaphragm forward to approximately 915 mm [36”] in front of the Backup. Orient and slide all other Diaphragms onto Monorail and position each approximately as shown in Figure 24.
8) **Attach Fender Panels**

**Note:** Do not mix the 5/8” rail nuts (large) with the 5/8” hex nuts (small) (See Figure 25).

![Rail Nuts are Oversize](Image)

Starting at the Backup, attach left and right Fender Panels shown on Page 24 and Fender Panel Assembly drawing.

**Step 1**

Place the Fender Panel so that the center of the slot of the rearward Diaphragm is lined up with the approximate center of the slot in the Fender Panel.

Attach Mushroom Washer Assembly as shown in Figure 26 and Detail 26a and Detail 26b, but do not torque at this time. This (Step 1) helps to balance the Fender Panel.

**Step 2**

Slide the Fender Panel forward until the holes in the Fender Panel line up with the holes in the forward Diaphragm.

**Step 3**

Use a drift pin to align the center hole of the Fender Panel with the center hole of the Diaphragm.

**Step 4**

Attach the front of the Fender Panels to the next Diaphragm using two rail bolts and large hex nuts per side. Use only the top and bottom holes; leave the center hole open until the next Fender Panel is attached.
Step 5

Be sure Mushroom Washer lays flat against the Fender Panel as shown in Figure 26b. Standoff on Mushroom Washer must be seated completely through slot.
**Step 6**

Check Diaphragm spacing to ensure 915 mm [36"] between rear faces of consecutive Diaphragms as shown in Figure 27 and Fender Panel Assembly drawing.

**Step 7**

Once proper spacing has been achieved, torque the Mushroom Washer Assembly (small hex) nut until it reaches the end of the threads.

Assemble the remaining Diaphragms and Fender Panels following the same procedures.

![Figure 27 Proper Spacing Between Diaphragms](image)
9) **Attach End Cap**
Using 5/8” x 3 1/2” G5 hex bolt, 5/8” hex nut and 5/8” lock washer, attach the End Cap to the front of the first Monorail segment as shown in Figure 28 and Monorail Assembly drawing.

![Monorail End Cap Assembly](image)

**Figure 28**
Monorail End Cap Assembly

10) **Attach Cartridge Support Brackets**
Attach lower Cartridge Support Bracket to front and back of all Diaphragms and front of Backup, as shown in Figures 30 to 32 Diaphragm Assembly drawings, and Backup Assembly drawings.

**Note:** 610 mm [24"] wide systems do not have Side Cartridge Support Brackets: 762 mm [30"], 914 mm [36"] and 1219 mm [48"] wide systems have Side Cartridge Support Brackets welded to the Backup and Diaphragms.

![Side Cartridge Support Brackets](image)

**Figure 29**
Side Cartridge Support Brackets
Figure 30
Lower Cartridge Support Bracket Assembly

Figure 31
Lower Cartridge Support Bracket Assembly (Tension Strut Backup)

Figure 32
Lower Cartridge Support Bracket (Concrete Backup)
11) Attach Nose Assembly

Bolt the Nose directly to the front Diaphragm, as shown in Figures 33a through 33c and the Nose Assembly drawing, using six threaded rods and four rail nuts per rod. Place Pullout Brackets under center bolts.

1. Position a 5/8” Rail Nut 2-3/4” from the end of the 5/8” Threaded Rod. Tighten a second 5/8” Rail Nut against the first (See Figure 33a). Repeat this step for all six fasteners.

2. Using the fastener, assemble the Fender Panel to the Diaphragm. The 2 3/4” sections of threads should pass through the Diaphragm (See Figure 33b).

3. Position a 5/8” Rail Nut and washer flush with the outer edge of the Fender Panel (See Figure 33b). Repeat this step in all six locations.
4. Assemble the Nose Assembly to the QuadGuard II system using the 5/8" Rail Nuts and washer. Verify the 5/8" outward nut is flush with the Fender Panel (See Detail 33b). Adjust as necessary (See Figure 33 and 33c).

Detail 33b
End View with no Nose Cover

Detail 33c
End View With Nose Cover

See Detail 33e

Detail 33d
Cartridge Support Bracket

Detail 33e
Detail 33e shows proper placement of front Cartridge Support Bracket.

Note difference of front Diaphragm Bracket. The Cartridge sits lower on this Bracket than the Bays to the rear.
12) Checking the System Assembly

At this point recheck to ensure that all fasteners are properly tightened throughout the system (anchor bolts, etc.). See warning below. Check all Fender Panels. If they do not fit tightly against the underlying Panel, system realignment may be necessary (See Figure 34).

<table>
<thead>
<tr>
<th>Warning:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anchor Studs</td>
</tr>
<tr>
<td>Torqued to 165 N-m [120 ft-lb]</td>
</tr>
<tr>
<td>Should NOT protrude above nuts</td>
</tr>
<tr>
<td>(See Figure 18, page 19)</td>
</tr>
<tr>
<td>All Other Bolts</td>
</tr>
<tr>
<td>Tightened</td>
</tr>
<tr>
<td>Fender Panel</td>
</tr>
<tr>
<td>Maximum gap allowed:</td>
</tr>
<tr>
<td>Narrow Systems – 20 mm [0.78&quot;]</td>
</tr>
</tbody>
</table>

**Figure 34**
Fender Panel Gap for Narrow Systems

13) Cartridge Assembly

Be sure the Adjustable Cartridge Support in the Nose is attached correctly. See “Attach Nose Assembly” in Step 11 on Page 28. The top surface of the Nose Cartridge should be horizontal.

To complete the assembly of a QuadGuard® II system, place the appropriate Cartridge in each Bay and Nose section of the system. Type 1 Cartridges are placed toward the front (Nose) of the system; Type 2 Cartridges are placed toward the rear (Backup) of the system (See Figures 35 and 36).

**Warning:** Placing the wrong Cartridge in the Nose or any Bay has not been crash tested pursuant to the NCHRP 350 criteria. Accordingly, this is likely to result in unacceptable crash performance as described in NCHRP 350.
Figure 35
Cartridge Placement

Figure 36
Typical Cartridge Layout 5 Bay System Shown
System Assembly for Wide Hazards

(Min. 3 bays req'd)
1755 mm [69"] MODEL NO. QG2_69

(Min. 3 bays req'd) 2285 mm [90”]
MODEL NO. QG2_90

Varies - Min. 6 Bays Required:
3200 mm [126"] MODEL NO. QG2100126

Figure 37
Wide Systems and Model Numbers
Site Preparation/Foundation

A QuadGuard® II system should be constructed only on an existing or freshly placed and cured concrete base (28 MPa [4000 psi] minimum). Location and orientation of the concrete base and attenuator must comply with project plans or as otherwise determined by the resident project engineer.

Recommended dimension and reinforcement specifications for new concrete foundations are provided in Energy Absorption Systems concrete foundation drawings, supplied with the system. The system may be assembled on a non-reinforced concrete roadway (minimum 200 mm [8"] thick). Deployment cross-slope shall not exceed 8% and should not twist more than 2% over the length of the system; the foundation surface shall have a light broom finish.

Caution: Accurate placement of all steel rebar is critical to avoid interference with the concrete anchor bolts.

Warning: Location of the Backup in relation to nearby objects will affect the operation of the attenuator. Upon impact, the Fender Panels telescope rearward and extend beyond the rigid Backup as much as 876.3 mm [34.5"] from their pre-impact location. Position the Backup so that the rear ends of the last Fender Panels are a minimum of 760 mm [30"] forward of objects that would otherwise interfere with movement of the rearmost Fender Panels. Failure to comply with this requirement is likely to result in system performance which has not been crash tested pursuant to NCHRP 350 criteria and may also cause component damage which will necessitate maintenance or replacement of the system.

Inspect Shipping

Before deploying the QuadGuard® II system, check the received parts against the shipping list supplied with system. Make sure all the parts have been received.

Assembly Procedures

Note: The Drawing Package supplied with the QuadGuard® II system must be used with these instructions for proper assembly and should take precedence over these general instructions.

1) Determine Backup and Transition Type

The QuadGuard® II is available with a Tension Strut Backup or a Concrete Backup. See Figures 38 and 39, along with the Backup assembly drawing, to determine which type of Backup is being deployed.

A Transition Panel or Side Panel must be used on each side of the Backup. A Side Panel is not needed when a Transition Panel is used. Several types of transitions are available for use with the QuadGuard® II system. See Figures 40 through 45 and the drawing package to determine which types of panels to attach.
Figure 38
Tension Strut Backup

Figure 39
Concrete Backup

Figure 40
Transitioning the QuadGuard® II System
Transition Panel Types

Note: The proper Transition Panel or Side Panel must be used to perform as crash tested. The correct Panel(s) to use will depend on the direction of traffic and what type of barrier or hazard the QuadGuard® II system is shielding (See Page 16). Contact the Customer Service Department prior to deployment if you have any questions.
2) Mark System Location

Locate the centerline of the system by measuring the proper offset from the hazard. See the Drawing Package supplied with the system. Place chalk line to mark the centerline of the system. Mark a construction line parallel to the center line and offset 165 mm [6.5"] to one side as shown in Figure 46. The edge of the Monorail will be placed on this line.

**Note:** The concrete foundation shall comply with the project plans supplied with the system.

**Warning:** Location of system with respect to the hazard is critical and dependent on the type of Transition Panel used. See the Project Plans supplied with the system for details.

---

3) Anchor the Backup

A) Concrete Backup Construction (Figure 47)

Locate Backup Face Plate using the Backup assembly drawing. Drill anchor holes in the Concrete Backup using the Face Plate as a template. Anchor the Face Plate to the Concrete Backup using the MP-3® Anchoring system (horizontal kit) supplied with the QuadGuard® II system (See “MP-3® Polyester Anchoring System” section on Page 51).

**Warning:** Every hole and slot in Backup and Monorail must have an MP-3® stud anchoring it.
B) **Tension Strut Backup Assembly**

Locate the Tension Strut Backup and Monorail on foundation with side of Monorail on the construction line (See Figure 52 on Page 39). Verify that any applicable Transition Panels fit properly before anchoring Backup. Drill anchor holes in foundation using the Backup as template. Anchor the Backup to the concrete foundation using the MP-3® Anchoring System (vertical kit) supplied with the QuadGuard® II system (See “MP-3® Polyester Anchoring System” section on Page 51).

**Caution:** Every hole and slot in Backup and Monorail must be anchored by an MP-3® stud.

![Figure 48
Anchoring Tension Strut Backup to Foundation](image-url)
C) Extra-Wide Tension Strut Backup Assembly (Figure 49)

Locate the Extra-Wide Tension Strut Backup center section and Monorail on foundation with side of Monorail on the construction line (See Figure 52 on Page 39).

Locate the Extra-Wide Tension Strut Backup left section on the left side of the center section, aligning the three holes in the side plates.

Locate the Extra-Wide Tension Strut Backup right section on the right side of the center section, aligning the three holes in the side plates.

Secure the Backup sections to each other using 5/8" x 2" hex bolt, 5/8" x 1 3/4" flat washer (2), 5/8" lock washer and 5/8" hex nut (6 places) as shown in Figure 49 and Detail 49a.

Verify that any applicable Transition Panels fit properly before anchoring Backup. Drill anchor holes in foundation using the Backup as template. Anchor the Backup to the foundation using the MP-3® vertical kits supplied with the QuadGuard® II system (See “MP-3® Polyester Anchoring System” on Page 51).

Warning: Every hole and slot in Backup and Monorail must be anchored by an MP-3® stud.

Figure 49
Anchoring Extra-Wide Tension Strut Backup to Foundation See Drawing Package

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www.highwayguardrail.com
4) Anchor the Monorail

A) Monorail Construction for Concrete Backup (See Figure 51).

Locate Monorail on foundation with side of Monorail on the construction line and rear edge of Monorail 10” forward of front face of Concrete Backup (See Figure 51).

Orient the Monorail so that the Monorail tongues face Backup (See Figure 51).

Drill 140 mm [5 1/2"] deep anchor holes using the Monorail as a template. Do not drill through foundation.

**Warning:** Improper alignment at the Monorail Splice Joints may prevent proper system collapse during an impact.

**Warning:** Every hole and slot in Backup and Monorail must be anchored by an MP-3® stud.
B) Monorail Construction for Tension Strut Backup (See Figure 52).

Locate Monorail on foundation with side of Monorail on the construction line and rear edge of Backup 4" forward of edge of foundation (See Figure 52).

Orient the Monorail so that the Monorail tongues face the Backup (See Figure 52).

Drill 140 mm [5 1/2"] deep anchor holes using the Monorail as a template. Do not drill through foundation.

![Figure 52: Backup and Monorail Location for Tension Strut Backup](image)

5) Attach Side Panels and/or Transition Panels to Backup Assembly

a. Attach Hinge Plate to the Transition Panel or Side Panel using 5/8" rail bolt and 5/8" rail nut (two places – top and bottom holes only).

b. Attach Transition Panel or Side Panel assembly to side of Backup using 5/8" hex bolt, 5/8" lock washer and 5/8" hex nut (three places each side of Backup). See illustration on Page 41.

c. Attach diagonal brace to Fender Panel and Backup using 3/8" hex bolt, 3/8" lock washer and 3/8" hex nut (two places per brace: 4 places per side).

d. Secure each diagonal brace with a 3/8" hex bolt; 3/8" lock washer, and 3/8" hex nut (two places per brace) as shown in Figure 53.

**Note:** A Side Panel is not needed when a Transition Panel is used. Diagonal braces not used with some Transition Panels (See drawing package).
Assembly tip:
Use drift pin to align the center hole of the Panel with the center hole of the Backup before attaching the rail bolts.

Figure 53
Side Panel/Transition Panel Attachment
6) Attach Monorail Guides

Attach Monorail guides to Diaphragm as follows:

Insert 3/4" x 2" G8 hex bolt through Monorail guide and Diaphragm, oriented as shown in Figure 54. Secure with 3/4" lock washer and 3/4" hex nut (typical two places per guide). See also Diaphragm assembly drawing. Shims are sandwiched between Monorail guides and Diaphragm.

Repeat process for each Diaphragm.

![Monorail Guide Attachment](image)

Figure 54
Monorail Guide Attachment
7) **Attach Diaphragms**

Orient the widest Diaphragm so that the front face of the Diaphragm shape faces toward the Nose of the system as shown in Figure 55. **The widest Diaphragm must be attached closest to the Backup with each subsequent Diaphragm being progressively narrower.**

Slide the widest Diaphragm onto the Monorail and all the way to the Backup to ensure system is able to collapse properly during impact. Once this has been verified, slide the Diaphragm forward to approximately 915 mm [36"] in front of the Backup.

Orient and slide all other Diaphragms onto Monorail and position each approximately as shown in Figure 56.
8) Attach Hinge Plate onto Fender Panels

**Note:** Do not mix the 5/8" rail nuts (large) with the 5/8" hex nuts (small).

![Figure 57](image)

**Figure 57**
Rail Nuts are Oversize

**Note:** For proper impact performance, Systems for wide hazards must have Hinge Plates. Attach Hinge Plate on each Fender Panel using two 5/8" rail bolts and two 5/8" rail nuts, using top and bottom holes only, leaving the center-hole open as shown in Figure 58.

![Figure 58](image)

**Figure 58**
Hinge Plate Assembly

9) Attach Fender Panels

Starting at the Backup, attach left and right Fender Panels as shown in Figure 59. Attach Mushroom Washer Assembly as shown in Figure 59 and Detail 59a but do not torque at this time.

**Step 1**

Place the Fender Panel so that the center of the slot of the rearward Diaphragm is lined up with the approximate center of the slot in the Fender Panel.

Attach Mushroom Washer Assembly as shown in Figure 59 and Detail 59a and Detail 59b and do not torque at this time. This (Step 1) helps to balance the Fender Panel.
**Step 2**
Slide the Fender Panel forward until the holes in the Fender Panel line up with the holes in the forward Diaphragm.

**Step 3**
Use a drift pin to align the center hole of the Fender Panel with the center hole of the Diaphragm.

**Step 4**
Attach the front of the Fender Panels to the next Diaphragm using 5/8" x 4" bolts, 5/8" lock washer and 5/8" hex nut (small) in three places on the Hinge Plate per side.

**Step 5**
Be sure Mushroom Washer lays flat against the Fender Panel as shown in Detail 59a. Standoff on Mushroom Washer must be seated completely through slot.
Step 6
Check Diaphragm spacing to endure 915 mm [36"] between rear faces of consecutive Diaphragms as shown in Figure 61 and Fender Panel Assembly drawing.

Step 7
Once the proper spacing has been achieved, torque the Mushroom Washer Assembly (small hex nut) until it reaches the end of the threads. Assemble the remaining Diaphragms and Fender Panels following the same procedures.

Figure 60
Fender Panel Assembly

Figure 61
Proper Spacing Between Diaphragms
10) Attach End Cap

Using 5/8" x 3 1/2" G5 hex bolt, 5/8" hex nut and 5/8" lock washer, attach the End Cap to the front of the first Monorail segment as shown in Figure 62 and the Monorail Assembly drawing.

![Figure 62: Monorail End Cap Assembly](image)
11) **Assemble Cartridge Support Brackets**

Attach Cartridge Support Bracket to all Diaphragms and Backup as shown in Figures 63 - 66, the Backup Assembly drawing, and the Diaphragm Assembly drawing.

---

**Figure 63**
Diaphragm with Cartridge Support Bracket

**Figure 64**
Cartridge Support Bracket (Tension Strut Backup)

**Figure 65**
Cartridge Support Bracket (Concrete Backup)
12) Attach Nose Assembly

(See Pages 28 and 29 for Nose Assembly instructions.)

13) Checking the System Assembly

At this point recheck to ensure that all fasteners are properly tightened throughout the system (anchor bolts, etc.). See warning below. Check all Fender Panels. If they do not fit tightly against the underlying Fender Panels, system realignment may be necessary (See Figure 67).

<table>
<thead>
<tr>
<th>Warning:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Anchor Studs</td>
<td>Torqued to 165 N-m [120 ft-lb] Should NOT protrude above nuts (See Figure 18 on Page 19).</td>
</tr>
<tr>
<td>All Other Bolts</td>
<td>Tightened</td>
</tr>
<tr>
<td>Fender Panel</td>
<td>Maximum Gap Allowed: <strong>Wide Systems – 25 mm [1.00&quot;]</strong></td>
</tr>
</tbody>
</table>

**MAXIMUM GAP = 25 mm [1.00"]**

**Figure 67**

Fender Panel Gap for **Wide Systems**
14) Cartridge Attachment

Be sure the Adjustable Cartridge Support in the Nose is attached correctly. See “Attach Nose Assembly” in Step 11 on Page 28. The top surface of the Nose Cartridge should be horizontal.

To complete the assembly of a QuadGuard® II system, place the appropriate Cartridge in each Bay and Nose section of the system. Type I Cartridges are placed toward the front (Nose) of the system; Type II Cartridges are placed toward the rear (Backup) of the system (See Figures 68 and 69).

**Warning:** Placing the wrong Cartridge in the Nose or any Bay may result in unacceptable crash performance as described in NCHRP Report 350 as other configurations have not been crash tested.

![Figure 68 Cartridge Placement](image)

**Figure 68**
Cartridge Placement

![Figure 69 Typical Cartridge Layout (5 Bay System Shown)](image)

**Figure 69**
Typical Cartridge Layout (5 Bay System Shown)
**MP-3® Polyester Anchoring System**

The MP-3® Polyester Anchoring System is a quick and easy way to securely anchor crash cushions and other common highway devices. MP-3® features high pullout strength, superior vibration resistance, and exceptional durability.

Each MP-3® kit contains a can of MP-3® resin, hardener, cold weather promoter, studs, and washers. The cold weather promoter shortens hardening time by as much as seven hours. Both vertical and horizontal assemblies are possible using the MP-3® system.

**Vertical Assemblies**

**Note:** Read MP-3® Instructions before starting.

1) **Prepare the Concrete Foundation**

**Warning:** Do not allow the MP-3® resin or hardener to contact skin or eyes. See material safety data sheet supplied with the MP-3® kit for first-aid procedures. Use only in well-ventilated area. Do not use near open flame.

**Warning:** Wear safety goggles, apron, and gloves during construction.

The anchor bolts (studs) that anchor the QuadGuard® II system Backup and/or Monorail sections to the concrete foundation must be those shipped in the kit or of high strength steel (830 MPa [120,000 psi] minimum tensile strength or equal). These studs must be set in minimum 28 MPa [4000 psi] concrete. Allow the concrete to cure a minimum of seven days before applying MP-3®.

2) **Drill Holes**

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

Use the part that is to be anchored as a drilling template. Drill the holes 3 mm [1/8"] larger than the stud diameter to the recommended depth, using a rotary percussive drill. If a diamond drill is used, the surface will be too smooth for the MP-3® to adhere and full strength will not be achieved. See the MP-3® assembly instructions provided with your kit. Check to be sure all the holes are drilled to the proper depth and aligned with the part to be anchored (See Table A).

**Table A**

<table>
<thead>
<tr>
<th>Stud Size:</th>
<th>Concrete Bit Size</th>
<th>Minimum Depth</th>
<th>Recommended Torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4&quot;x 6 1/2&quot;</td>
<td>22 mm [7/8&quot;]</td>
<td>125 mm [5&quot;]</td>
<td>165 N-m [120 ft-lb]</td>
</tr>
<tr>
<td>3/4&quot;x 7&quot;</td>
<td>22 mm [7/8&quot;]</td>
<td>140 mm [5 1/2&quot;]</td>
<td>165 N-m [120 ft-lb]</td>
</tr>
<tr>
<td>3/4&quot;x 18&quot;</td>
<td>22 mm [7/8&quot;]</td>
<td>420 mm [16 1/2&quot;]</td>
<td>&lt;15 N-m [&lt;10 ft-lb]</td>
</tr>
</tbody>
</table>
3) **Clean the Holes**

Blow the concrete dust from the hole using oil-free compressed air. Thoroughly brush it with a stiff-bristled brush and then blow it out again. If the hole is wet, completely flush it with water while brushing. Then blow it clean using oil-free compressed air.

4) **Mix the Resin and Hardener**

Wearing gloves, apron and safety goggles, remove the lids from the MP-3® Part A-resin and Part B-hardener containers. Pour Part B into Part A, then mix vigorously for 30 seconds to form MP-3® grout (an anchor stud may serve as a stirring rod).

5) **Add Cold Weather Promoter (in Cold Weather)**

For faster hardening in cold weather, promoter may be used. Add the entire contents of the partially filled promoter container to the MP-3® grout, then mix for an additional 30 seconds. Use immediately because the MP-3® grout will thicken quickly. See Table B for hardening times.

**Warning:** Do not use promoter when the temperature is above 15 degrees Celsius (60 degrees Fahrenheit). Grout will harden too quickly. Use only in well-ventilated area. Do not use near open flame.

6) **Pour Grout into Holes**

Crimp the mouth of the can to form a sprout, and pour the MP-3® grout mixture down into the hole through the part. Fill the hole to 1/3 - 1/2 full.

**Caution:** Do not overfill or underfill the hole. If the hole is overfilled, there will not be enough grout to use all of the anchor studs/kit. If hole is underfilled, the grout may not develop the required pull out strength.

7) **Add the Washers and Nuts**

Place a flat washer onto the stud, then thread a nut on until 1 or 2 threads of the NUT are left exposed.

8) **Insert Studs in Holes and Wait for Grout to Harden**

Push the stud down through the part to be anchored and into the hole. Give the stud several twists in the MP-3® to wet the threads.

**Caution:** Do not disturb or load the stud until the MP-3® material has hardened (See Table B).

9) **Torque the Nuts**

Once the grout has hardened, torque the nut to the recommended values (See Table A on Page 51).
Table B
Approximate Hardening Times (hours)

<table>
<thead>
<tr>
<th>Temperature Concrete Bit Size</th>
<th>Hardening Times (hours) Recommended Torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>(C)</td>
<td>(F)</td>
</tr>
<tr>
<td>&gt;26</td>
<td>&gt;80</td>
</tr>
<tr>
<td>22-26</td>
<td>70-79</td>
</tr>
<tr>
<td>16-21</td>
<td>60-69</td>
</tr>
<tr>
<td>10-15</td>
<td>50-59</td>
</tr>
<tr>
<td>4-9</td>
<td>40-49</td>
</tr>
<tr>
<td>-1-3</td>
<td>30-39</td>
</tr>
<tr>
<td>&lt;1</td>
<td>&lt;30</td>
</tr>
</tbody>
</table>

*Not recommended
**Contact Customer Service Department for more information

Horizontal Assemblies

The horizontal MP-3® kit is the same as the vertical kit except that a Cartridge for a standard caulking gun is supplied in the horizontal kits and the resin for the horizontal kits is a thixotropic (TX) resin. The TX-Resin is a gelled resin intended to keep the grout in place in horizontal holes during application.

When using the horizontal MP-3® kits, follow the vertical instructions with the following exceptions:

1) **Thread Dispensing Tip onto Dispenser**
   Prior to mixing the grout, carefully thread the dispensing tip onto the dispenser.

2) **Pour Mixed Grout into Dispenser**
   Once the grout is mixed, crimp the mouth of the can to form a spout and pour the MP-3® grout into the open end of the dispenser (use mixing stud to scrape out the portion remaining in the can). You may use the box to hold the dispenser upright. Close the box lid and poke the dispenser tip into the top of it. Seal the dispenser with the plunger provided.

3) **Place Dispenser in Caulking Gun and Dispense Grout**
   Cut the small end of the dispenser tip off. Place the dispenser into a caulking gun and dispense until MP-3® TX grout reaches the tip of the dispenser, then release pressure. Push the dispenser tip through the part to the bottom of the hole and dispense while slowly withdrawing the tip.

   **Caution:** Do not over fill or under fill the hole. Fill hole approximately 1/3 to 1/2 full. If the hole is overfilled, there will not be enough grout to use all of the anchor studs/kit. If hole is underfilled the grout may not develop the required pull out strength.

4) **Add the Washers and Nuts**
   Put washer and nut on stud leaving nut flush with end of stud (See Figure 70).
5) **Insert Studs into Holes**

Push stud through part to be anchored and into hole. Twist the stud in the MP-3® grout to wet the threads.

**Note:** In horizontal applications the stud should be flush with the top of the nut (See Figure 70).

6) **Torque the nuts**

Once the grout has hardened, torque the nut to 165 N-m [120 ft-lb].
**MP-3® Assembly Cautions**

1) **Shelf life**

If the shelf life of the MP-3® has expired (See MP-3® kit for expiration information), mix a small amount of MP-3® in the proportions of one part A to two parts B by volume. If the material does not set according to the instructions, contact Energy Absorption Systems for guidance (See Page 3).

**Warning:** Do not use the MP-3® if: the material fails to set up, Part A-Resin had gelled (for vertical applications), or TX-Resin is NOT gelled (for horizontal applications).

2) **Steel rebar**

If steel rebar is encountered while drilling an MP-3® anchor bolt hole, apply one of the following solutions:

A) Using a diamond core drill or rebar drilling tool, drill through the rebar only, then switch back to the concrete bit and drill into the underlying concrete until the proper hole depth is reached.

**Caution:** Do not drill through rebar without first obtaining permission to do so from the local project engineer.

B) Drill a new hole down at an angle past the rebar to the proper depth. Anchor the stud by completely filling both holes with MP-3®.
**Maintenance and Repair**

**Inspection Frequency**
Inspections are recommended as needed based upon volume of traffic and impact history. Visual Drive-By Inspections are recommended at least once a month. Walk-Up Inspections are recommended at least once a year for QuadGuard® II systems on asphalt.

**Visual Drive-By Inspection**
1) Check to see if there is evidence of a hit. If so, a walk-up inspection will be necessary.
2) Check to see if the Cartridges appear to be off the Support Brackets. Any damaged Cartridges will need to be replaced.

> **Warning:** See Cartridge placement instructions on Pages 31 and 50.

3) Be sure the Steel Nose is in place.
4) Note the location and condition of the QuadGuard® II system and the date of visual drive-by inspection.

**Walk-Up Inspection**
1) Clear and dispose of any debris on the site.
2) Be sure all bolts are tight and rust free.
3) Be sure concrete anchor bolts are securely anchored.
4) Be sure Diaphragm Legs are straight.
5) Be sure all Mushroom Washer Assemblies are properly aligned and positioned.
6) Fender Panels and Transition Panels should nest tightly against the system.

> **Warning:** See Cartridge placement instructions on Pages 31 and 50.

<table>
<thead>
<tr>
<th>Fender Panel</th>
<th>Maximum gap allowed:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Narrow Systems – 20 mm [0.78”]</td>
<td></td>
</tr>
<tr>
<td>Wide Systems – 25 mm [1.00”]</td>
<td></td>
</tr>
</tbody>
</table>

See Figures 74 and 75 on Page 60.

7) Be sure Cartridges have not been damaged and are properly positioned on their Support Brackets. Replace crushed or sagging Cartridges. To ensure 100% of the intended speed characteristics, partially crushed Cartridges (due to slow speed impacts) shall be replaced.

> **Warning:** See Cartridge placement instructions on Pages 31 and 50.
8) Make all necessary repairs as described above. See Post-Impact Instructions, Page 58, for more information.

9) Note the location and condition of the QuadGuard® II system and any work done in the Impact Attenuator Inspection Logbook under the date of this inspection. If further repair is necessary, note repair request date in logbook. See Post-Impact Instructions, Page 58, and assembly section of this Manual for more information.
Post-Impact Instructions

Narrow Systems

1) Deploy the appropriate traffic-control devices for protection.

2) Check to see that all anchor bolts have remained firmly anchored in the roadway surface. Replace any that are loose, broken, or pulled out.

   If the system is anchored to asphalt, up to 20% of the total anchors may be replaced if damaged. If more than 20% of the anchors are damaged, the system should be relocated to fresh, undisturbed asphalt and redeployed using the 460 mm [18"] threaded rods.

   The proper performance of the system during an angle impact depends on the Monorail anchors being properly anchored.

3) Clear and dispose of any debris on the site.

4) Check the system to be certain that the Mushroom Washer Assemblies holding the Fender Panels together are still intact and that the system has not been deformed in a way that would prevent pulling it back to its original position.

5) Be sure that the Diaphragm Support Legs are all properly attached to the Monorail.

Wide Systems

1) Deploy the appropriate traffic-control devices for protection.

2) Check to see that all anchor bolts have remained firmly anchored in the roadway surface. Replace any that are loose, broken, or pulled out.

   The proper performance of the system during an angle impact depends on the Monorail Anchors being properly anchored.

Note: QuadGuard® II systems for Wide Hazards should never be anchored to asphalt.

3) Clear and dispose of any debris on the site.

4) Check the system to be certain that the Mushroom Washer Assemblies holding the Fender Panels together are still intact and that the system has not been deformed in a way that would prevent pulling it back to its original position.

5) Be sure that the Diaphragm Support Legs are all properly attached to the Monorail.

Caution: Use safety goggles and gloves when refurbishing the Mushroom Spring Assembly. Do not place fingers underneath an assembled Mushroom Washer. Parts may suddenly shift and fingers may be pinched. If the spring is still under compression as the nut is nearing the end of the bolt, to prevent injury, make sure that the spring is restrained with a clamp so it does not suddenly release when nut is removed from the Mushroom Washer Bolt.

6) Attach chain to Pullout Brackets on first Diaphragm (See Figure 71). Attach both ends of chain to a heavy vehicle (such as a 1 ton pickup.)
Warning: Stand clear in case chain breaks or becomes disconnected.

FIGURE 71
Pullout

Pull the QuadGuard® II system forward slowly until the system reaches its original length. Have someone watch the system during repositioning to be certain previously undetected damage does not cause the Diaphragms to bind or pull out improperly.

7) Remove all **crushed Cartridges** from within the system.

8) Check to see that the **Diaphragms** are in usable condition. Diaphragms which are bowed or have bent legs must be replaced.

9) Check that the **Fender Panels** are properly attached with the **Mushroom Washer Assemblies**. Damaged Fender Panels and Transition Panels must be replaced. Often, **Cartridge Support Brackets** with minor damage can be straight-ended and reused by doing the following:

   a. Remove damaged Cartridge Support Bracket from Diaphragm.
   
   b. Clamp Cartridge Support Bracket to Backup and begin bending using pipe wrench as shown in Figure 72.

FIGURE 72
Straighten Cartridge Support Bracket
c. Then, using a sledge hammer and Quad-Beam™ Panel on Backup as an anvil, straighten Cartridge Support Bracket back into 90° shape (See Figure 73).

**Figure 73**
Form Cartridge Support Bracket

<table>
<thead>
<tr>
<th>Warning:</th>
<th>Maximum gap allowed:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fender Panel</td>
<td>Narrow Systems – 20 mm [0.78”]</td>
</tr>
<tr>
<td></td>
<td>Wide Systems – 25 mm [1.00”]</td>
</tr>
</tbody>
</table>

10) Check the gaps between Fender Panels. The maximum gap allowed for these overlapping parts (including Fender Panels overlapping Panels behind the system) is 20 mm [.78"] for narrow systems and 25 mm [1.00"] for wide systems. Be sure the Mushroom Washer Assemblies are torqued to the end of the threads. If the gaps between the Fender Panels are still too large, it may be necessary to replace bent parts.

11) Replace all crushed Cartridges. See Cartridge Placement on Pages 31 and 50.

12) Remove damaged Nose Assembly. Attach the new Nose to the first Diaphragm, using the six threaded rods and four rail nuts per rod. See Pages 28 and 29 for the Nose Assembly.
13) Check the **torque of all bolts** on the system.

14) Check to be certain that the site is free from **any debris**. The QuadGuard® II system is once again ready for use.

---

### Table C

<table>
<thead>
<tr>
<th>Warning:</th>
<th>Torqued to 165 N-m [120 ft-lb] Should NOT Protrude Above Nuts (See Figure 50 on Page 39).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anchor Studs</td>
<td>Torqued to 165 N-m [120 ft-lb] Should NOT Protrude Above Nuts (See Figure 50 on Page 39).</td>
</tr>
<tr>
<td>All Other Bolts</td>
<td>Tightened</td>
</tr>
<tr>
<td>Fender Panel</td>
<td>Maximum Gap Allowed</td>
</tr>
<tr>
<td>Narrow Systems</td>
<td>20 mm [.78&quot;](See Figure 74)</td>
</tr>
<tr>
<td>Wide Systems</td>
<td>25 mm [1.00](See Figure 75)</td>
</tr>
</tbody>
</table>
Parts Ordering Procedure

Make a list of all damaged parts using part descriptions shown on Pages 63 and 64 of the system images. Answer the following questions in the spaces provided. This information is necessary to receive the proper parts.

### Table D
**QuadGuard® II System Ordering Information Chart**

<table>
<thead>
<tr>
<th>Description:</th>
<th>Choices</th>
<th>Fill in this section</th>
</tr>
</thead>
<tbody>
<tr>
<td>What is the Width of System? (See “Measuring the Width” Page 12.)</td>
<td>610 mm [24&quot;]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>760 mm [30&quot;]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>915 mm [36&quot;]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1219 mm [48&quot;]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1755 mm [69&quot;]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2285 mm [90&quot;]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3200 mm [126&quot;]</td>
<td></td>
</tr>
<tr>
<td>What is the Number of Bays? (See “Counting The Number of Bays” Page 11.)</td>
<td>Narrow Hazards: 1 through 9</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Wide Hazards: 3 through 9</td>
<td></td>
</tr>
<tr>
<td>What Type of Backup Does the System Have? (See Figure 3 and 4 on Page 12.)</td>
<td>Concrete Tension Strut</td>
<td></td>
</tr>
<tr>
<td>What Type of Transition Panel? (See “Side Panel and Transition Panel Types” Pages 15 and 16,) Be sure to note right side, left side, both sides, (See “How to Determine Left/Right” Page 11) or no Transitions.</td>
<td>• Quad to W</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Quad to Thrie</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Quad to Safety Shape Barrier</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Quad to End Shoe</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• 4” Offset Panel</td>
<td></td>
</tr>
</tbody>
</table>
Figure 76
QuadGuard® II for Narrow Hazards
Figure 77
QuadGuard® II for Wide Hazards
Notes: