

APPENDIX 'C'

QUADGUARD II PRODUCT MANUAL

QuadGuard® System



The World Wide Standard In Crash Cushions



ENERGY ABSORPTION
SYSTEMS, INC.

A Quixote Company
Saving Lives By Design

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Installation Manual

QuadGuard® System

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Important Introductory Notes

Proper installation of the QuadGuard 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.

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

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.

System Overview

The QuadGuard 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 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 the QuadGuard Product Manual to determine the appropriate length System for a given design speed.

Crash Performance

The 6 bay QuadGuard 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 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.

QuadGuard® System

Installation

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: 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"

Personal protective equipment

- Protective Eyewear
- 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® System

Installation (cont'd.)

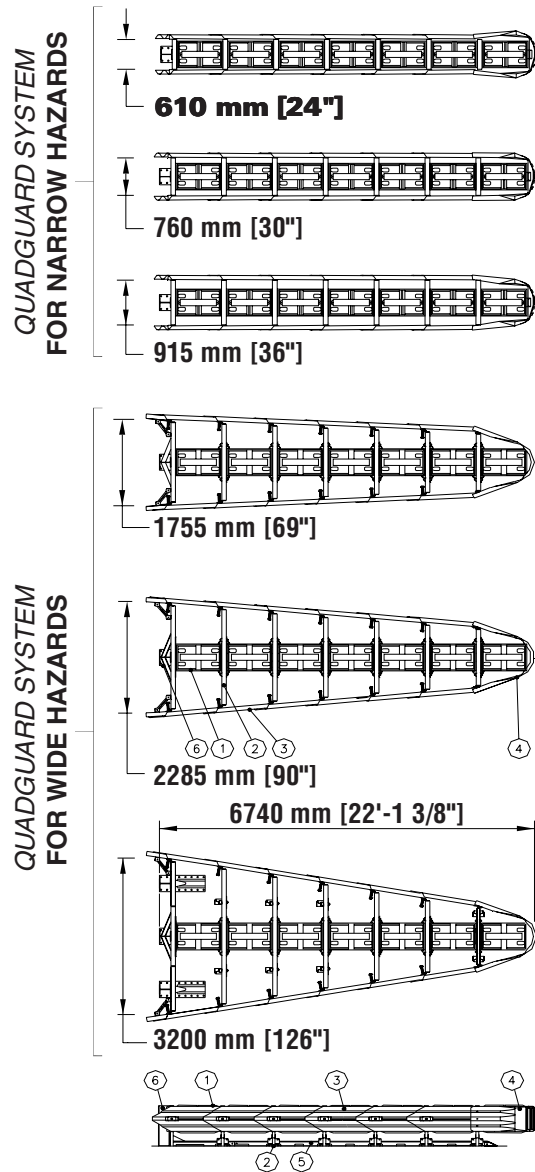


Figure 1 - Plans & Elevation
(Six bay Systems with Tension Strut Backups shown)

Key

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

QuadGuard® System

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 2. 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 2 (5 bay System shown).

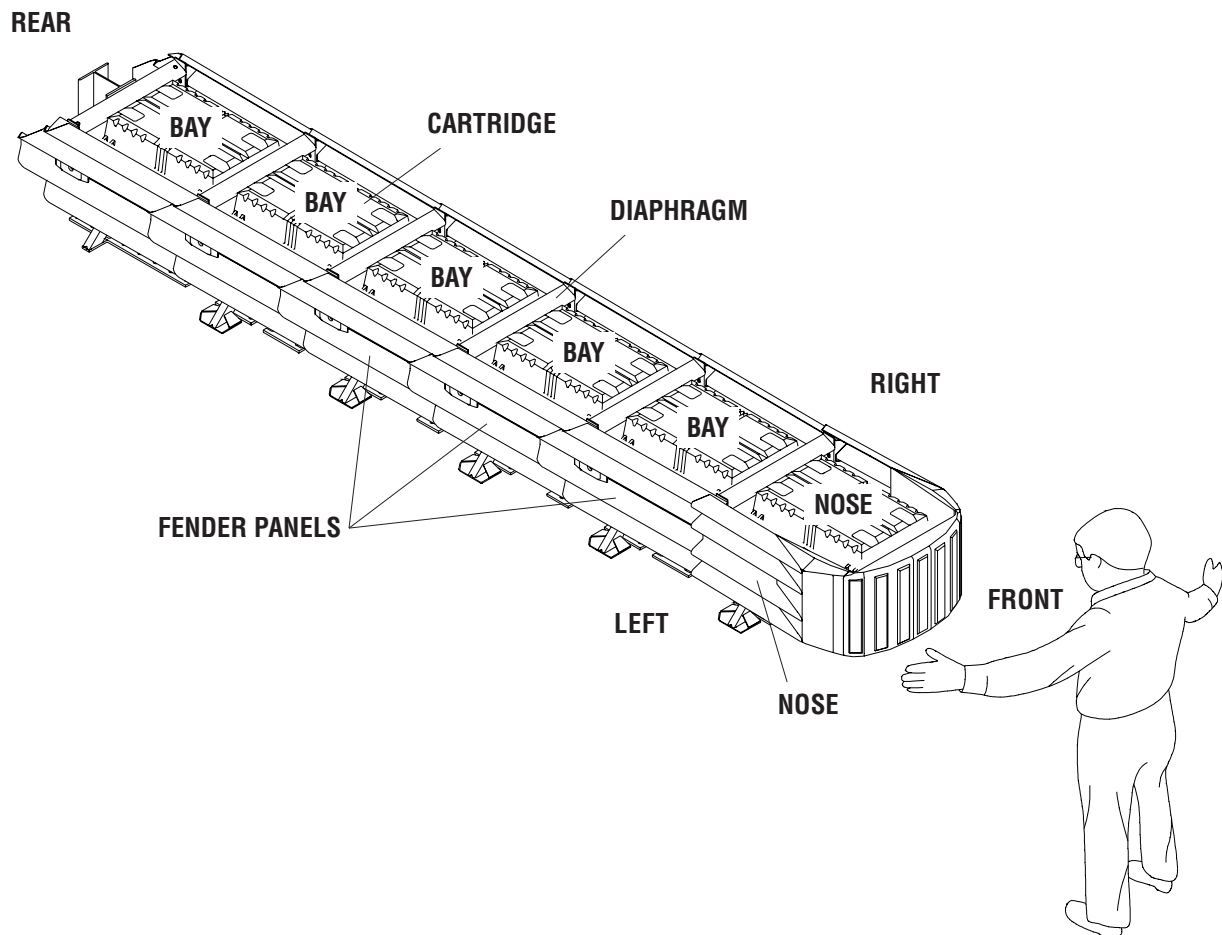


Figure 2
System Orientation

QuadGuard® System

Installation (cont'd.)

Measuring The Width

The QuadGuard System is available in six nominal widths:

- 610 mm [24"]
- 760 mm [30"]
- 915 mm [36"]
- 1755 mm [69"]
- 2285 mm [90"]
- 3200 mm [126"]

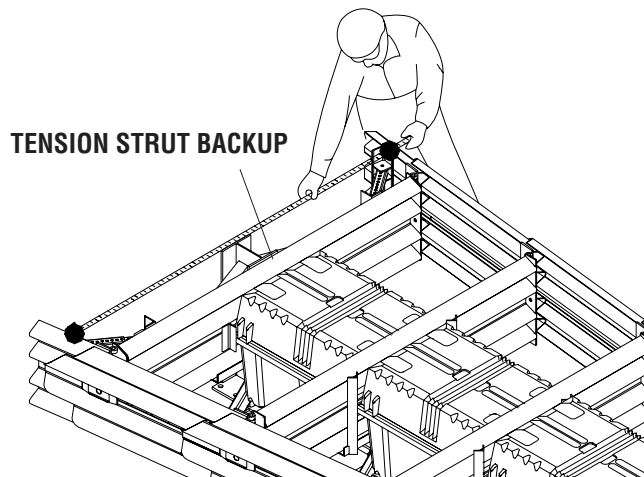


Figure 3
Width of System with Tension Strut Backup

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.

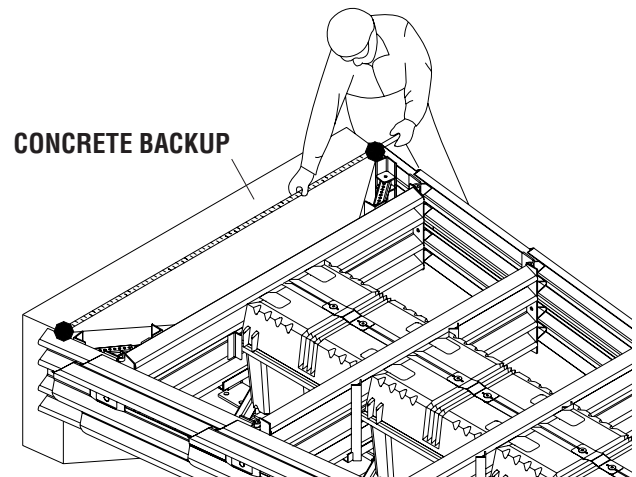
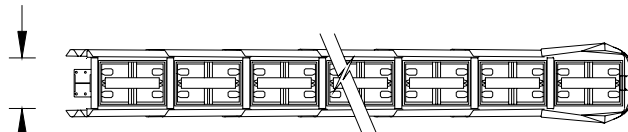


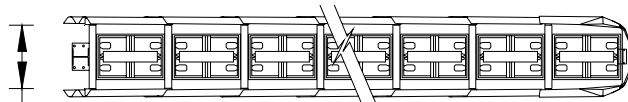
Figure 4
Width of System with Concrete Backup

QuadGuard[®] System

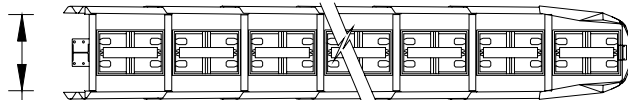
QUADGUARD SYSTEMS FOR NARROW HAZARDS



610 mm [24"] MODEL NO. QS24__



762 mm [30"] MODEL NO. QS30__



914 mm [36"] MODEL NO. QS36__

QuadGuard® System

Installation for Narrow Hazards (cont'd.)

Site Preparation/Foundation

A QuadGuard System should be installed 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 pads are provided in Energy Absorption Systems, Inc. concrete pad drawings, supplied with the System. System may be installed on concrete roadway (minimum 200 mm [8"] thick). Installation cross slope shall not exceed 8% (see figure 5) and should not vary (twist) more than 2% over the length of the System; the pad surface shall have a light broom finish.

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

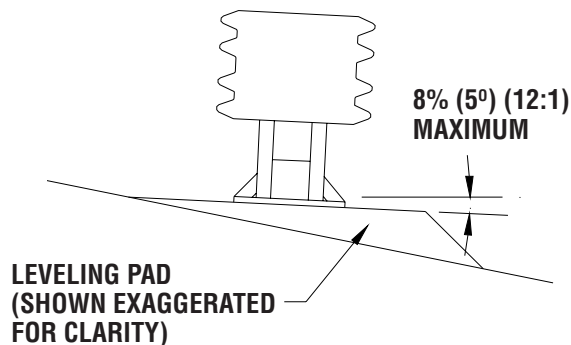


Figure 5
Cross-Slope

WARNING!

Location of the backup in relation to nearby objects will affect the operation of the attenuator. Upon impact, the fender panels telescope toward and extend beyond the rigid backup as much as 760 mm [30"] 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 panels. Failure to comply with this requirement may result in impaired System performance offering motorists less protection and cause component damage.

QuadGuard® System

Installation for Narrow Hazards (cont'd.)

Inspect Shipping

Before installing the QuadGuard System, check the received parts against the shipping list supplied with System. Make sure all parts have been received.

Installation Procedures

Note: The drawing package supplied with the QuadGuard 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 System is available with a tension strut backup or a concrete backup. Refer to figures 6 and 7, along with the backup assembly drawing to determine which type of backup is being installed.

A transition panel or side panel will 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 System. Refer to figures 8 through 13 and the drawing package to determine which type of panels are being installed.

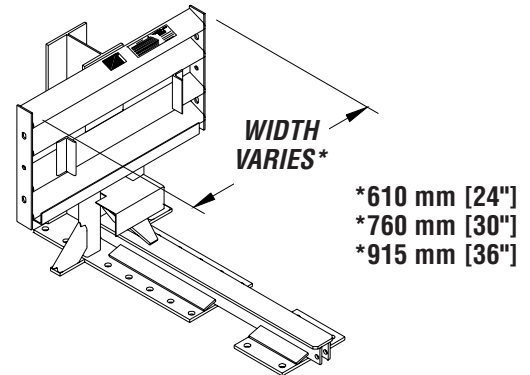


Figure 6
Tension Strut Backup

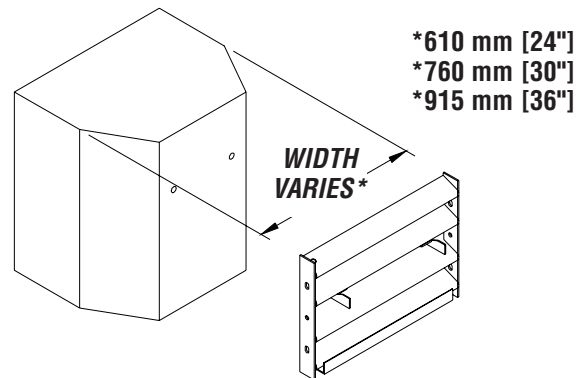


Figure 7
Concrete Backup

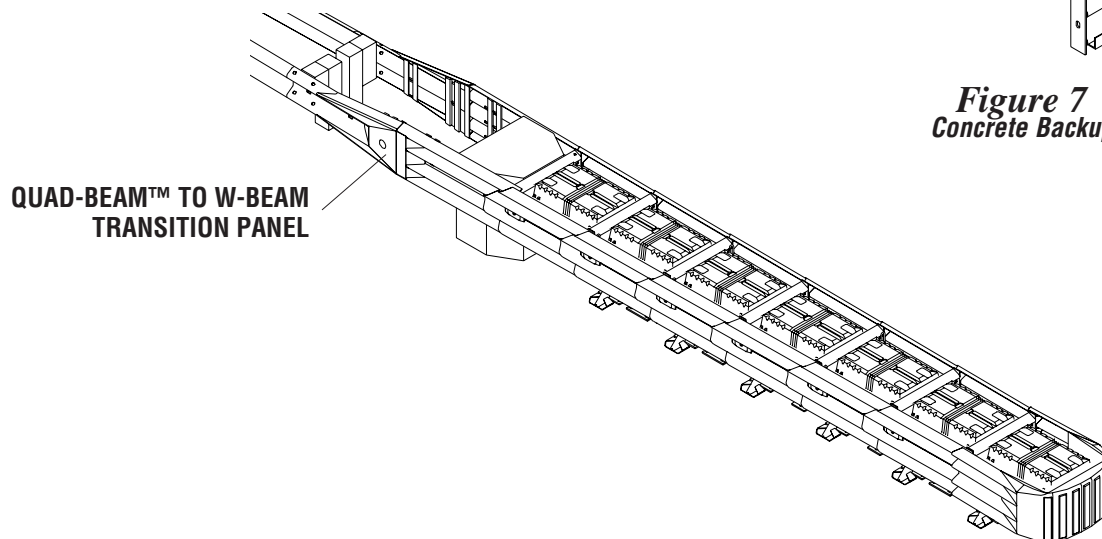


Figure 8
Transitioning the QuadGuard System

QuadGuard® System

Installation for Narrow Hazards (cont'd.)

Transition Panel Types

Note: The proper transition or side panel must be used for optimum impact performance of the System. The correct panel to use will depend on the direction of traffic and what type of barrier or hazard the QuadGuard System is shielding. Contact the Customer Service Department prior to installation if you have any questions.

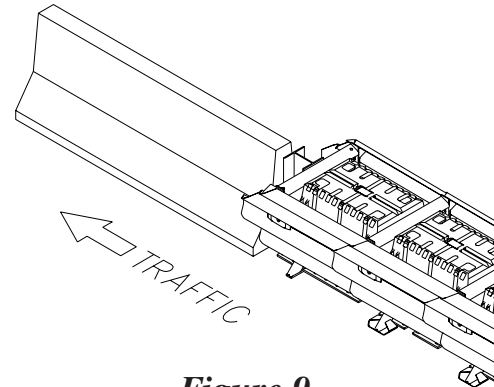


Figure 9
No Transition

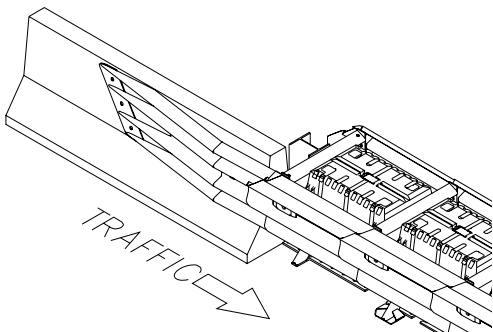


Figure 10
Quad-Beam to Safety Shape Barrier Transition Panel

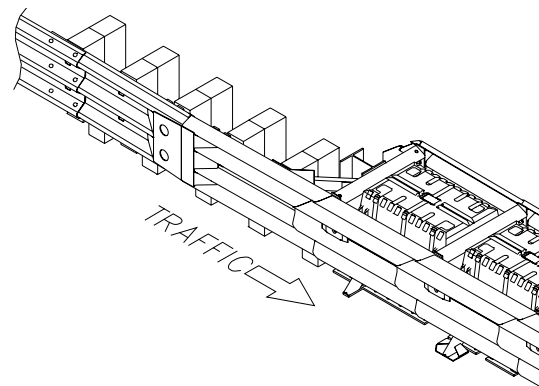


Figure 11
Quad-Beam to Thrie-Beam Transition Panel

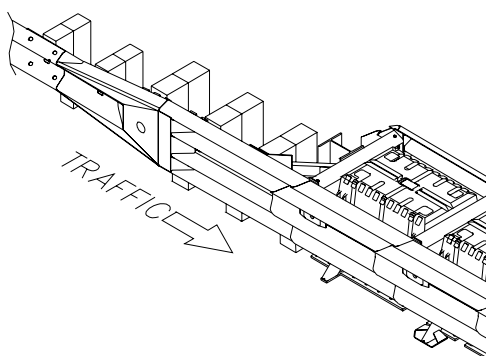


Figure 12
Quad-Beam to W-Beam Transition Panel

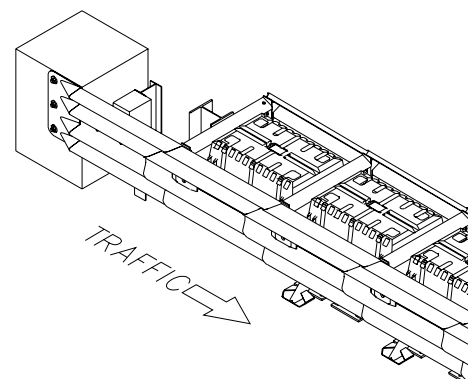


Figure 13
Quad-Beam End Shoe Transition Panel

Note: Wheel Deflectors may be required for this application.

QuadGuard® System

Installation for Narrow Hazards (cont'd.)

2) Mark System Location

Locate the centerline of the System by measuring the proper offset from the hazard. Refer to 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 14. The edge of the monorail will be placed on this line.

Note: The concrete pad should be installed per 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.

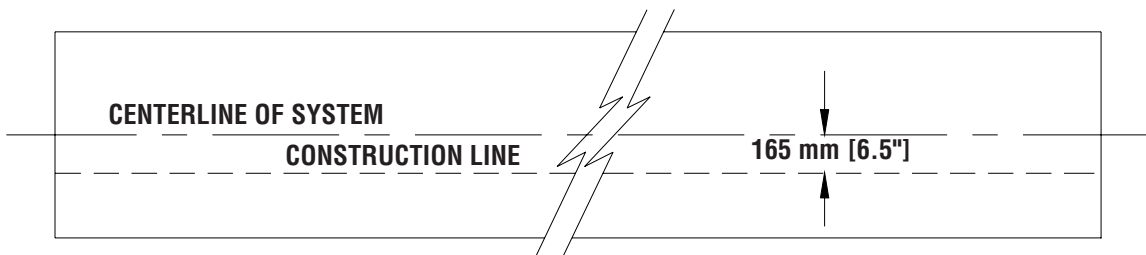


Figure 14
*(Top view of concrete pad)
Locating Construction Line*

QuadGuard® System

Installation for Narrow Hazards (cont'd.)

3a) Anchor the Backup

Concrete Backup Installation (Figure 15)

Locate front 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 System (see MP-3 Polyester Anchoring, page 47).

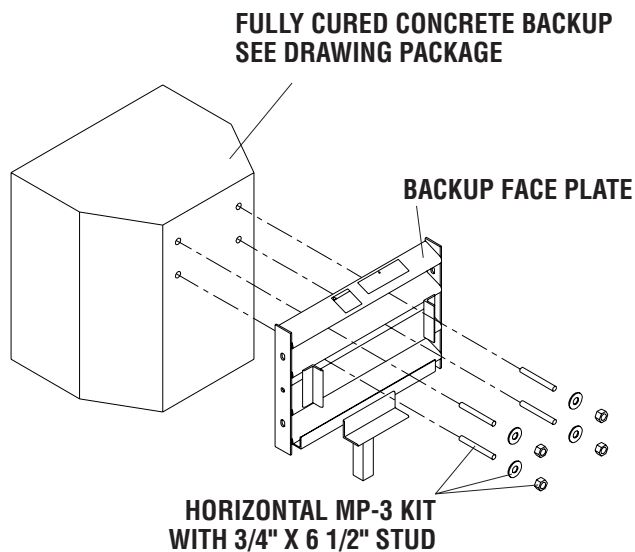


Figure 15
Anchoring Backup Face Plate to Concrete Backup

3b) Anchor the Backup

Tension Strut Backup installation (Figure 16)

Locate tension strut backup and monorail on pad with side of monorail on the construction line (see Figure 18). Verify that any applicable transition panels fit properly before anchoring backup. Drill anchor holes in pad using the backup as template. Anchor the backup to the concrete pad using the MP-3 vertical kits provided. (See "MP-3 Polyester Anchoring System" on page 47).

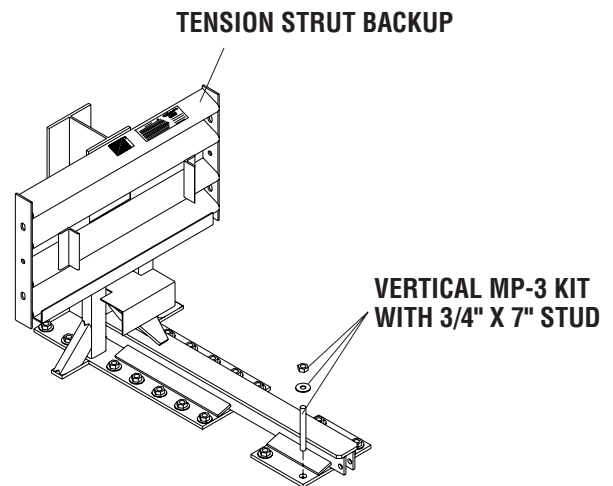


Figure 16
Anchoring Tension Strut Backup to Foundation

QuadGuard® System

Installation for Narrow Hazards (cont'd.)

4a) Anchor the Monorail

Monorail Installation for Concrete Backup (Figure 18)

Locate monorail on pad with side of monorail on the construction line and rear edge of monorail foot 10" forward of front face of concrete backup (see Figure 18).

Orient monorail so that the monorail tongues face the backup (see figure 18).

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

WARNING!

Every hole and slot in backup and monorail must have an MP-3 stud anchoring it.

Anchor each monorail section using the MP-3 vertical kits provided. Refer to Figure 17 and the MP-3 Polyester Anchoring System Instructions included with this manual. It is important to install 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.

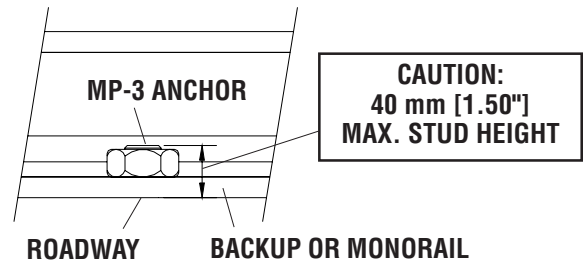


Figure 17
Proper Stud Height

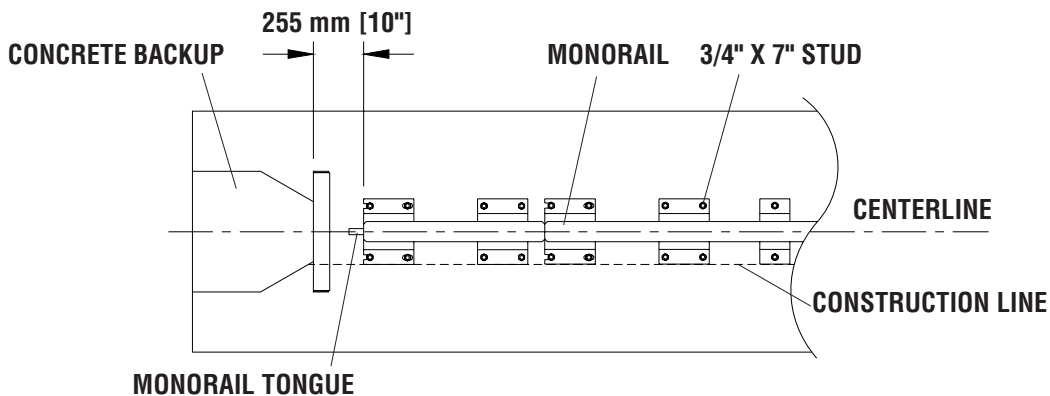


Figure 18
Monorail Location for Concrete Backup

QuadGuard® System

Installation for Narrow Hazards (cont'd.)

4b) Anchor the Monorail

Monorail Installation for Tension Strut Backup (Figure 19)

Locate monorail on pad with side of monorail on the construction line and rear edge of backup foot 4" forward of edge of pad (see Figure 19).

Orient monorail so that the monorail tongues face the backup (see figure 18).

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

WARNING!

Every hole and slot in backup and monorail must have an MP-3 stud anchoring it.

Anchor each monorail section using the MP-3 vertical kits provided. Refer to Figure 17 and the MP-3 Polyester Anchoring System Instructions included with this manual. It is important to install 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.

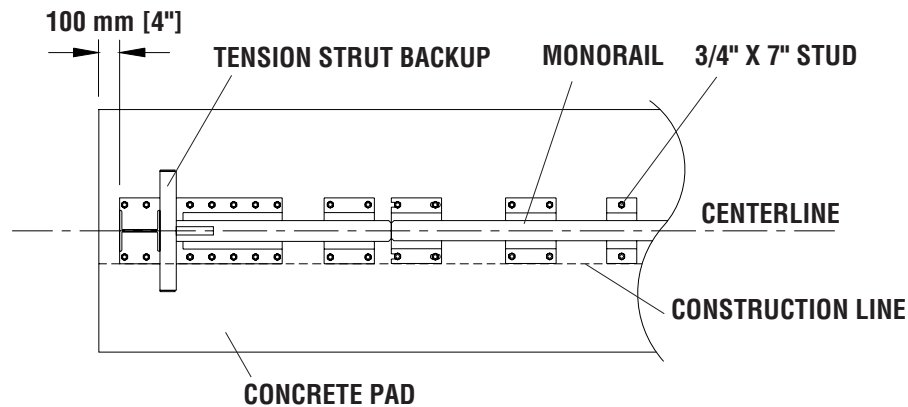


Figure 19

Backup and Monorail Location for Tension Strut Backup

QuadGuard® System

Installation for Narrow Hazards (cont'd.)

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

Attach transition panel or side panel to side of backup using 5/8" rail bolt & 5/8" rail nut (two places - top & bottom holes only). See Figure 20 and backup assembly drawing.

Note: A side panel is not needed when a transition panel is used.

Installation tip:

Use drift pin to align the center hole of the panel with the center hole of the backup before installing the rail bolts.

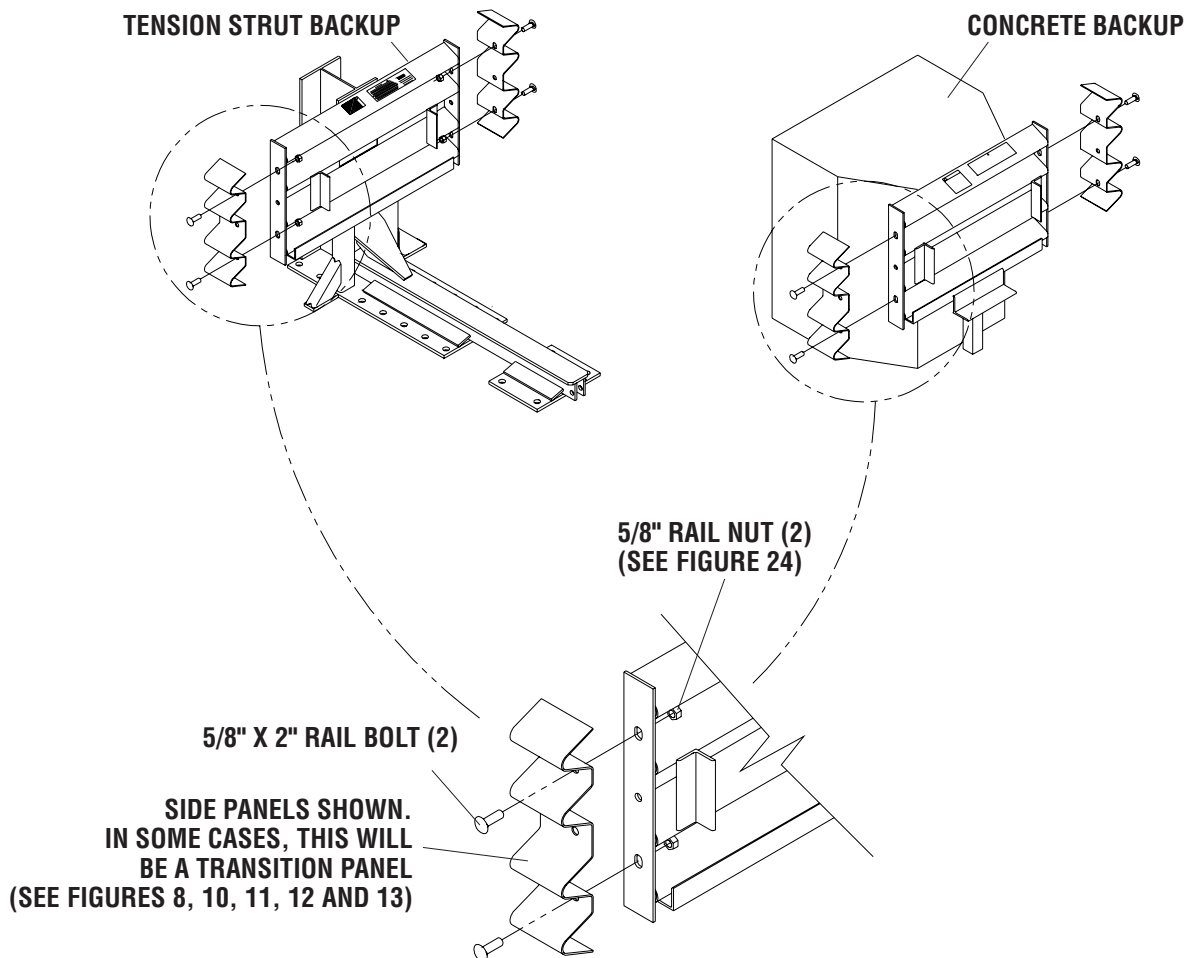


Figure 20
Side Panel/Transition Panel Attachment

QuadGuard® System

Installation for Narrow Hazards (cont'd.)

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 21. Secure with 3/4" lock washer & 3/4" hex nut (typical 4 places). See also diaphragm assembly drawing.

Repeat for each diaphragm.

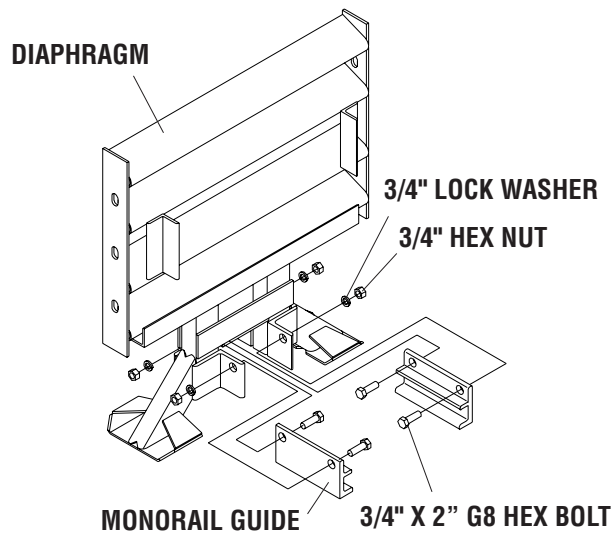


Figure 21
Monorail Guide Attachment

7) Install Diaphragms

Orient a diaphragm so that the front face of the Quad-Beam shape faces toward the nose of the System as shown in Figure 22. 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 23.

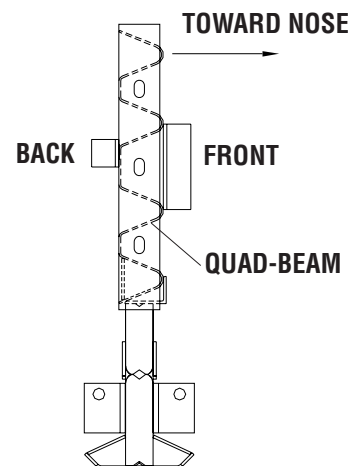


Figure 22
Diaphragm Orientation

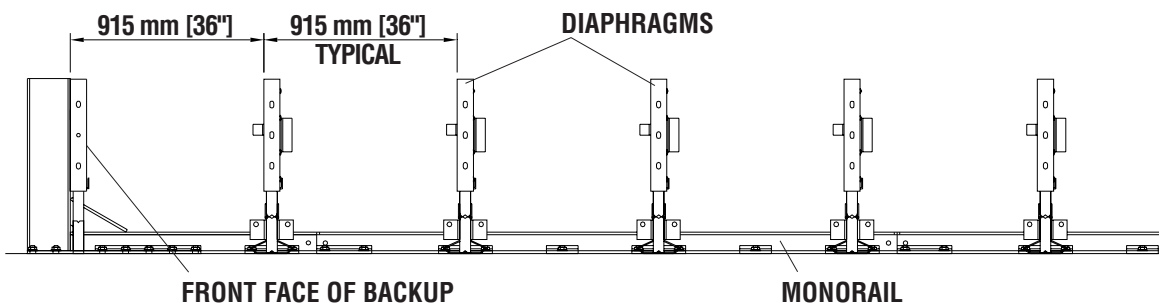


Figure 23
Diaphragm spacing

QuadGuard® System

Installation for Narrow Hazards (cont'd.)

8) Install Fender Panels

Note: Do not mix the 5/8" rail nuts (large) with the 5/8" hex nuts (small). See Figure 24.

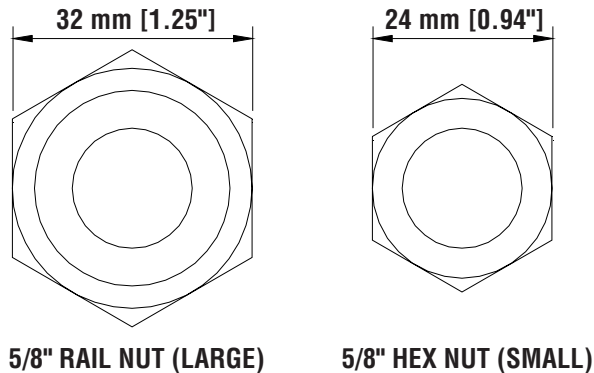


Figure 24
Rail Nuts are Oversize

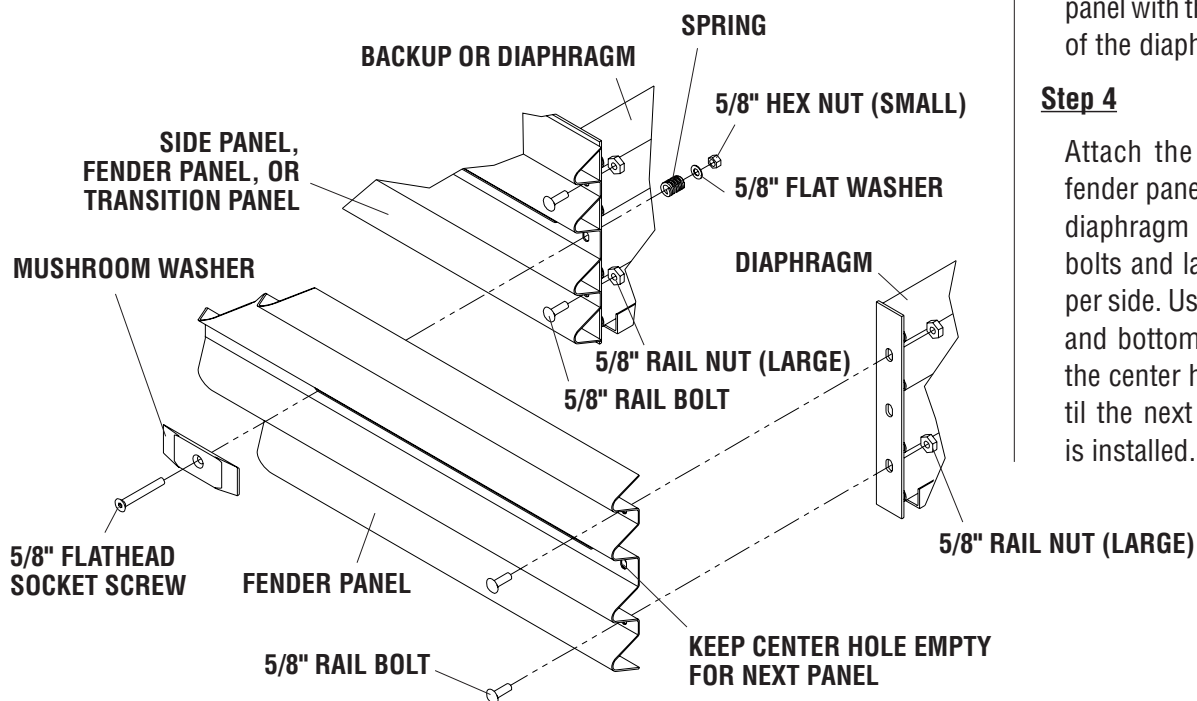


Figure 25
Fender Panel Assembly

Starting at the backup, install left and right fender panels as shown in Figure 25, Detail 25a 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 25 and Detail 25a, but do not torque at this time. (This 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

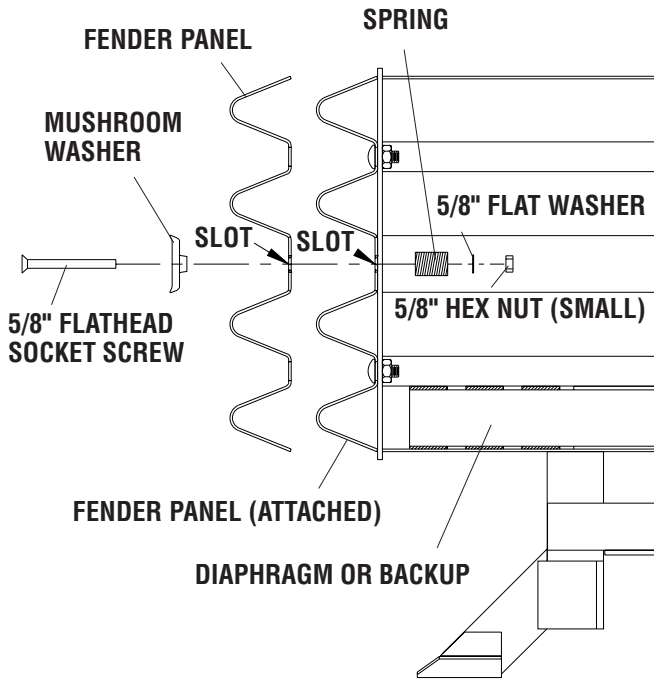
Use a drift pin to align the center hole of the fender panel with the center hole of the diaphragm.

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 installed.

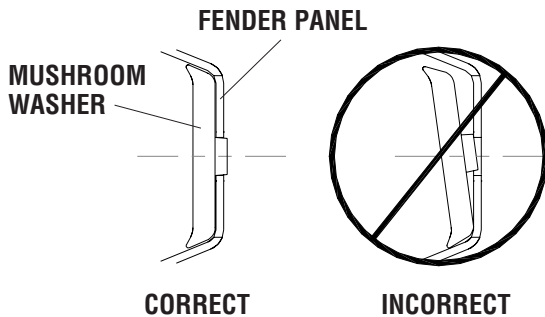
QuadGuard® System

Installation for Narrow Hazards (cont'd.)



Detail 25a
Mushroom Washer Attachment

Be sure mushroom washer lays flat against the fender panel as shown in Figure 27. Standoff on washer must be seated completely through slot.



Detail 25b
Mushroom Washer Orientation

Check diaphragm spacing to ensure 915 mm [36"] between rear faces of consecutive diaphragms as shown in Figure 26 and fender panel assembly drawing.

Once the proper spacing has been achieved, torque the mushroom washer assembly (small hex) nuts to hold the diaphragm and fender panels in place during assembly of the rest of the System.

Install the remaining diaphragms and fender panels following the same procedures.

Tighten the nut so that the spring is compressed 1mm to 3mm [1/16" to 1/8"] to complete the assembly.

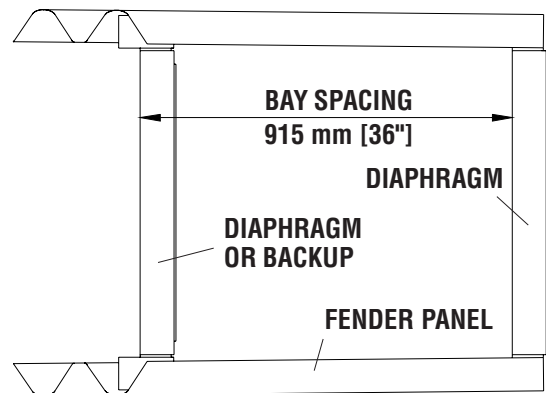


Figure 26
Proper Spacing Between Diaphragms

QuadGuard® System

Installation for Narrow Hazards (cont'd.)

9) Install 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 27 and monorail assembly drawing.

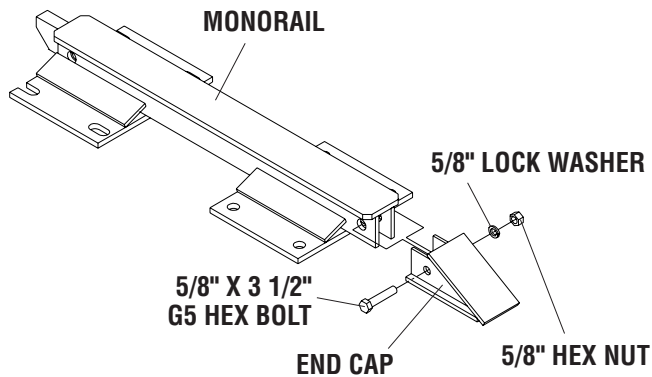


Figure 27
Monorail End Cap Installation

10) Install Cartridge Support Brackets

Attach lower cartridge support bracket to front and back of all diaphragms and front of backup as shown in figures 29, 30, diaphragm assembly drawing & backup assembly drawing.

Note: 610 mm [24"] wide Systems do not have side cartridge support brackets; 762 mm [30"] and 914 mm [36"] wide Systems have side cartridge support brackets welded to the backup and diaphragms.

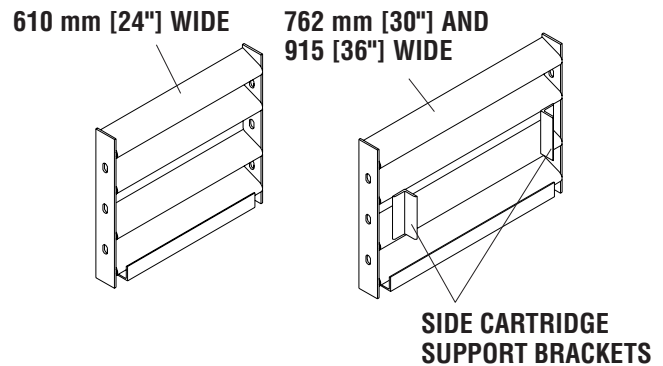


Figure 28
Side Cartridge Support Brackets

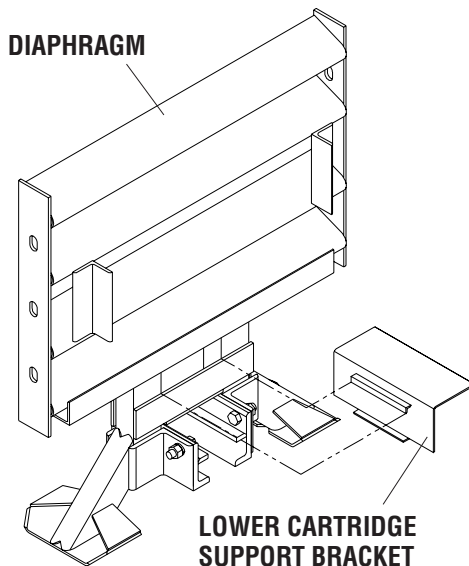
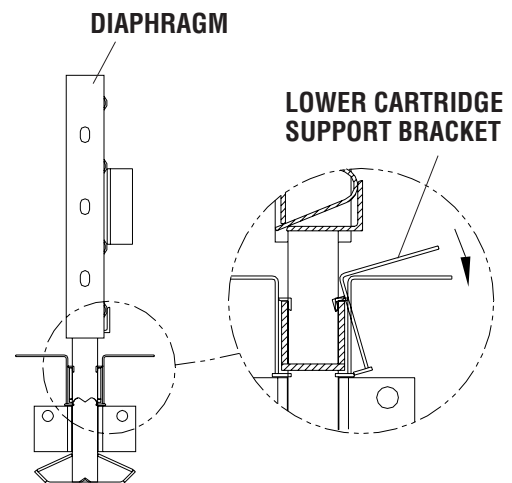


Figure 29
Lower Cartridge Support Bracket Installation



QuadGuard® System

Installation for Narrow Hazards (cont'd.)

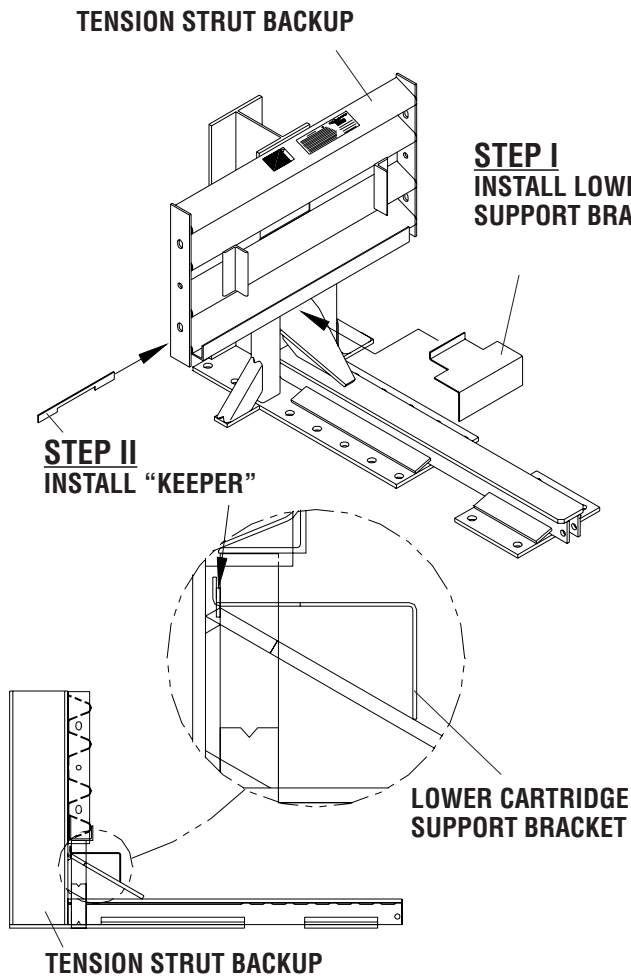


Figure 30
*Lower Cartridge Support Bracket Installation
(Tension Strut Backup)*

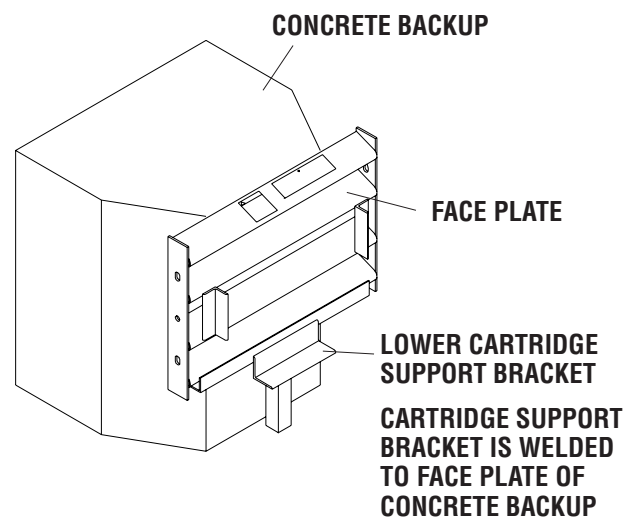


Figure 31
*Lower Cartridge Support Bracket
(Concrete Backup)*

QuadGuard® System

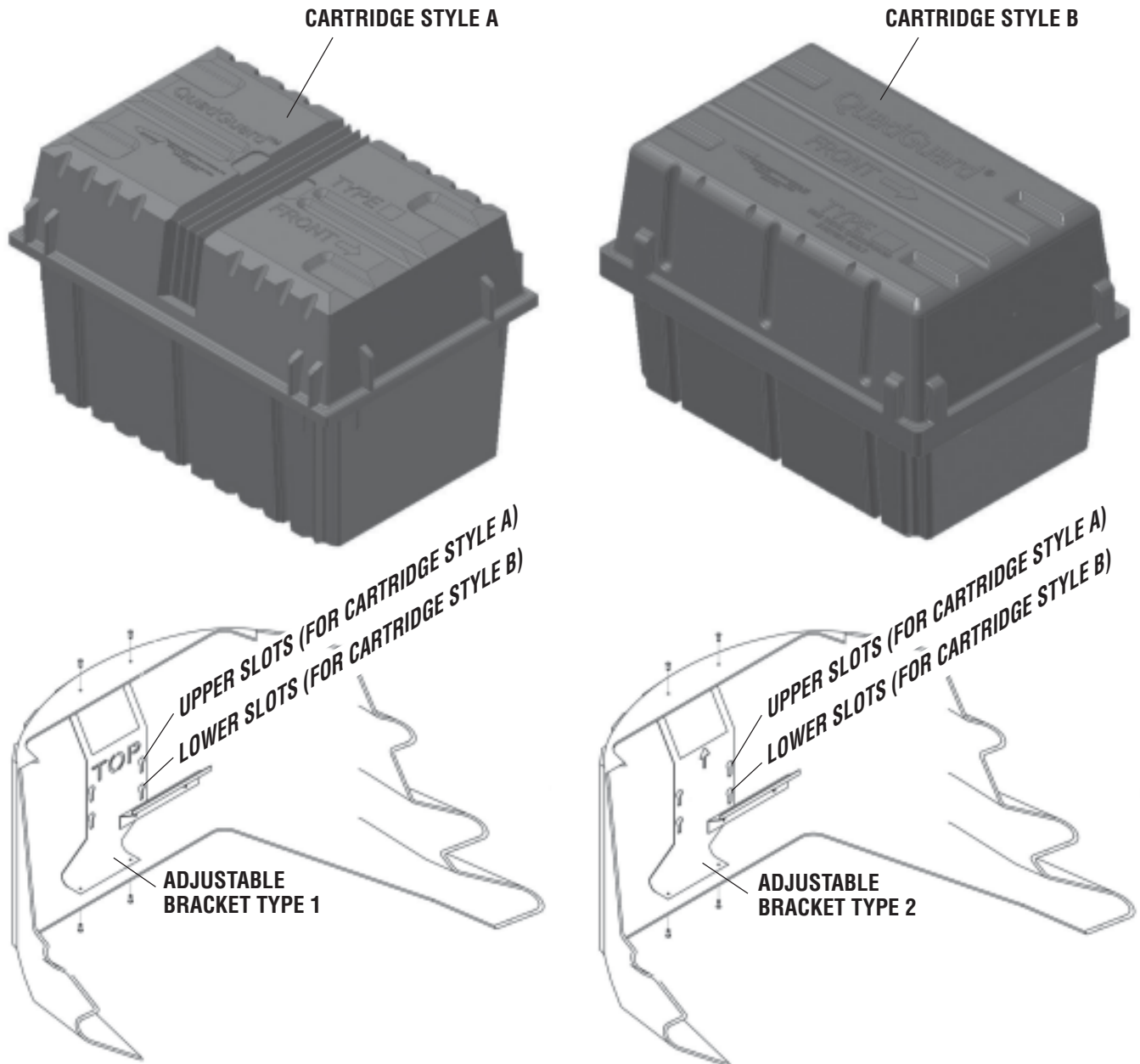
Installation for Narrow Hazards (cont'd.)

11a) Install Nose Assembly

Determine which style of cartridges your system has.

If your system has cartridge style A as shown in Detail 32, install cartridge support in the upper two slots as shown.

If your system has cartridge style B as shown in Detail 32, install cartridge support in the lower two slots as shown.

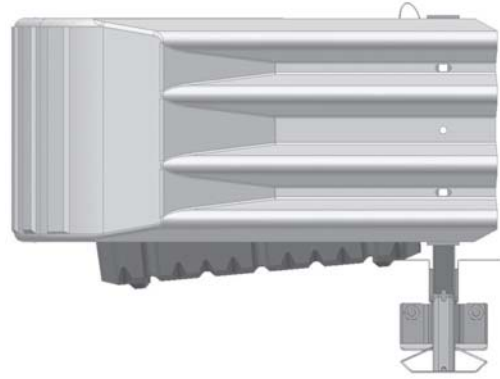


Detail 32
Adjustable Bracket Locations

QuadGuard® System

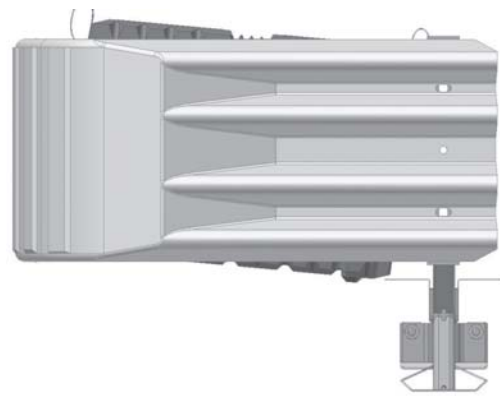
Installation for Narrow Hazards (cont'd.)

As shown in Detail 32c, cartridge style A is installed with the adjustable cartridge support bracket **incorrectly** in the lower position.



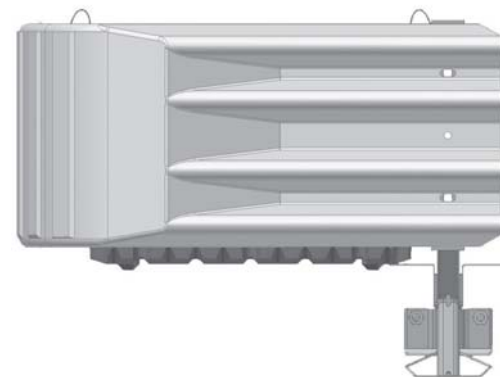
Detail 32c
Incorrect Installation of
Adjustable Cartridge Support Bracket

As shown in Detail 32d, cartridge style B is installed with the adjustable cartridge support bracket **incorrectly** in the upper position.



Detail 32d
Incorrect Installation of
Adjustable Cartridge Support Bracket

Detail 32e shows the adjustable cartridge support bracket installed **correctly**.



Detail 32e
Correct Installation of
Adjustable Cartridge Support Bracket

QuadGuard® System

Installation for Narrow Hazards (cont'd.)

Bolt the nose directly to the front diaphragm, as shown in figures 32, 33 and the nose assembly drawing, using six rail bolts which also hold the front two fender panels to the diaphragm with bar washer under each bolt.

Place pullout brackets under center nuts.

The top and bottom holes of the nose are slotted to provide adjustment. Adjust so the top edge of the nose is level with the top edge of the fender panels, then torque all six nuts to 35 Nm [25 ft-lbs].

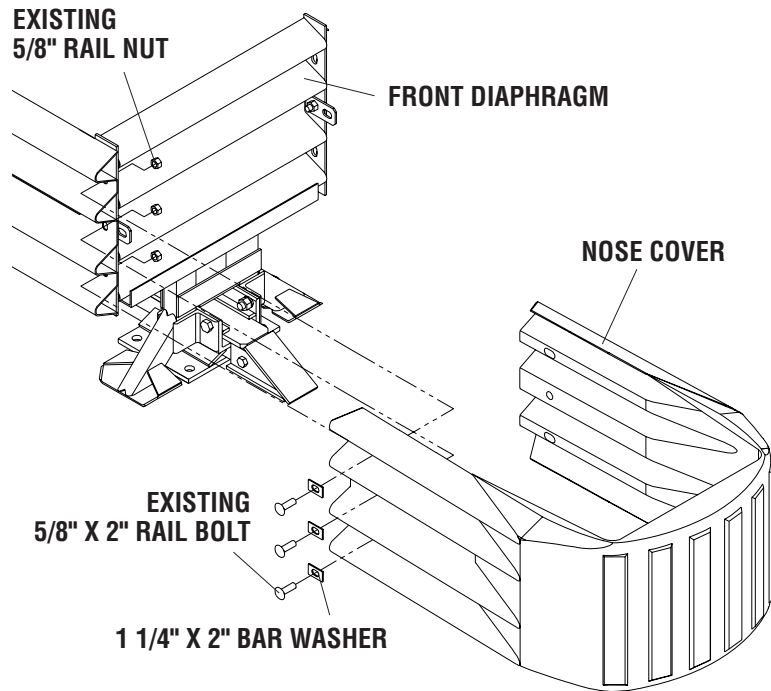


Figure 32
Nose Assembly

PLACE A BOARD OVER THE FIRST TWO DIAPHRAGMS AS SHOWN TO FACILITATE PROPER ALIGNMENT OF NOSE

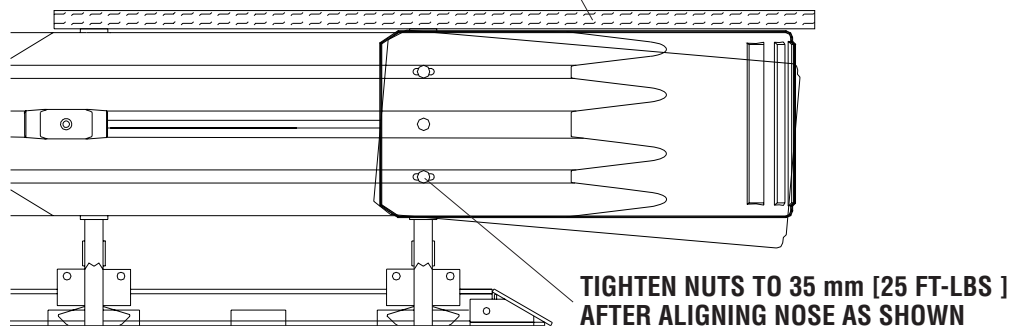


Figure 33
Adjust Nose

QuadGuard® System

Installation for Narrow Hazards (cont'd.)

11b) For Systems with Optional Nose Belt Assembly

- Using 5/8" x 5" hex bolt, two 5/8" x 1 3/4" flat washers and 5/8" hex nut, attach fender panel to front diaphragm top and bottom as shown in Figure 34 (two places per side).
- Using 5/8" x 5" hex bolt and 5/8" hex nut, attach pullout bracket to front diaphragm and fender panel middle as shown (one place per side).
- Thread second 5/8" nuts onto the installed bolts. Be sure the face of the nuts are flush with humps on fender panels (see detail 34a). Slide third 5/8" x 1 3/4" flat washers onto bolts (three places per side).
- Align holes in each end of the nose belt with the installed bolts (three per side) and slide nose belt onto bolts.
- Align holes in belt clamps with bolts and slide belt clamps onto bolts.
- Using fourth 5/8" x 1 3/4" flat washer and third 5/8" hex nut, secure the belt clamps and nose belt (three places per side).

Refer also to nose belt assembly drawing.

Note: Nose alignment shown in figure 33 not necessary with nose belt assembly.

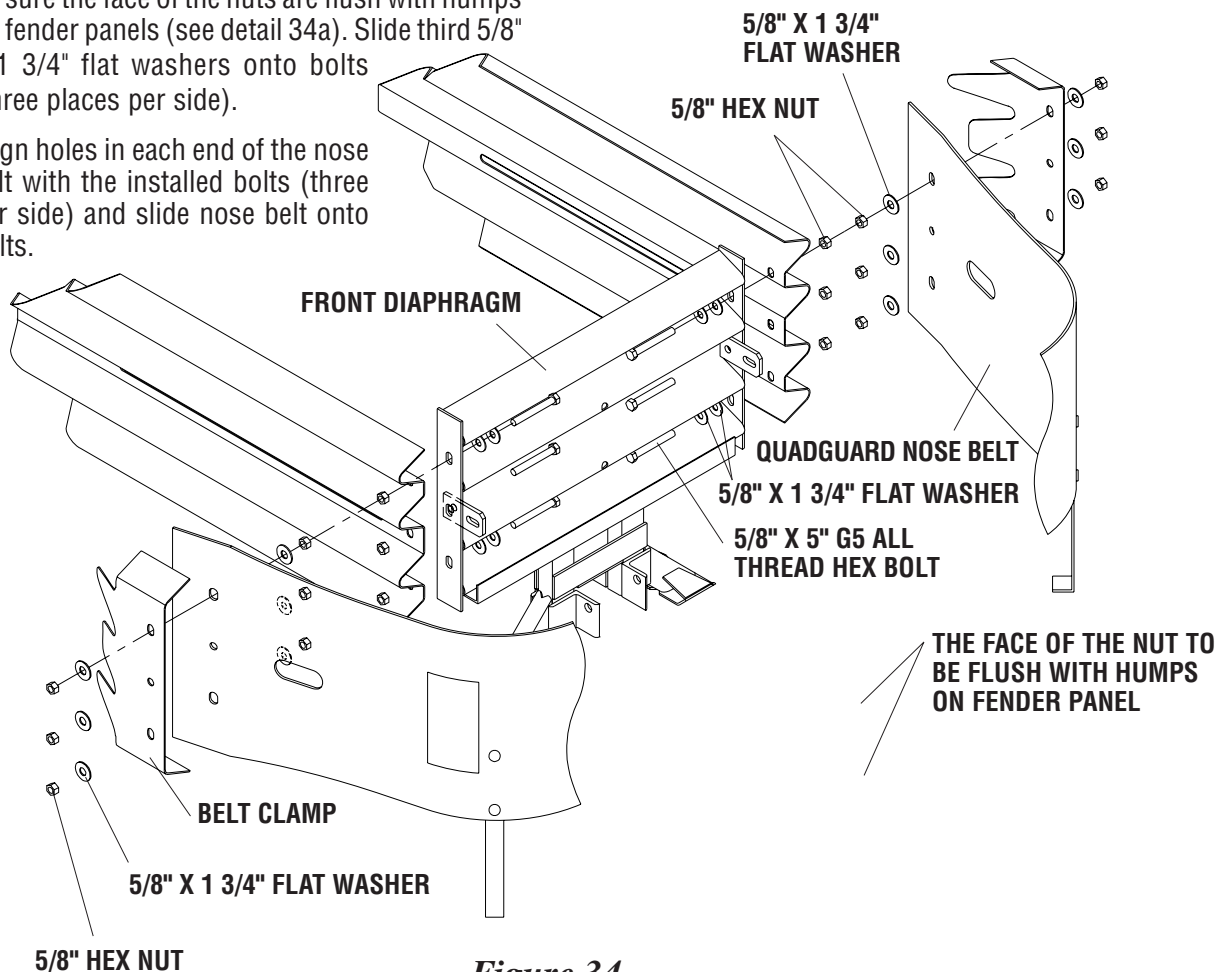


Figure 34
Optional Nose Belt Assembly

Note: Nose of System may be delineated to comply with local codes (chevron, reflective material, signs, etc. supplied by others).

Detail 34a

QuadGuard® System

Installation for Narrow Hazards (cont'd.)

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 35).

WARNING!

Anchor Studs.... Torqued to 165 Nm [120 ft-lbs]
Should NOT protrude above nuts
(see Figure 16, page 13)

All Other Bolts... Tightened

Fender Panel..... Maximum gap allowed:
Narrow Systems - 20 mm [0.78"]

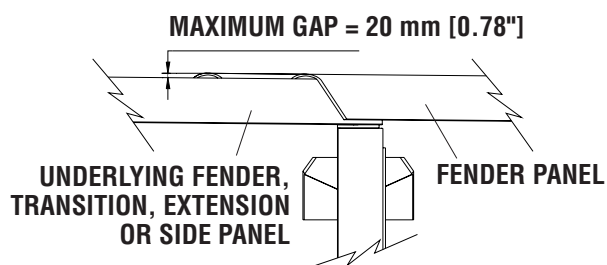


Figure 35
Fender Panel Gap for Narrow Systems

13) Cartridge Installation

Be sure the adjustable cartridge support in the nose is installed correctly. See "Install Nose Assembly" 10a.

To complete the assembly of a QuadGuard 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. Refer to figures 36 and 37.

WARNING!

Placing the wrong Cartridge in the Nose or any Bay will result in unacceptable crash performance as described in NCHRP 350.

I - TYPE I CARTRIDGE
II - TYPE II CARTRIDGE

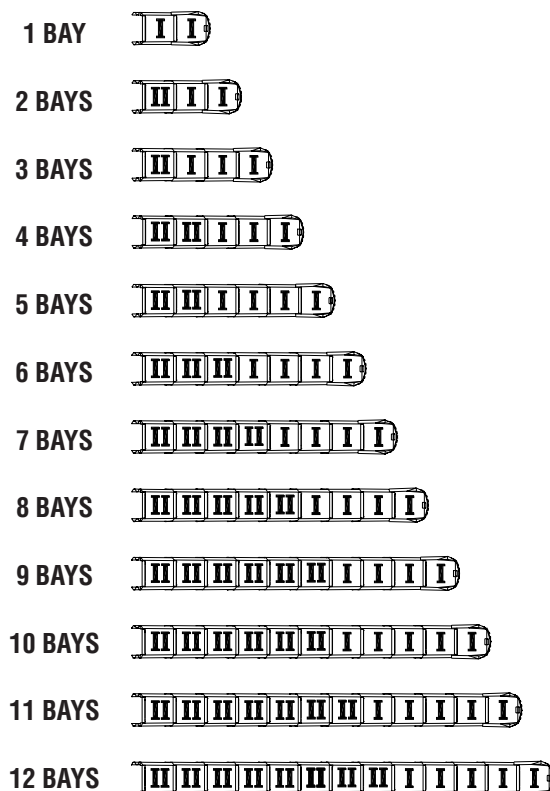


Figure 36
Cartridge Placement

QuadGuard® System

Installation for Narrow Hazards (cont'd.)

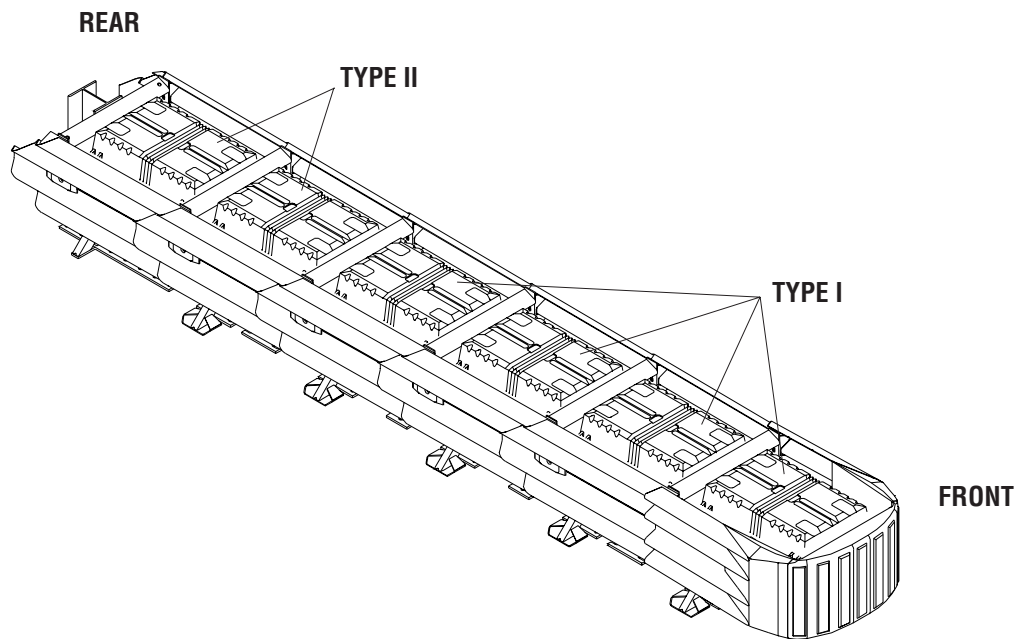
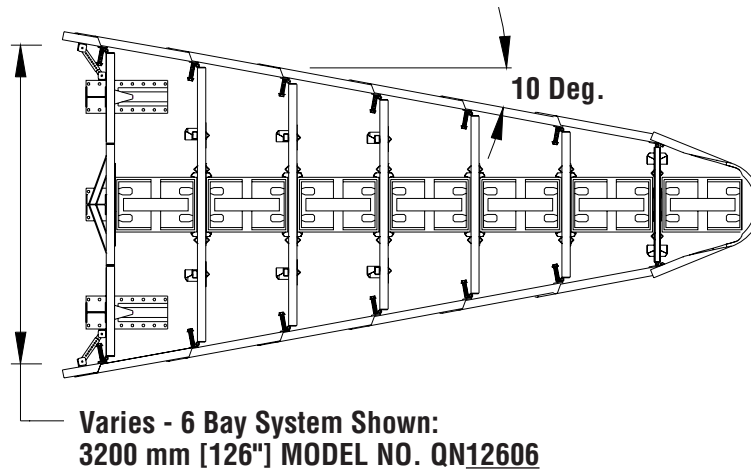
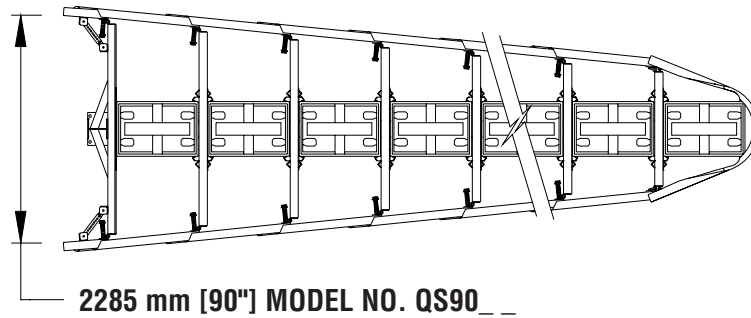
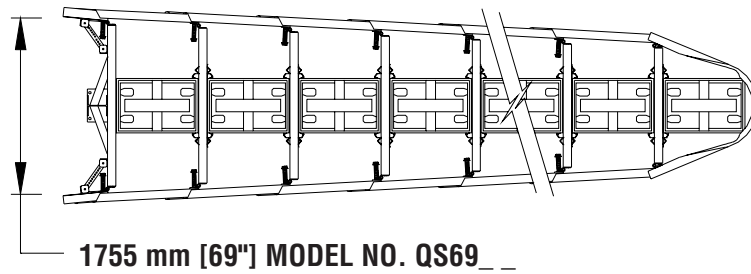


Figure 37
Typical Cartridge Layout
5 Bay System Shown

QuadGuard® System

QUADGUARD® SYSTEMS FOR WIDE HAZARDS



QuadGuard® System

Installation for Wide Hazards (cont'd.)

Site Preparation/Foundation

A QuadGuard System should be installed 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 pads are provided in Energy Absorption Systems, Inc. concrete pad drawings, supplied with the System. System may be installed on concrete roadway (minimum 200 mm [8"] thick). Installation cross slope shall not exceed 8% and should not vary (twist) more than 2% over the length of the System; the pad 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 toward and extend beyond the rigid backup as much as 760 mm [30"] 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 panels. Failure to comply with this requirement will result in impaired System performance offering motorists less protection and cause component damage.

QuadGuard® System

Installation for Wide Hazards (cont'd.)

Inspect Shipping

Before installing the QuadGuard System, check the received parts against the shipping list supplied with System. Make sure all parts have been received.

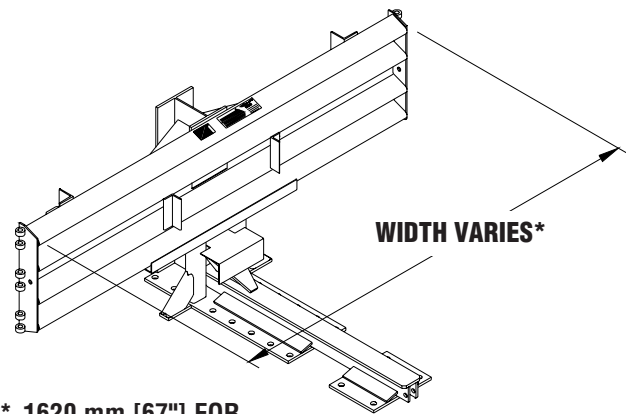
Installation Procedures

Note: The Drawing Package supplied with the QuadGuard 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 System is available with a tension strut backup or a concrete backup. Refer to Figures 38 and 39, along with the backup assembly drawing to determine which type of backup is being installed.

A transition panel or side panel will 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® System. Refer to Figures 40 through 45 and the drawing package to determine which type of panels are being installed.



- * 1620 mm [67"] FOR 1755 mm [69"] WIDE SYSTEM
- * 2100 mm [83"] FOR 2285 mm [90"] WIDE SYSTEM
- * 3050 mm [120"] FOR 3200 mm [126"] WIDE SYSTEM

Figure 38
Tension Strut Backup

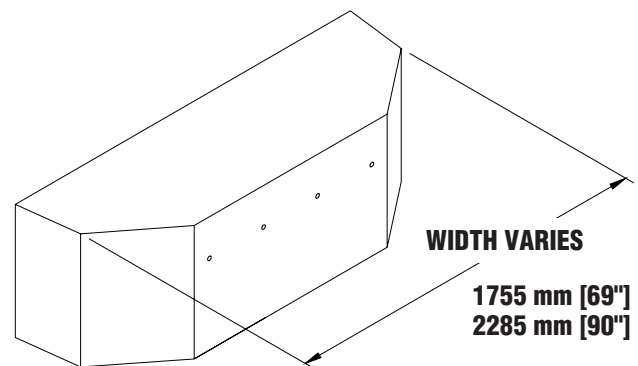


Figure 39
Concrete Backup

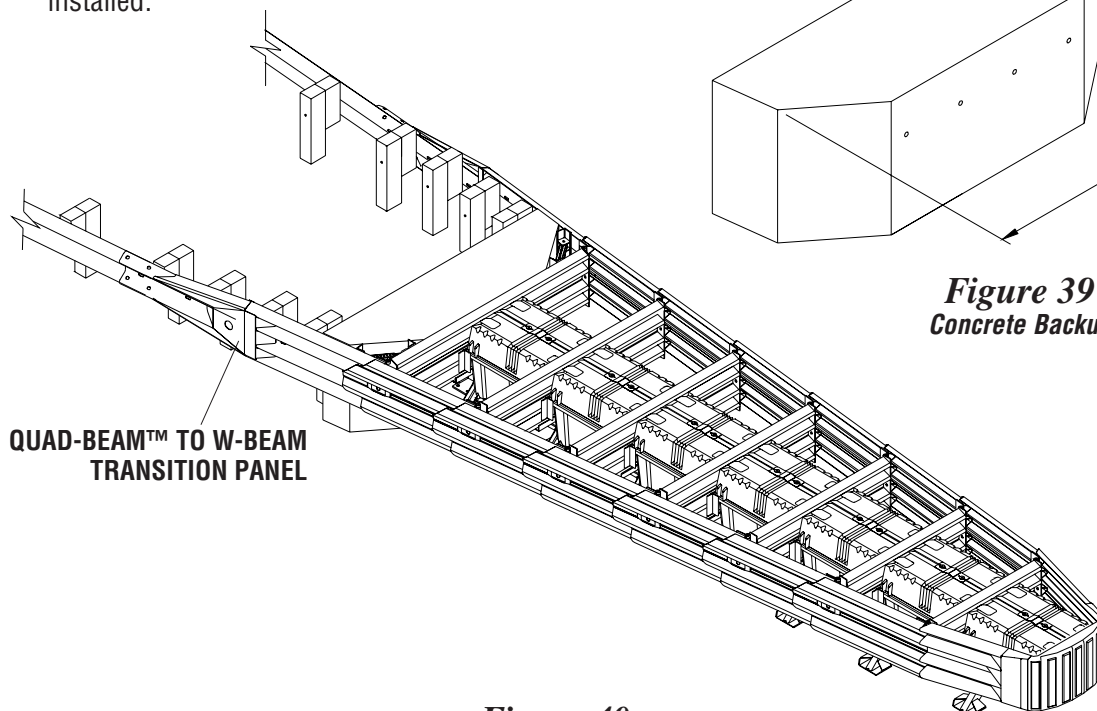


Figure 40
Transitioning the QuadGuard System

QuadGuard® System

Installation for Wide Hazards (cont'd.)

Transition Panel Types

Note: The proper transition or side panel must be used for optimum impact performance of the System. The correct panel to use will depend on the direction of traffic and what type of barrier or hazard the QuadGuard System is shielding. Contact the Customer Service Department prior to installation if you have any questions.

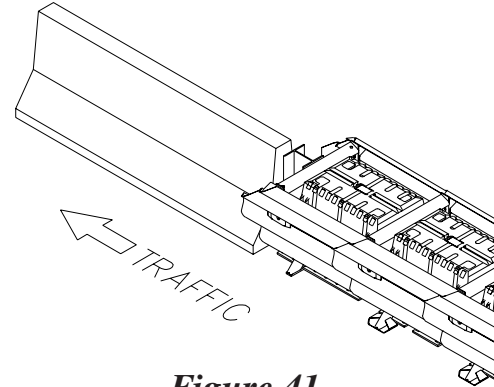


Figure 41
No Transition

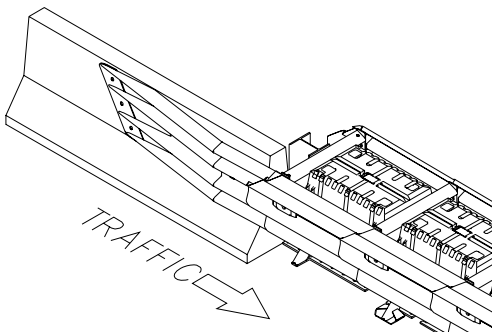


Figure 42
Quad-Beam to Safety Shape Barrier Transition Panel

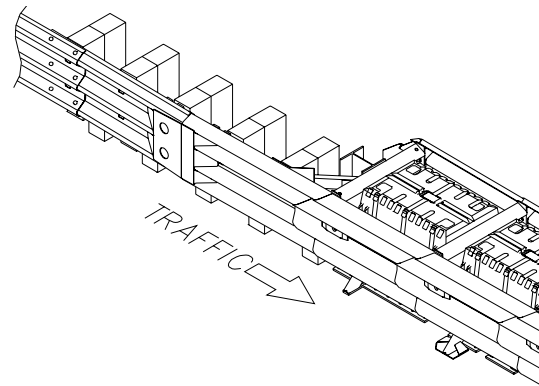


Figure 43
Quad-Beam to Thrie-Beam Transition Panel

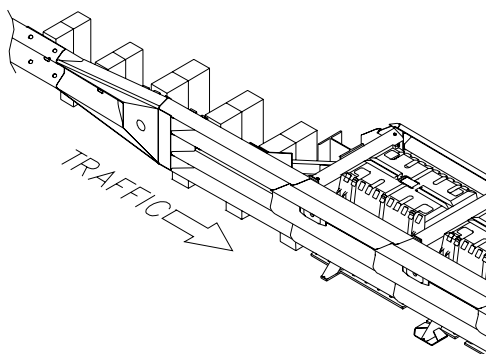


Figure 44
Quad-Beam to W-Beam Transition Panel

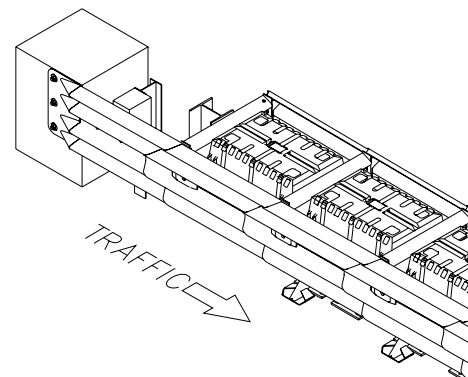


Figure 45
Quad-Beam End Shoe Transition Panel

Note: Wheel Deflectors may be required for this application.

QuadGuard[®] System

Installation for Wide Hazards (cont'd.)

2) Mark System Location

Locate the centerline of the System by measuring the proper offset from the hazard. Refer to 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 pad should be installed per 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.



Figure 46
*(Top view of Concrete Pad)
Locating Construction Line*

QuadGuard® System

Installation for Wide Hazards (cont'd.)

3a) Anchor the Backup

Concrete Backup Installation (figure 47)

Locate front 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 System (see MP-3 Polyester Anchoring, page 43).

Caution: Every hole and slot in backup and monorail must have an MP-3 bolt anchoring it.

FULLY CURED CONCRETE BACKUP
(SEE DRAWING PACKAGE)

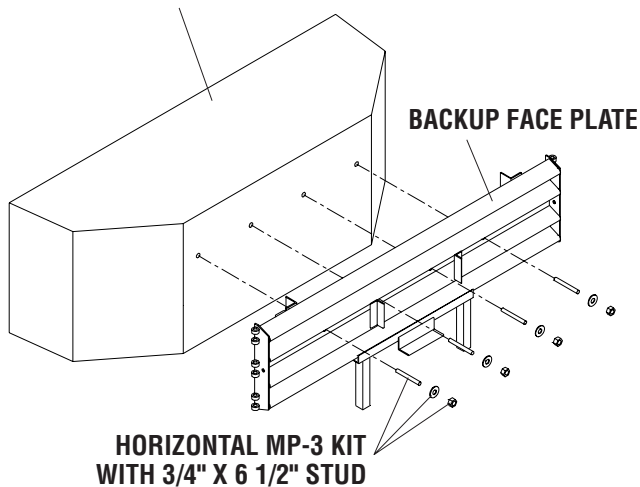


Figure 47

Anchoring Backup Face Plate to Concrete Backup

3b) Anchor the Backup

Tension Strut Backup Installation (figure 48)

Locate tension strut backup and monorail on pad with side of monorail on the construction line (see Figure 51). Verify that any applicable transition panels fit properly before anchoring backup. Drill anchor holes in pad using the backup as template. Anchor the backup to the foundation using the MP-3 vertical kits provided. (See "MP-3 Polyester Anchoring System" on page 43).

Caution: Every hole and slot in backup and monorail must have an MP-3 bolt anchoring it.

TENSION STRUT BACKUP

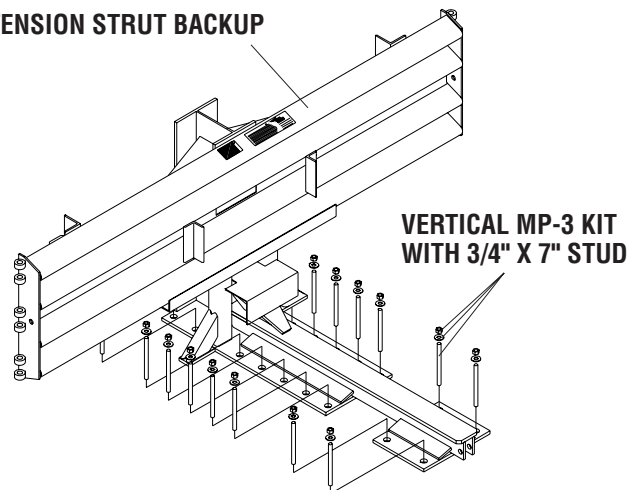


Figure 48

Anchoring Tension Strut Backup to Foundation

QuadGuard® System

Installation for Wide Hazards (cont'd.)

3c) Anchor the Backup

Extra-Wide Tension Strut Backup Installation (figure 49)

Locate the extra-wide tension strut backup center section and monorail on pad with side of monorail on the construction line (see Figure 51).

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 & 5/8" hex nut (6 places) as shown in Figure 49 & Detail 49a.

Verify that any applicable transition panels fit properly before anchoring backup. Drill anchor holes in pad using the backup as template. Anchor the backup to the foundation using the MP-3 vertical kits provided. (See "MP-3 Polyester Anchoring System" on page 43).

Caution: Every hole and slot in backup and monorail must have an MP-3 bolt anchoring it.

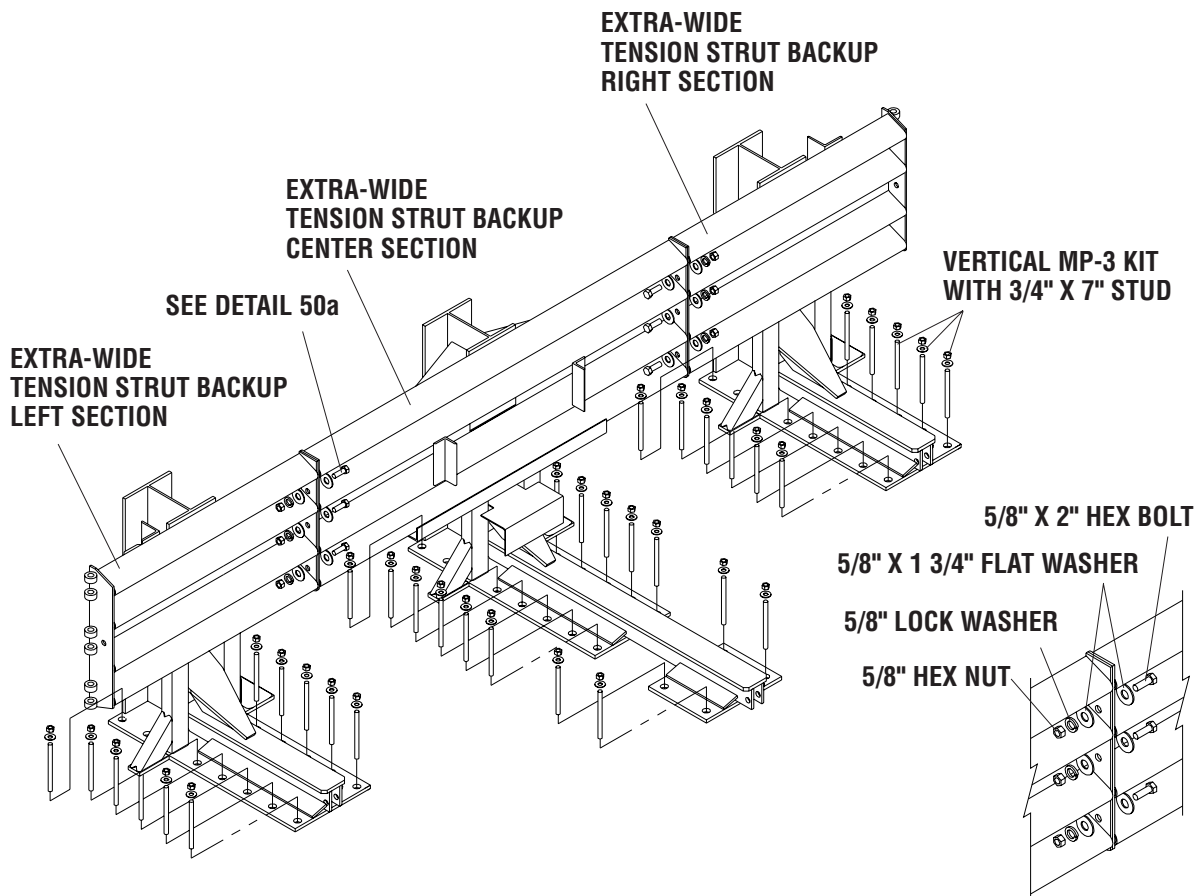


Figure 49
Anchoring Extra-Wide Tension Strut Backup to Foundation
See Drawing Package

Detail 49a

QuadGuard® System

Installation for Wide Hazards (cont'd.)

4) Install Monorail

Locate the monorail using the monorail assembly drawings.

Drill 140 mm [5 1/2"] deep anchor holes using the monorail as a template (see figures 51 and 52). Do not drill through pad.

Anchor each monorail section using the MP-3 vertical kits provided. Refer to Figure 50 and the MP-3 Polyester Anchoring System Instructions included with this manual.

It is important to install 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.

WARNING!

Every hole and slot in backup and monorail must have an MP-3 stud anchoring it.

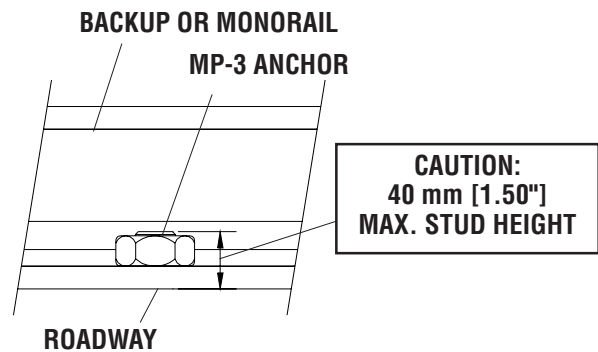


Figure 50
Proper Stud Height

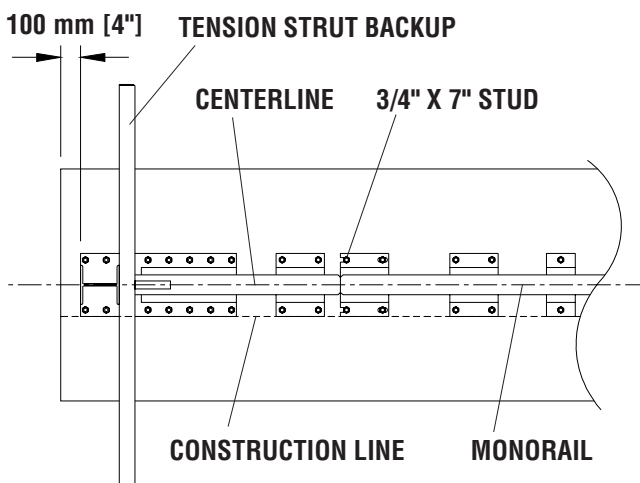


Figure 51
Backup and Monorail Location
for Tension Strut Backup

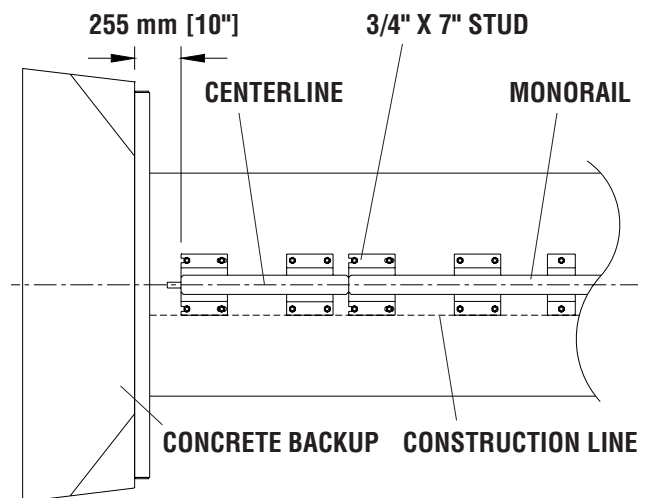


Figure 52
Monorail Location for Concrete Backup

QuadGuard® System

Installation for Wide Hazards (cont'd.)

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

- Attach hinge plate to the transition panel or side panel using 5/8" rail bolt & 5/8" rail nut (two places - top & bottom holes only).
- Attach transition panel or side panel assembly to side of backup using 5/8" hex bolt, 5/8" lock washer & 5/8" hex nut (three places each side of backup). See Figure 53.
- Attach diagonal brace to fender panel and backup using 3/8" hex bolt, 3/8" lock washer & 3/8" hex nut (two places per brace; 4 places per side).

- Secure each diagonal brace with 3/8" hex bolt, 3/8" lock washer & 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.

Installation tip:

Use drift pin to align the center hole of the panel with the center hole of the backup before installing the rail bolts.

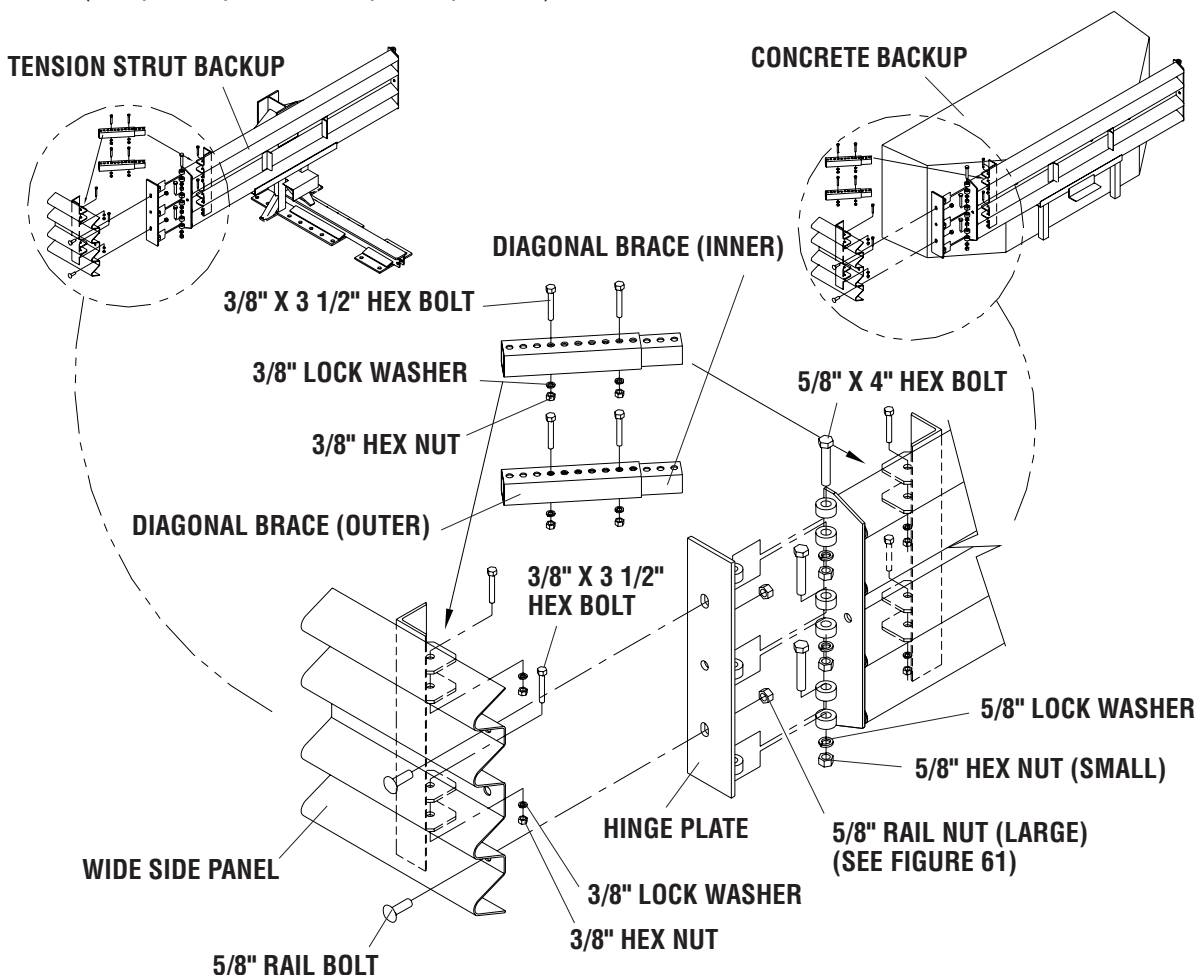


Figure 53
Side Panel/Transition Panel Attachment

QuadGuard® System

Installation for Wide Hazards (cont'd.)

6a) Install Monorail Guides

Wide Systems

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 & 3/4" hex nut (typical two places per guide). See also diaphragm assembly drawing.

Repeat for each diaphragm.

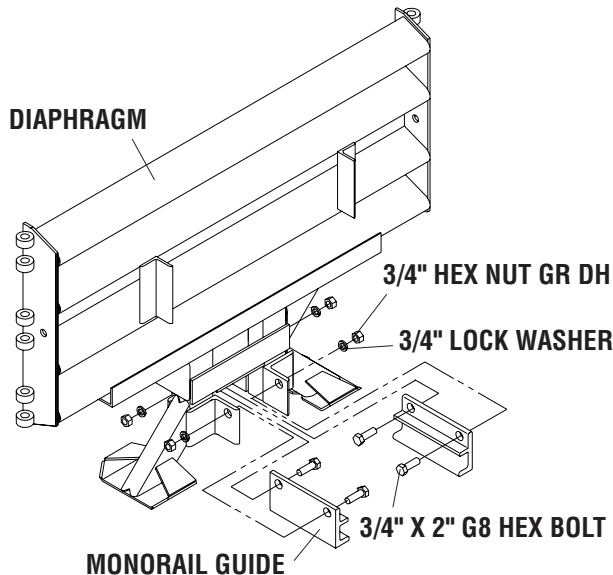


Figure 54
Monorail Guide Attachment

6b) Install Monorail Guides

Extra-Wide Systems

Attach monorail guides to diaphragms as follows:

Second through Last Diaphragms

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 & 3/4" hex nut (typical two places per guide).

Repeat for all diaphragms except the first.

First Diaphragm

Slide monorail guide up between the monorail guide brackets at the bottom of the first diaphragm, aligning the two holes. See Figure 55.

Insert 3/4" x 4" G5 hex bolt through monorail guide bracket on diaphragm and through monorail guide, oriented as shown in Figure 55. Secure with 3/4" lock washer & 3/4" hex nut (typical two places per guide). See also diaphragm assembly drawing.

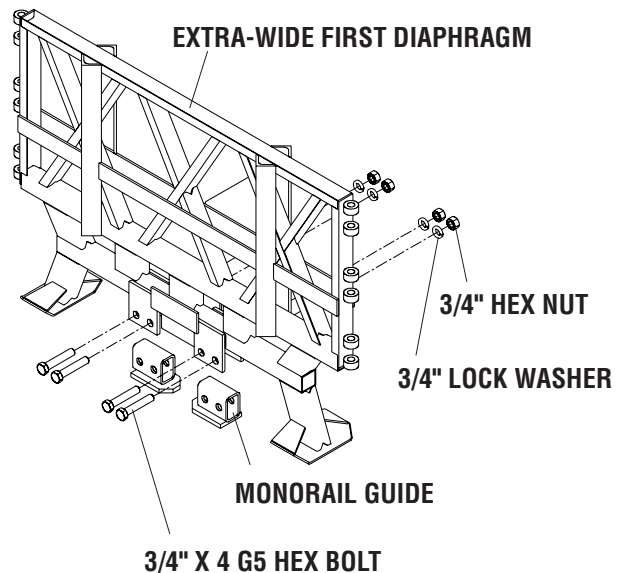


Figure 55
Monorail Guide Attachment
(Extra-Wide First Diaphragm)

QuadGuard® System

Installation for Wide Hazards (cont'd.)

7a) Install Diaphragms

Wide Systems

Orient the widest diaphragm so that the front face of the Quad-Beam™ shape faces toward the nose of the System as shown in Figure 56. **The widest diaphragm must be installed 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 57.

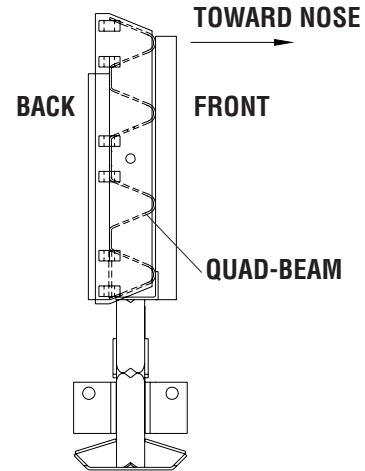


Figure 56
Diaphragm Orientation

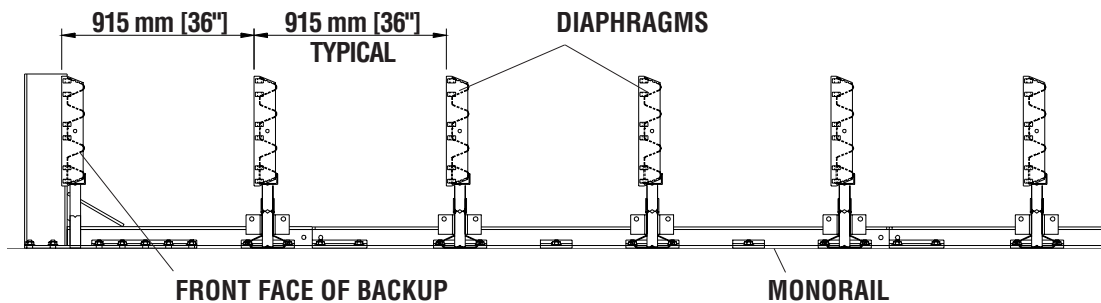


Figure 57
Diaphragm spacing

QuadGuard® System

Installation for Wide Hazards (cont'd.)

7b) Install Diaphragms

Extra-Wide Systems

Quad-Beam Diaphragms

Orient the widest diaphragm so that the front face of the Quad-Beam shape faces toward the nose of the System as shown in figure 58. **The widest diaphragm must be installed closest to the backup with each subsequent diaphragm being progressively narrower.**

Slide the widest diaphragm all the way to the backup to ensure the System is able to collapse properly

during impact. Once this has been verified then slide the diaphragm forward to approximately 915mm [36"] in front of the backup.

Orient and slide all other Quad-Beam diaphragms onto monorail and position each approximately as shown in figure 60.

Extra-Wide First Diaphragm

Orient the first diaphragm so the hinges are toward the rear of the system. Slide the extra-wide first diaphragm (see figure 59) onto the monorail and position approximately 915 mm [36"] forward of the previous diaphragm as shown in Figure 60.

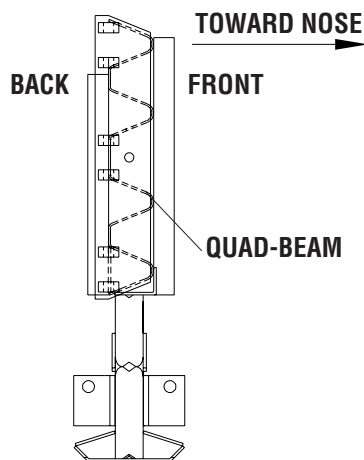


Figure 58
Quad-Beam Diaphragm Orientation
(Diaphragms 2 through the last)

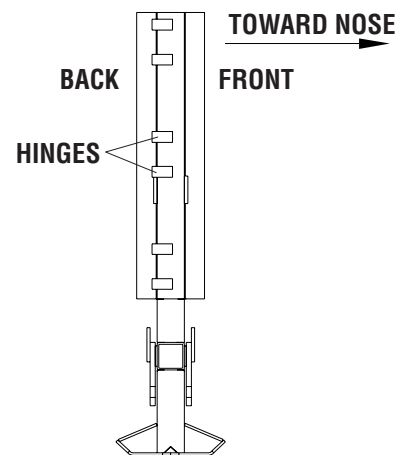


Figure 59
Extra Wide Diaphragm
(Diaphragm 1)

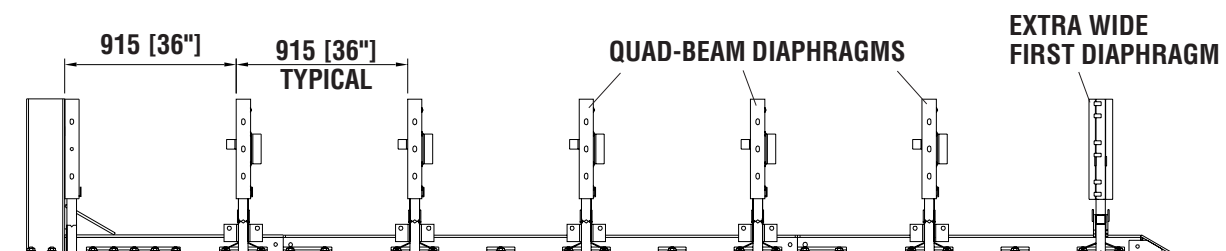


Figure 60
Diaphragm spacing

QuadGuard® System

Installation for Wide Hazards (cont'd.)

8) Install Hinge Plates onto Fender Panels

Note: Do not mix the 5/8" rail nuts (large) with the 5/8" hex nuts (small). See Figure 61.

Note: For proper impact performance, Systems for wide hazards must have hinge plates.

Install a hinge plate on each fender panel using two 5/8" rail bolts & two 5/8" rail nuts, using top and bottom holes only, leaving the center hole open as shown in Figure 62.

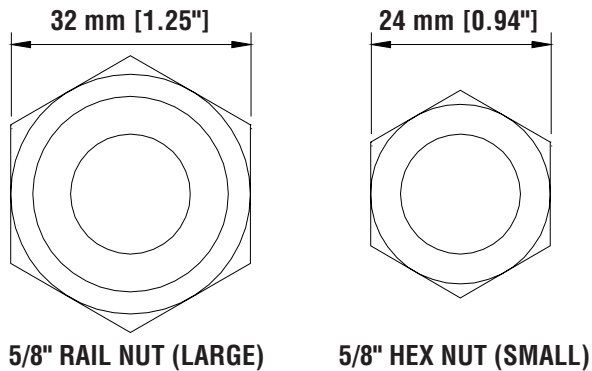


Figure 61
Rail Nuts are Oversize

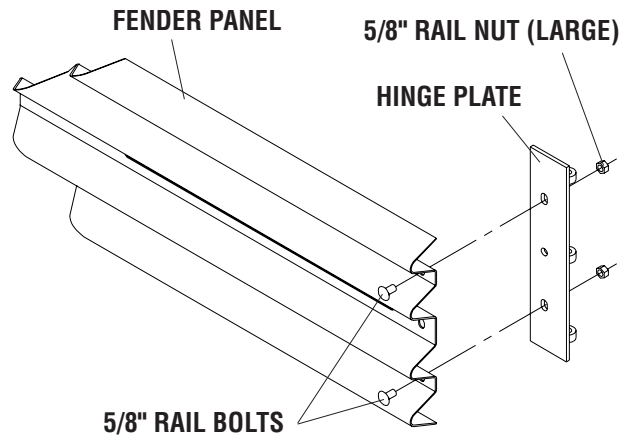


Figure 62
Hinge Plate Assembly

QuadGuard® System

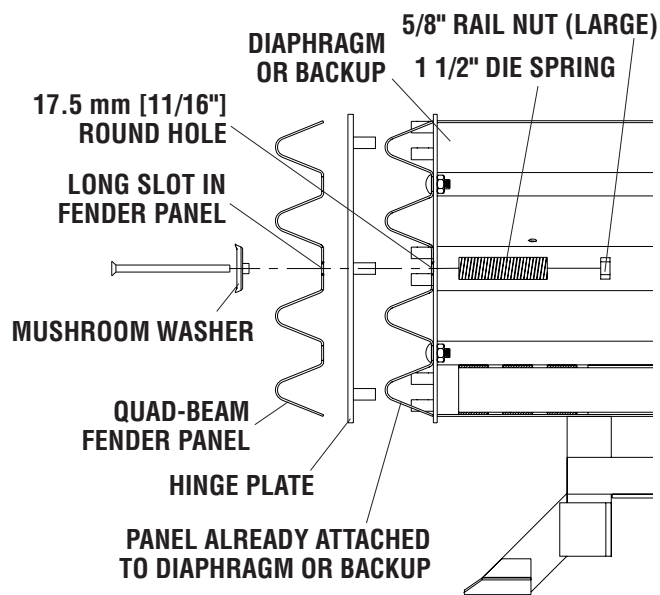
Installation for Wide Hazards (cont'd.)

9) Install Fender Panels

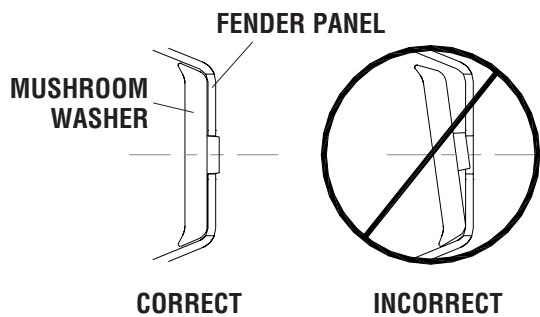
Starting at the last bay, install left and right fender panels as shown in Figure 63. Attach the hinge plate at the front of the fender panels to the diaphragm in front using three 5/8" hex bolts, nuts and washers.

Attach mushroom washer assembly as shown in Figures Figure 63 & Detail 63a but do not torque at this time.

Be sure mushroom washer lays flat against the fender panel as shown in Detail 63b. Standoff on washer must be seated completely through slot.



Detail 63a
Mushroom Washer Assembly



Detail 63b
Mushroom Washer Orientation

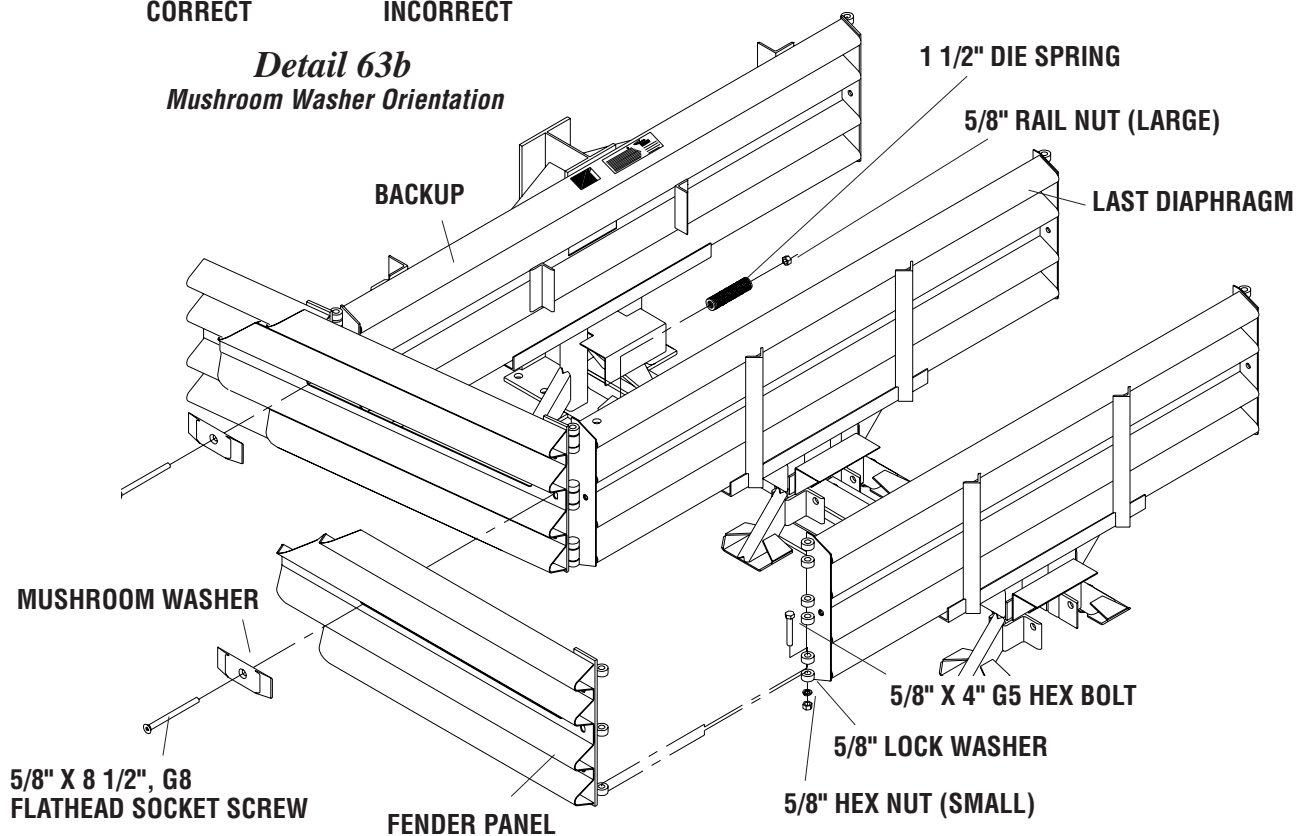


FIGURE 63
Fender Panel Assembly

QuadGuard® System

Installation for Wide Hazards (cont'd.)

Check diaphragm spacing to ensure 915 mm [36"] between rear faces of consecutive diaphragms as shown in Figure 64. Once the proper spacing has been achieved, torque the mushroom washer assembly nut until it reaches the end of the threads. Install the remaining diaphragms and fender panels following the same procedures.

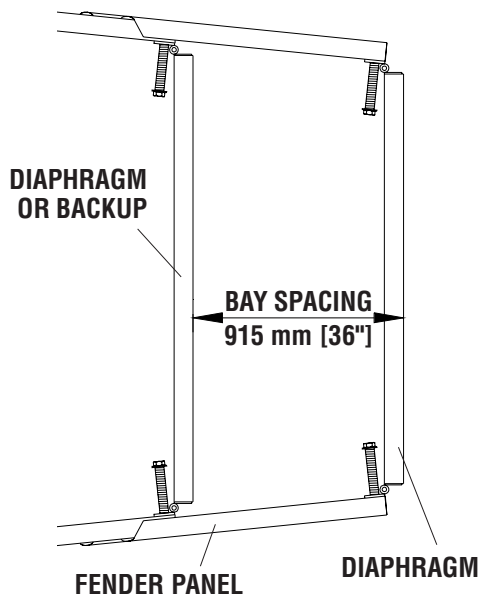


Figure 64
Proper Spacing Between Diaphragms

10) Install 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 65.

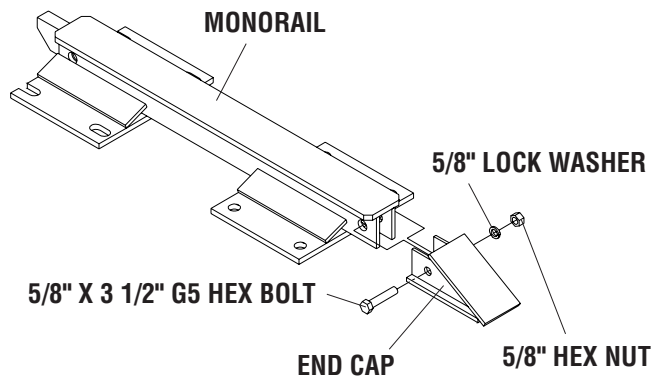


Figure 65
Monorail End Cap Installation

QuadGuard® System

Installation for Wide Hazards (cont'd.)

11) Install Cartridge Support Brackets

Attach cartridge support bracket to all diaphragms and backup as shown in Figures 66, 67, 68, 69, the backup assembly drawing and the diaphragm assembly drawing.

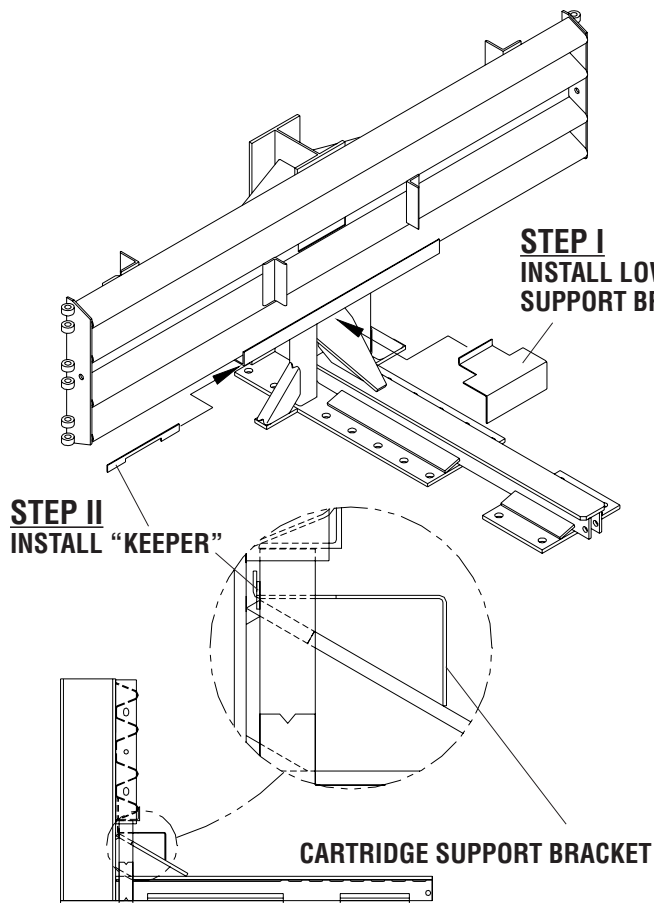


Figure 66
Tension Strut Backup with Cartridge Support Bracket

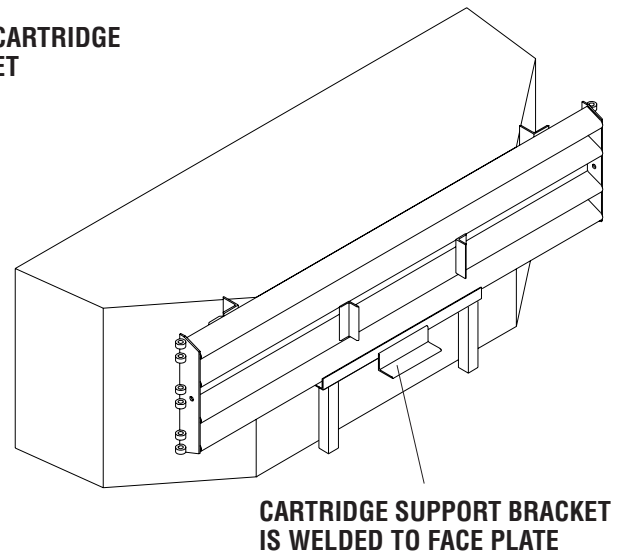


Figure 67
Concrete Backup with Cartridge Support Bracket

QuadGuard® System

Installation for Wide Hazards (cont'd.)

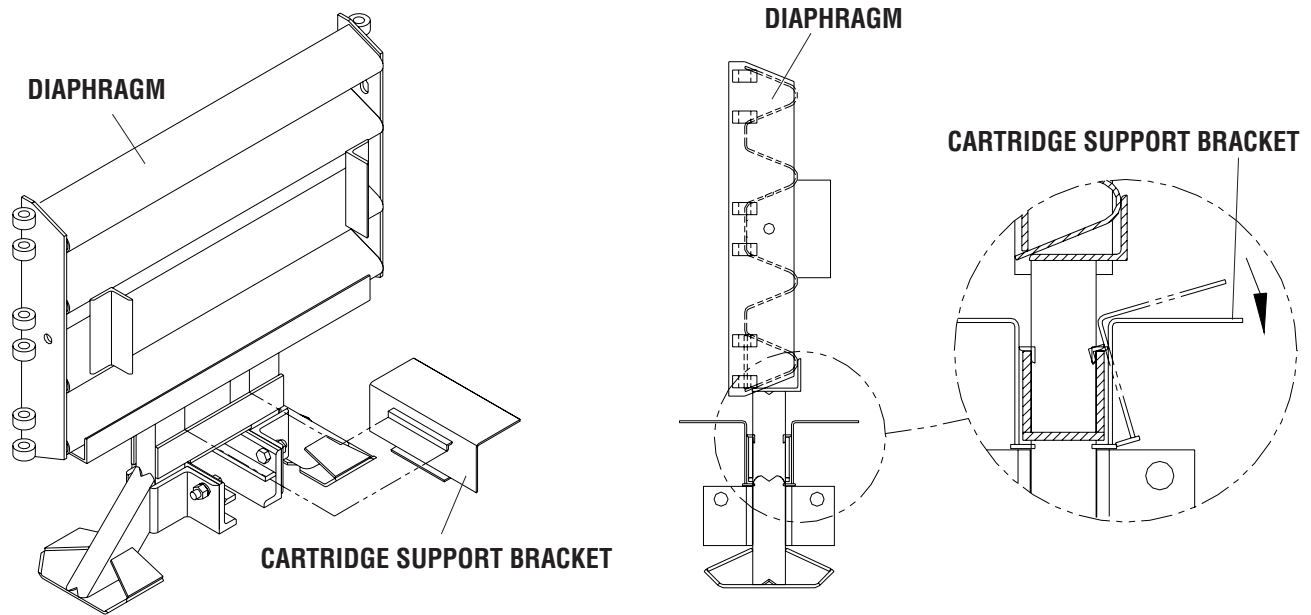


Figure 68
Diaphragm with Cartridge Support Bracket

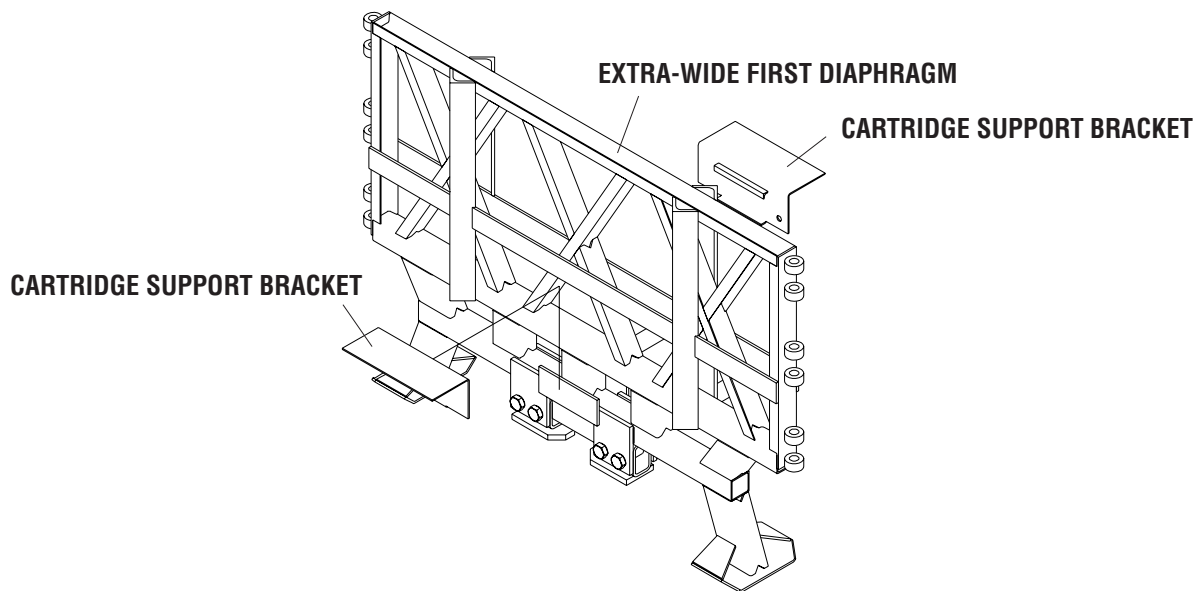


Figure 69
Extra-Wide First Diaphragm
with Cartridge Support Bracket
See Drawing Package

QuadGuard® System

Installation for Wide Hazards (cont'd.)

12a) Install Nose Assembly

Install the nose assembly (see Figures 70 through 74 and the nose assembly drawing) in the following order:

- Step 1. (Figure 70) Attach pullout brackets to diaphragm with 5/8" x 1 1/2" hex bolts & 5/8" nuts 1 place each side.
- Step 2. (Figure 71) Bolt nose attachment bracket between hinge and fender panel with 5/8" x 1 1/2" hex bolts, 5/8" nuts and 5/8" flat washers.
- Step 3. (Figure 72) Bolt fender panel assembly to diaphragm with 5/8" x 4" hex bolts, 5/8" nuts and 5/8" lock washers 3 places each side.

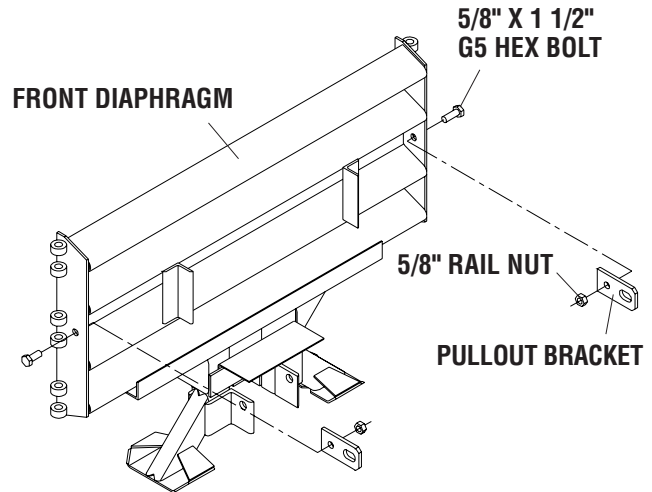


Figure 70
Attach Pullout Brackets to Diaphragm

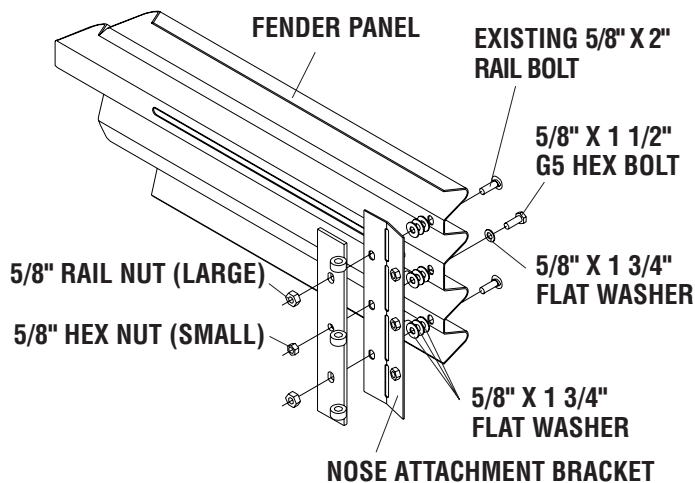


Figure 71
*Bolt Nose Attachment Bracket
between Hinge and Fender Panel*

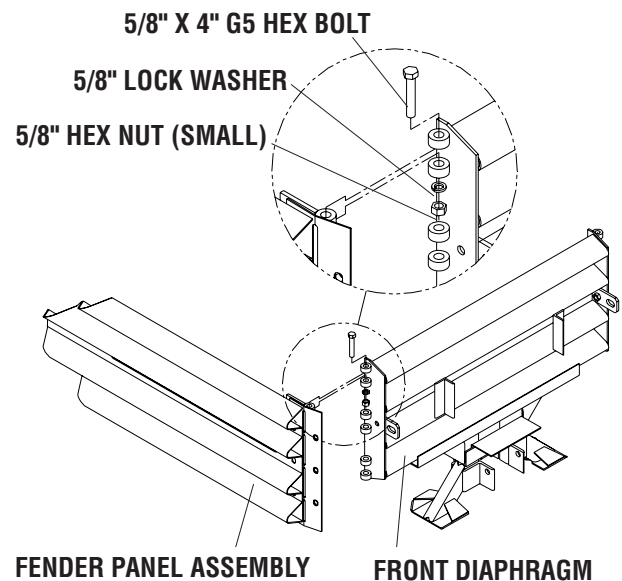


Figure 72
Bolt Fender Panel Assembly to Diaphragm

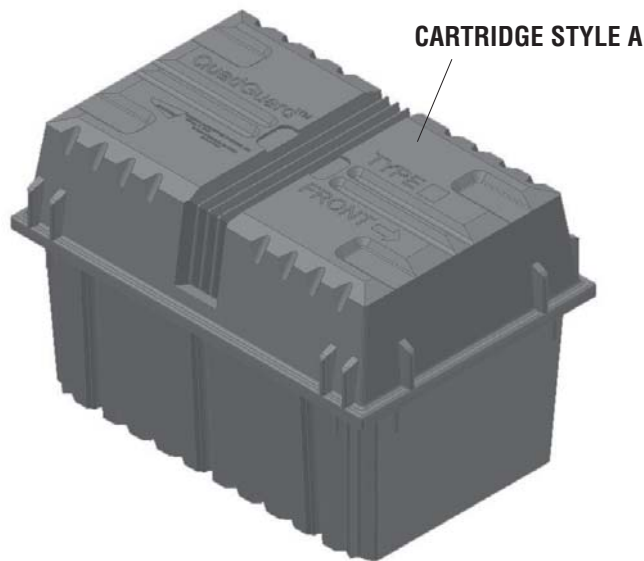
QuadGuard® System

Installation for Wide Hazards (cont'd.)

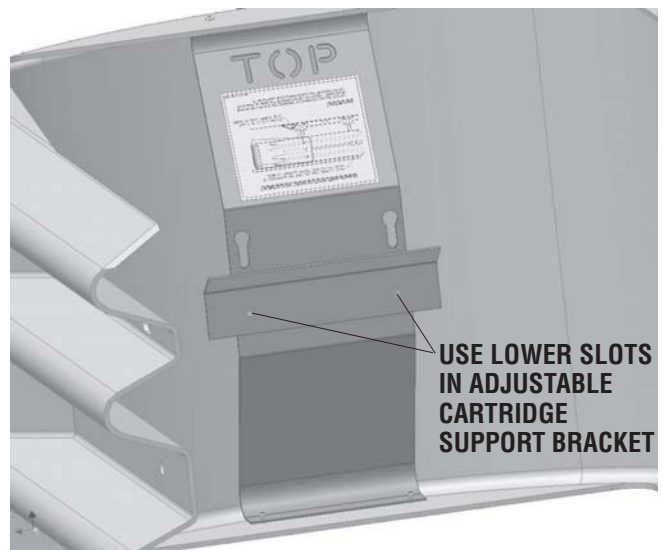
Step 4. Determine which style of cartridges your system has. See below.

If your system has cartridge style A as shown in Detail 73a, install cartridge support in the upper two slots as shown.

If your system has cartridge style B as shown in Detail 73b, install cartridge support in the lower two slots as shown.



Detail 73a
Adjustable Bracket Location
when using Cartridge Style A

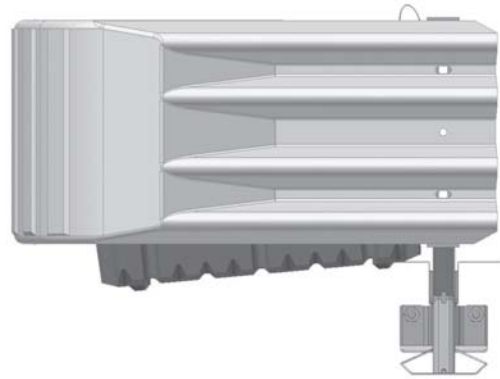


Detail 73b
Adjustable Bracket Location
when using Cartridge Style B

QuadGuard® System

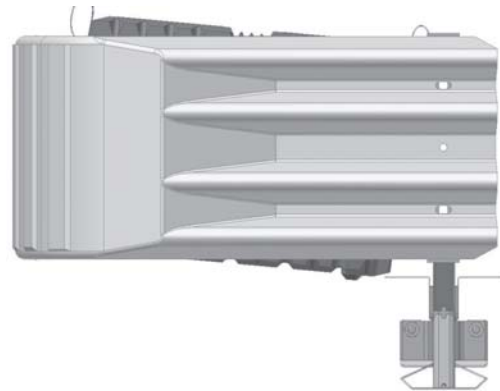
Installation for Wide Hazards (cont'd.)

As shown in Detail 73c, cartridge style A is installed with the adjustable cartridge support bracket **incorrectly** in the lower position.



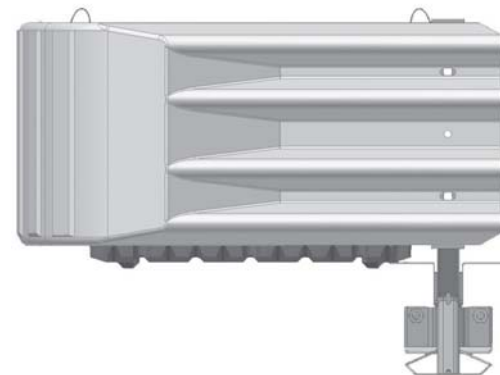
Detail 73c
Incorrect Installation of
Adjustable Cartridge Support Bracket

As shown in Detail 73d, cartridge style B is installed with the adjustable cartridge support bracket **incorrectly** in the upper position.



Detail 73d
Incorrect Installation of
Adjustable Cartridge Support Bracket

Detail 73e shows the adjustable cartridge support bracket installed **correctly**.



Detail 73e
Correct Installation of
Adjustable Cartridge Support Bracket

QuadGuard® System

Installation for Wide Hazards (cont'd.)

Step 5. (Figure 73) Bolt nose to attachment bracket with 5/8" x 2" hex bolts, and bar washers, 3 places each side as shown.

Note: Nose of System may be delineated to comply with local codes (chevron, reflective material, signs, etc.).

Step 6. (Figure 74) The top and bottom holes of the nose are slotted to provide adjustment. Adjust so the top edge of the nose is level with the top edge of the fender panels. Torque all six nuts to 35 Nm [25 ft-lbs].

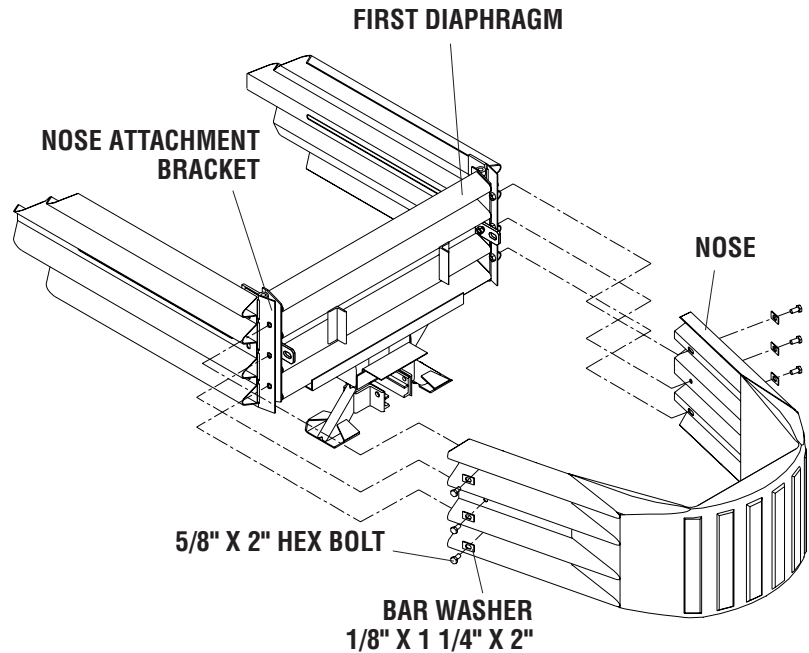


Figure 73
Attach Nose to Attachment Bracket

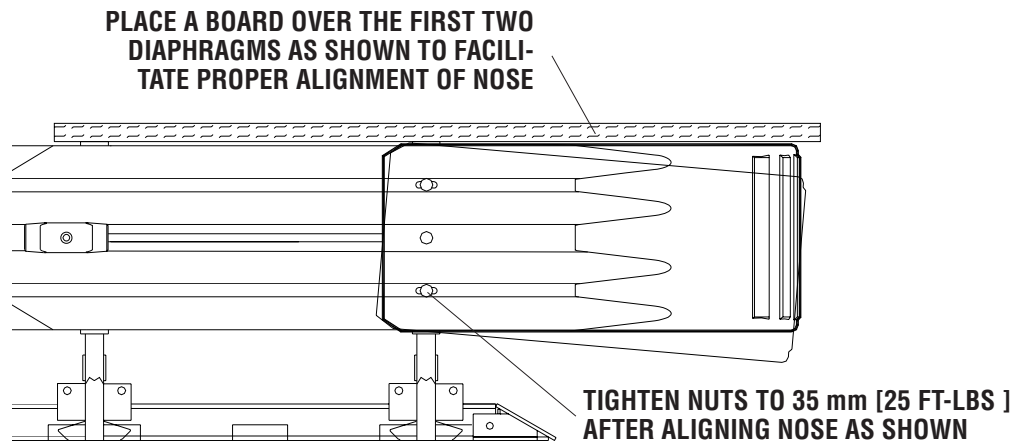


Figure 74
Adjust Nose

QuadGuard® System

Installation for Wide Hazards (cont'd.)

12b) For Wide Systems with Optional Nose Belt Assembly:

- Using 5/8" x 5" hex bolts, 5/8" x 1 3/4" flat washers and 5/8" hex nuts, attach hinge plate to fender panel as shown in Figure 75 (three places per side).
- Thread second 5/8" nuts onto the installed bolts. Be sure the face of the nuts are flush with humps on fender panels (see detail 75a). Slide second 5/8" x 1 3/4" flat washers onto bolts (three places per side).
- Align holes in each end of the nose belt with the installed bolts (three per side) and slide nose belt onto bolts.
- Align holes in belt clamps with bolts and slide belt clamps onto bolts.

- Using third 5/8" x 1 3/4" flat washers and third 5/8" hex nuts, secure the belt clamps and nose belt (three places per side).
- Be sure fender panel assembly is bolted to diaphragm at the hinge plate with 5/8" x 4" hex bolts, 5/8" nuts and 5/8" lock washers 3 places each side.

Refer also to nose belt assembly drawing.

Note: Nose alignment shown in Figure 74 not necessary with nose belt assembly.

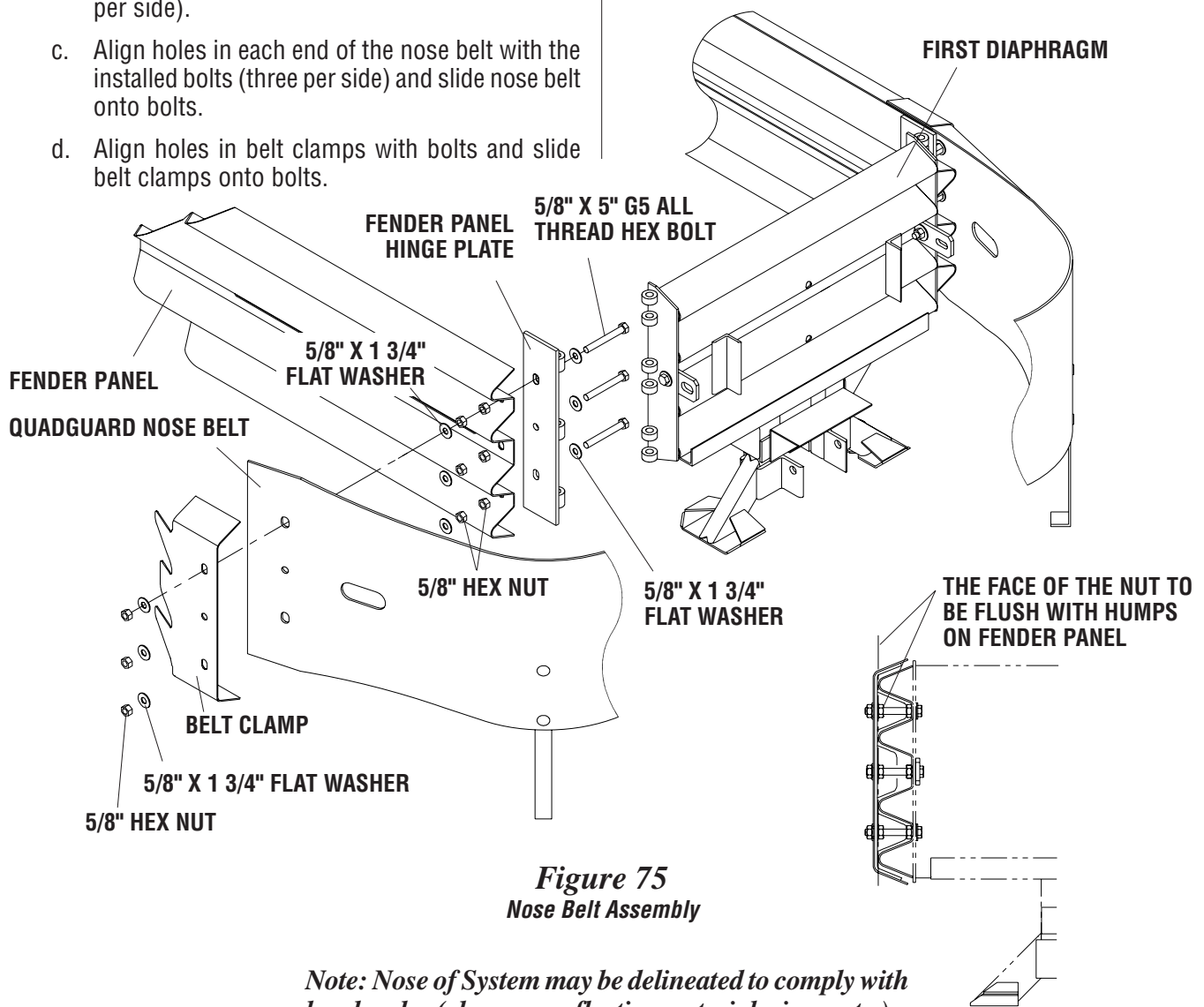


Figure 75
Nose Belt Assembly

Note: Nose of System may be delineated to comply with local codes (chevron, reflective material, signs, etc.).

Detail 75a

QuadGuard® System

Installation for Wide Hazards (cont'd.)

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 panel, System realignment may be necessary. (See Figure 76).

WARNING!

Anchor Studs.... Torqued to 165 Nm [120 ft-lbs]
Should NOT protrude above nuts
(see Figure 17, page 13)

All Other Bolts... Tightened

Fender Panel.... Maximum gap allowed:
Wide Systems - 25 mm [1.00"]

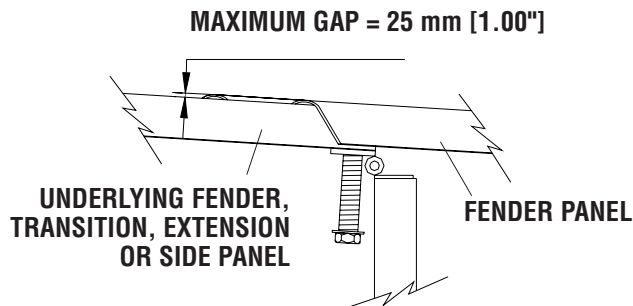


Figure 76
Fender Panel Gap for Wide Systems

14) Cartridge Installation

Be sure the adjustable cartridge support in the nose is installed correctly. See "Install Nose Assembly" 11a.

To complete the assembly of a QuadGuard 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. Refer to figures 77 and 78.

WARNING!

Placing the wrong Cartridge in the Nose or any Bay will result in unacceptable crash performance as described in NCHRP 350.

I - TYPE I CARTRIDGE
II - TYPE II CARTRIDGE

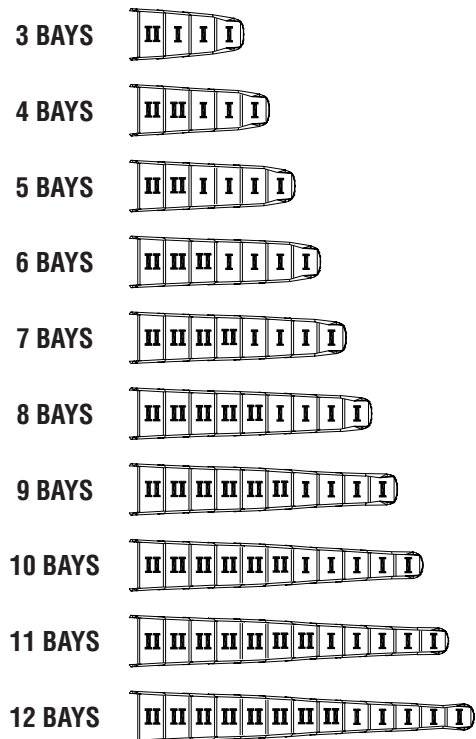


Figure 77
Cartridge Placement

QuadGuard® System

Installation for Wide Hazards (cont'd.)

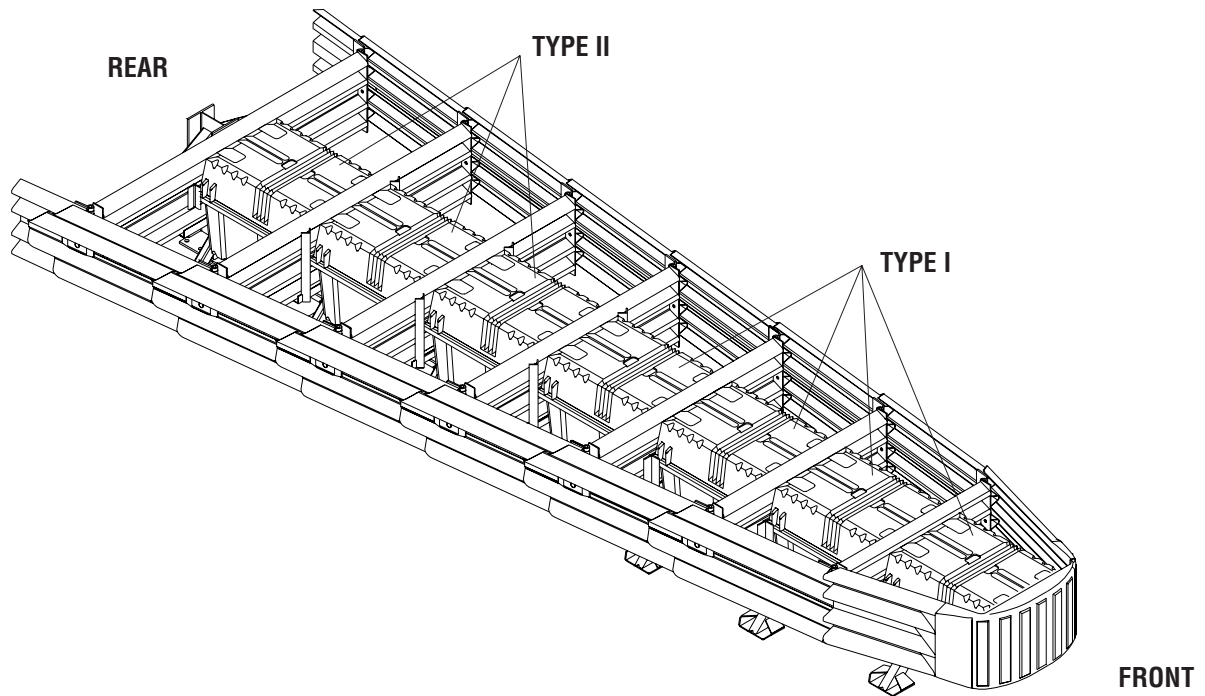


Figure 78
Typical Cartridge Layout - 6 Bay System Shown

QuadGuard® System

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 promotor, studs, washers, and a complete safety sheet. The cold weather promotor shortens hardening time by as much as seven hours. Both vertical and horizontal installations are possible using the MP-3 System.

Vertical Installations

Note: Read MP-3 Instructions before starting.

1) Prepare the concrete pad

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 and gloves during installation.

The anchor bolts (Studs) that anchor the QuadGuard® System to the concrete pad 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 7 days before installing MP-3.

2) Drill holes

Note: Energy Absorption Systems recommends using two fluted drills to achieve optimum tensile strength when installing 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. Full strength will not be achieved if a diamond drill is used. Refer to the MP-3 installation 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. Refer to Table A.

Table A

MP-3 Anchoring Information

Stud size	Concrete bit size	Minimum Depth	Recommended Torque
3/4" x 6 1/2"	22 mm [7/8"]	125 mm [5"]	165 Nm [120 ft-lbs]
3/4" x 7"	22 mm [7/8"]	140 mm [5 1/2"]	165 Nm [120 ft-lbs]
3/4" x 7 1/2"			
3/4" x 8 1/2"			
3/4" x 18"	22 mm [7/8"]	420 mm [16 1/2"]	<15 Nm [<10 ft-lbs]

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 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 promotor (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. Refer to Table B for hardening times.

6) Pour grout into holes

WARNING!

Do not use Promoter when the temperature is above 15 degrees Celsius (60 degrees Fahrenheit). Grout will harden too quickly.

QuadGuard® System

MP-3® Polyester Anchoring System (cont'd.)

Crimp the mouth of the can to form a spout, and pour the MP-3® grout mixture down into the hole through the part. Fill the hole 1/3 to 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 under-filled 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 for hardening times).

9) Torque the nuts

Once the grout has hardened, torque the nut to the recommended values. (See Table A.) Now no threads of the nut should be exposed.

Table B
Approximate Hardening Times (hrs)

Temperature (C)	Temperature (F)	No Promoter	With Promoter
>26	>80	1/2	N/R*
22-26	70-79	1	N/R*
16-21	60-69	2	N/R*
10-15	50-59	4	3/4
4-9	40-49	8	1
-1-3	30-39	N/R*	1 1/2
<-1	<30	N/R*	N/R*

* Not recommended. Contact Energy Absorption Systems Inc.'s Customer Service Department for more information.

Horizontal Installations

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 designed to keep the grout in place in horizontal holes during installation.

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 off the small end of the dispenser tip. 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 overfill or underfill 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 under-filled the grout may not develop the required pull out strength.

QuadGuard® System

MP-3® Polyester Anchoring System (cont'd.)

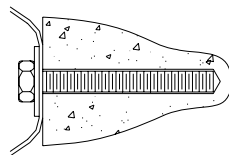
4) Add the washers and nuts

Put washer and nut on stud leaving nut flush with end of stud. See figure 79.

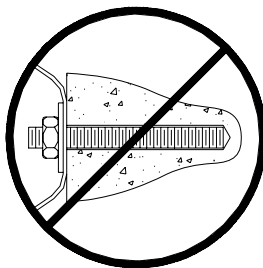
5) Insert Studs into holes

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 79.



CORRECT



INCORRECT

Figure 79
MP-3 Horizontal Installation

Caution: Do not disturb or load the stud until the MP-3 material has hardened (see Table B for hardening times).

6) Torque the nuts

Once the grout has hardened, torque the nut to 165 Nm [120 ft-lbs.].

MP-3® Installation 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, Inc. for guidance.

WARNING!

Do not use the MP-3 if the material fails to set up, Part A-Resin has 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.

QuadGuard® System

Maintenance and Repair

Inspection Frequency

Inspections are recommended as needed based upon volume of traffic & impact history. Visual Drive-By Inspections are recommended at least once a month. Walk-Up Inspections are recommended at least once a year for installations on concrete and at least once every six months for installations 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!

Refer to Cartridge placement on pages 23 and 45.

- 3) Be sure the Nose cover is in place.
- 4) Note the location and condition of the QuadGuard 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.
- 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!

Fender Panel..... Maximum gap allowed:
Narrow Systems - 20 mm [0.78"]
Wide Systems - 25 mm [1.00"]

(See figures 83 and 84 on page 53)

- 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 full design speed characteristics, partially crushed Cartridges (due to slow speed impacts) should be replaced.

WARNING!

Refer to Cartridge placement on pages 23 and 45.

- 8) Make all necessary repairs as described above. Refer to Post-Impact Instructions, page 48, for more information.
- 9) Note the location and condition of the QuadGuard 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. Refer to Post-Impact Instructions, next page, and installation section of this manual for more information.

QuadGuard® System

Maintenance and Repair (cont'd.)

Post-Impact Instructions (Narrow Hazards)

1. Deploy the appropriate **traffic-control** devices to protect your crew.
2. Check to see that all **Anchor Bolts** have remained firmly anchored in the roadway surface. Failed anchor bolts are those found to be loose, broken, or showing signs of pull-out and are to be replaced.

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 reinstalled 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.

Post-Impact Instructions (Wide Hazards)

1. Deploy the appropriate **traffic-control** devices to protect your crew.
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 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 bolt.

QuadGuard® System

Maintenance and Repair (cont'd.)

6. Attach chain to **Pullout Brackets** on first Diaphragm (see Figure 80). 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.

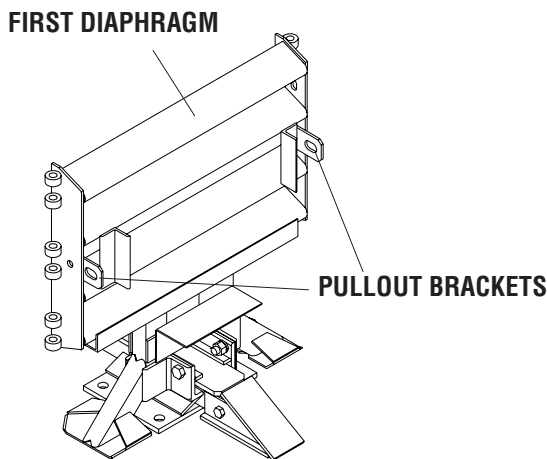


Figure 80
Pullout

Pull the QuadGuard 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 straightened 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 81.

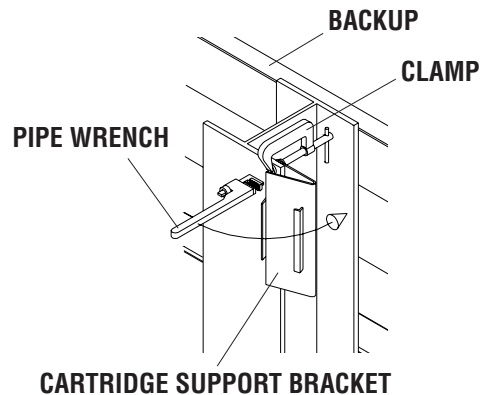


Figure 81
Straighten Cartridge Support Bracket

- C. Then, using a sledge hammer and Quad-Beam™ shape on backup as an anvil, form Cartridge Support Bracket back into 90° shape (see Figure 82).

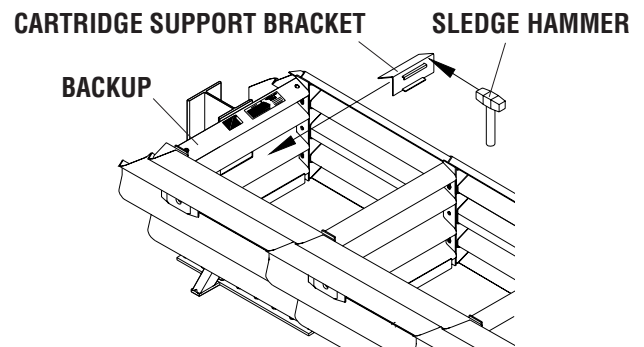


Figure 82
Form Cartridge Support Bracket

QuadGuard® System

Maintenance and Repair (cont'd.)

WARNING!

Fender Panel..... Maximum gap allowed:
Narrow Systems - 20 mm [0.78"]
Wide Systems - 25 mm [1.00"]

Narrow Hazards

10. Check **gaps between Fender Panels**. The maximum gap allowed for these overlapping parts (including Fender Panels overlapping panels behind the System) is 20 mm [.78"] (see figure 83).

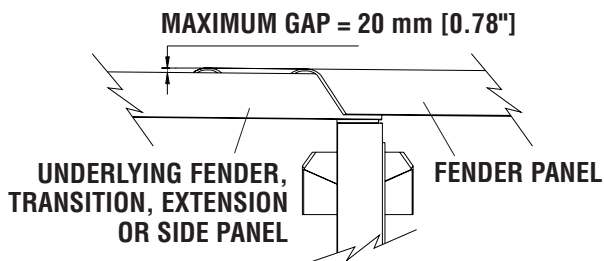


Figure 83

Fender Panel Gap for Narrow Hazards

Be sure the **Mushroom Washer Assemblies are torqued** so that the spring is compressed. If the gaps between the Fender Panels are still too large it may be necessary to replace bent parts.

Wide Hazards

10. Check **gaps between Fender Panels**. The maximum gap allowed for these overlapping parts (including Fender Panels overlapping panels behind the System) is 25 mm [1.00"] (see figure 84).

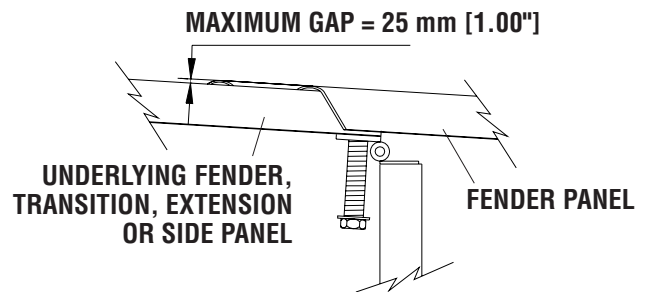


Figure 84

Fender Panel Gap for Wide Hazards

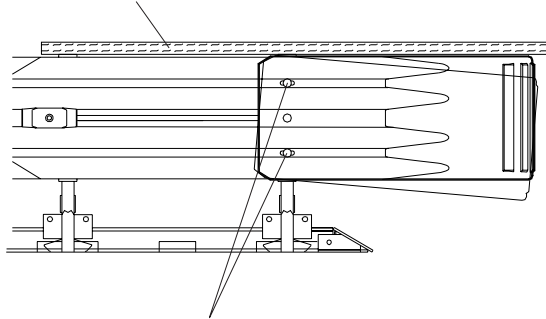
Be sure the **Mushroom Washer Assemblies are torqued** to 80 Nm [60 ft-lbs]. If the gaps between the Fender Panels are still too large it may be necessary to replace bent parts.

QuadGuard® System

Maintenance and Repair (cont'd.)

11. Replace all crushed Cartridges. Refer to **Cartridge Placement** on pages 25 & 49.
12. Remove damaged plastic **Nose Cover**. Attach the new nose cover to the first diaphragm, using the six rail bolts, rail nuts, and bar washers that hold the front fender panels to the first diaphragm. The top and bottom holes of the nose cover are slotted to provide adjustment. Adjust nose to align with fender panels, then torque all six nuts to 35 Nm [25 ft-lbs]. See Figure 85, Nose Adjustment.

PLACE A BOARD OVER THE FIRST TWO DIAPHRAGMS AS SHOWN TO FACILITATE PROPER ALIGNMENT OF NOSE



TIGHTEN NUTS TO 35 NM [25 FT-LBS] AFTER ALIGNING NOSE AS SHOWN

Figure 85
Nose Adjustment

FOR SYSTEMS FITTED WITH OPTIONAL NOSE BELT

Normally, with a design speed impact, the nose belt will not need replacement. After pulling System out and replacing the nose cartridge, it may be necessary to adjust nuts attaching nose belt to diaphragm and/or legs to 35 Nm [25 ft-lbs]. Nose belt assembly is available for replacement or retrofit by calling the Customer Service Department at 1-888-32-ENERG.

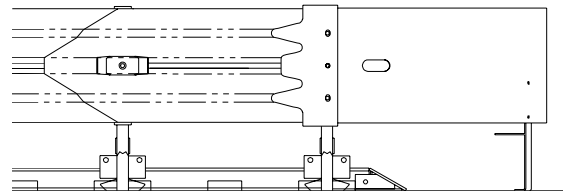


Figure 86
Optional Nose Assembly

Table C

QuadGuard System Bolt Torque Specifications

WARNING!

Anchor Studs....	Torqued to 165 Nm [120 ft-lbs] Should NOT protrude above nuts (see figure 17, page 13)
All Other Bolts...	Tightened
Fender Panel....	Maximum gap allowed: Narrow - 20 mm [0.78"] Wide - 25 mm [1.0"]

13. Check the **torque of all bolts** on the System (see Table C).
14. Check to be certain that the site is free from **any debris**. The QuadGuard System is once again ready for use.

QuadGuard® System

Maintenance and Repair (cont'd.)

Parts Ordering Procedure

Make a list of all damaged parts using part descriptions shown on pages 56 and 57. Answer the following questions in the spaces provided. This information is necessary to receive the proper parts.

Table D
QuadGuard System Ordering Information Chart

DESCRIPTION	CHOICES	FILL IN THIS SECTION
What is the Width of System? (refer to "Measuring the Width" page 6.)	610 mm [24"] 760 mm [30"] 915 mm [36"] 1755 mm [69"] 2285 mm [90"] Extra-Wide [specify width]	
What is the Number of Bays? (refer to "Counting The Number of Bays" page 5.)	Narrow Hazards: 1 through 12 Wide Hazards: 3 through 12	
What Type of Backup Does the System Have?	Concrete Tension Strut	
What Type of Transition Panel? (Refer to "Side Panel & Transition Panel Types" page 10.) Be sure to note right side, left side, both sides (refer to "How to Determine Left/Right" page 5) or no transitions.	<ul style="list-style-type: none"> • Quad to W • Quad to Thrie • Quad to Safety Shape Barrier • Quad to End Shoe • 4" Offset Panel 	

QuadGuard® System

Maintenance and Repair (cont'd.)

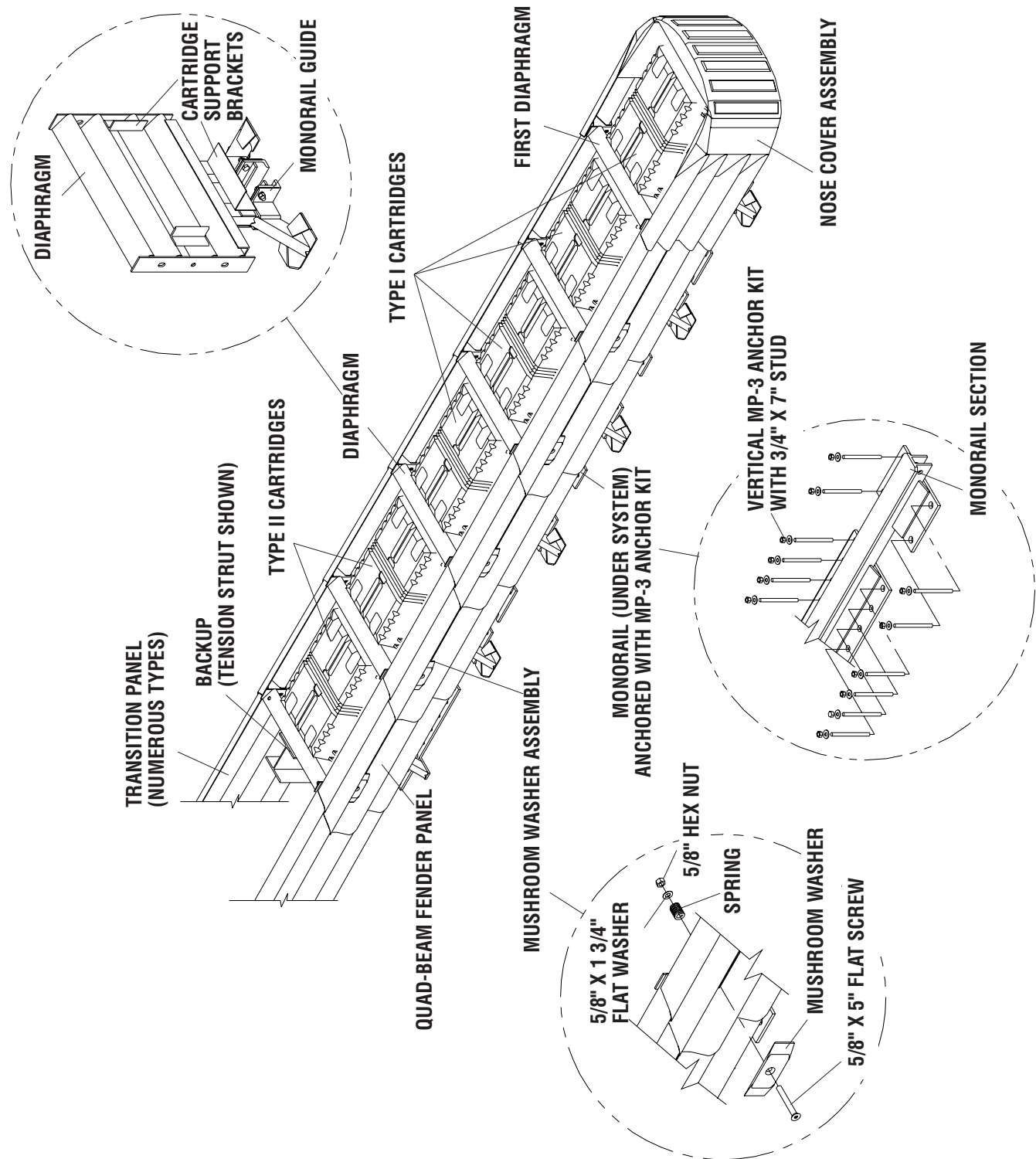


Figure 87
QuadGuard for Narrow Hazards

QuadGuard® System

Maintenance and Repair (cont'd.)

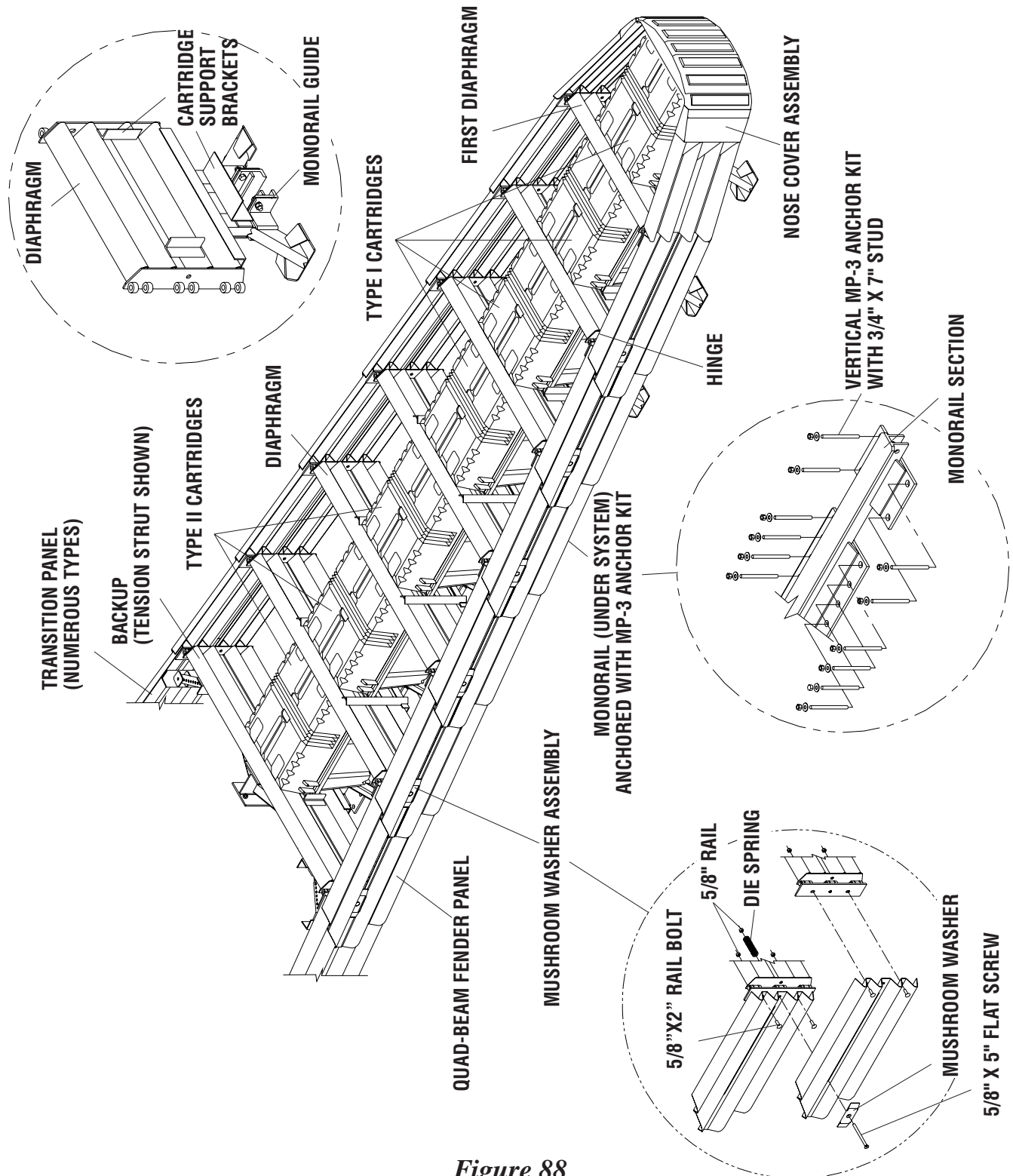


Figure 88
QuadGuard for Wide Hazards

QuadGuard® System

Limitations And Warnings

The 6 bay QuadGuard® System has been tested and evaluated per the recommendations of the NCHRP 350 Guidelines* for Test Level 3 (TL-3) terminals and crash cushions. The impact conditions recommended in this guideline are intended to encompass the majority but not all, of the possible in-service collisions.

Properly installed and maintained, the QuadGuard System is capable of performing its function of stopping or containing and redirecting the test vehicles in a predictable and safe manner under the nominal NCHRP 350 TL-3 terminal and crash cushion impact conditions of:

Vehicles: Small car and pickup

Mass: 820 and 2000 kg [1808 and 4409 lb.]

Speed: 100 km/h [62 mph]

Angle: 15 degrees for small vehicle
20 degrees for pickup

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.

* Copy may be obtained from:

Transportation Research Board
National Research Council
2101 Constitution Avenue, N.W.
Washington, D.C. 20418

QuadGuard[®] System

Notes

Customer Service Department

USA

Phone 1-888-323-6374

Fax 1-312-467-1356

Asia Pacific

Phone +65 6276 3398

Fax +65 6276 6218

Europe

Phone +44-1473-221-105

Fax +44-1473-221-106

**35 East Wacker Dr., 11th Floor
Chicago, IL 60601-2076
Engineering and Manufacturing Facilities:
Rocklin, California and Pell City, Alabama**



**ENERGY ABSORPTION
SYSTEMS, INC.**

A Quixote Company

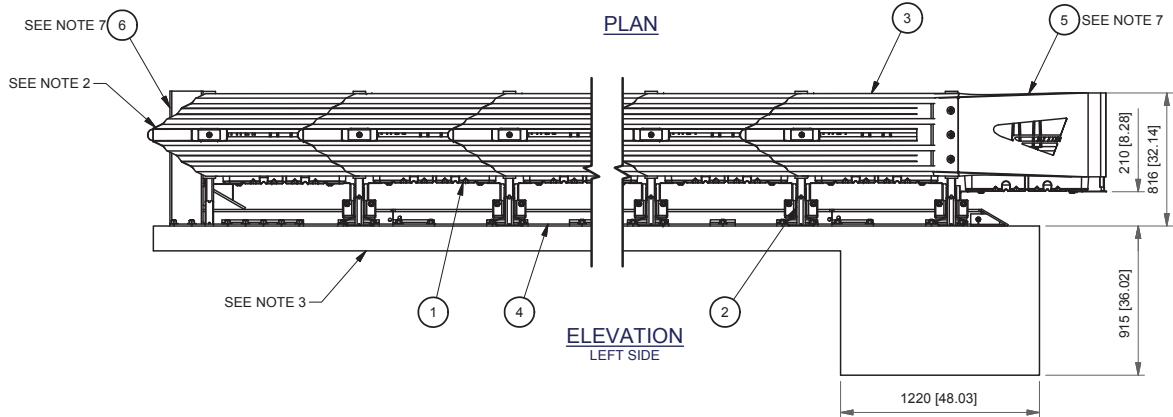
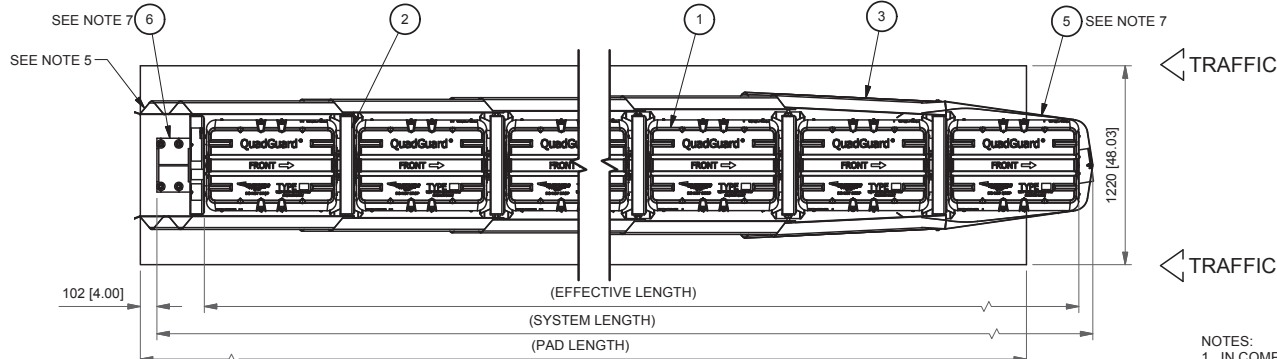
Saving Lives By Design

Rev. 12/6/07

<http://www.energyabsorption.com/>

Part No. 2750871-0000

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- 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.
 3. 150 [6.00] MIN. REINFORCED 28 MPa [4000 PSI] P.C. CONCRETE PAD OR 200 [8.00] MIN. NON-REINFORCED 28MPa [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 SYSTEM HAS BEEN TESTED TO NCHRP 350.

BAYS	610 [24"] WIDTH		762 [30"] WIDTH		914 [36"] WIDTH		1220 [48"] WIDTH		SYSTEM LENGTH		EFFECTIVE LENGTH		PAD LENGTH		MAX DESIGN SPEED		NO. OF CARTRIDGES	
	MODEL NO.	MODEL NO.	MODEL NO.	MODEL NO.	MODEL NO.	MODEL NO.	MODEL NO.	MODEL NO.	m	ft-in	m	ft-in	m	ft-in	Km/h	[MPH]	TYPE I	TYPE II
1	QG24024	QG24030	QG24036	QG24048	2.13	[7'-0"]	1.73	[5'-8"]	2.74	[9'-0"]	40	[25]	2	0				
2	QG27024	QG27030	QG27036	QG27048	3.05	[10'-0"]	2.64	[8'-8"]	2.74	[9'-0"]	70	[43]	2	1				
3	QG28024	QG28030	QG28036	QG28048	3.96	[13'-0"]	3.56	[11'-8"]	3.66	[12'-0"]	80	[50]	2	2				
4	QG29024	QG29030	QG29036	QG29048	4.87	[16'-0"]	4.47	[14'-8"]	4.57	[15'-0"]	90	[56]	3	2				
5	QG210024	QG210030	QG210036	QG210048	5.79	[19'-0"]	5.38	[17'-8"]	5.49	[18'-0"]	100	[62]	3	3				
6	QG210524	QG210530	QG210536	QG210548	6.71	[22'-0"]	6.30	[20'-8"]	6.40	[21'-0"]	105	[65]	4	3				
7	QG211024	QG211030	QG211036	QG211048	7.63	[25'-0"]	7.21	[23'-8"]	7.32	[24'-0"]	110	[68]	4	4				
8	QG211524	QG211530	QG211536	QG211548	8.53	[28'-0"]	8.13	[26'-8"]	8.23	[27'-0"]	115	[71]	4	5				
9	QG212024	QG212030	QG212036	QG212048	9.45	[31'-0"]	9.04	[29'-8"]	9.14	[30'-0"]	120	[75]	4	6				

UNIDIRECTIONAL

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

Revision	Date	Rev	By	Chk.	App.
MONORAIL ASSY IN REFERENCES WAS 35-40-06, CONCRETE PAD WAS 35-40-11	6/22/09	B	DDS	STT	RCB
REVISED DESIGN SPEED COLUMN IN TABLE.	8/31/09	C	DK	JME	RCB
UPDATED SYSTEM LENGTH AND EFFECTIVE LENGTH COLUMNS IN TABLE.	10/23/09	D	DDS	JME	FJP

REFERENCES

DIAPHRAGM ASSY.	35-40-07
SHIM KIT, DIAPHRAGM	3540078-0000
NOSE ASSY.	3540042-0000
FENDER PANEL ASSY.	35-40-04
BACKUP ASSY.	35-40-03
MONORAIL ASSY.	35-40-75
CONCRETE PAD	35-40-76

DRAWN:	D. Kohfeld	DATE:	2/25/2009
DESIGNED:	M. Buehler	DATE:	12/30/2008
CHECKED:	JME	DATE:	3/4/2009
APPROVED:	MJB	DATE:	3/19/2009
FILE:	QG2TSCVR-U.idw		
NEXT ASSEMBLY:			



QUADGUARD II® SYSTEM
WITH TENSION STRUT BACKUP

SCALE:	DRAWING:	SHEET:	REV:
	QG2TSCVR-U	1 of 1	D

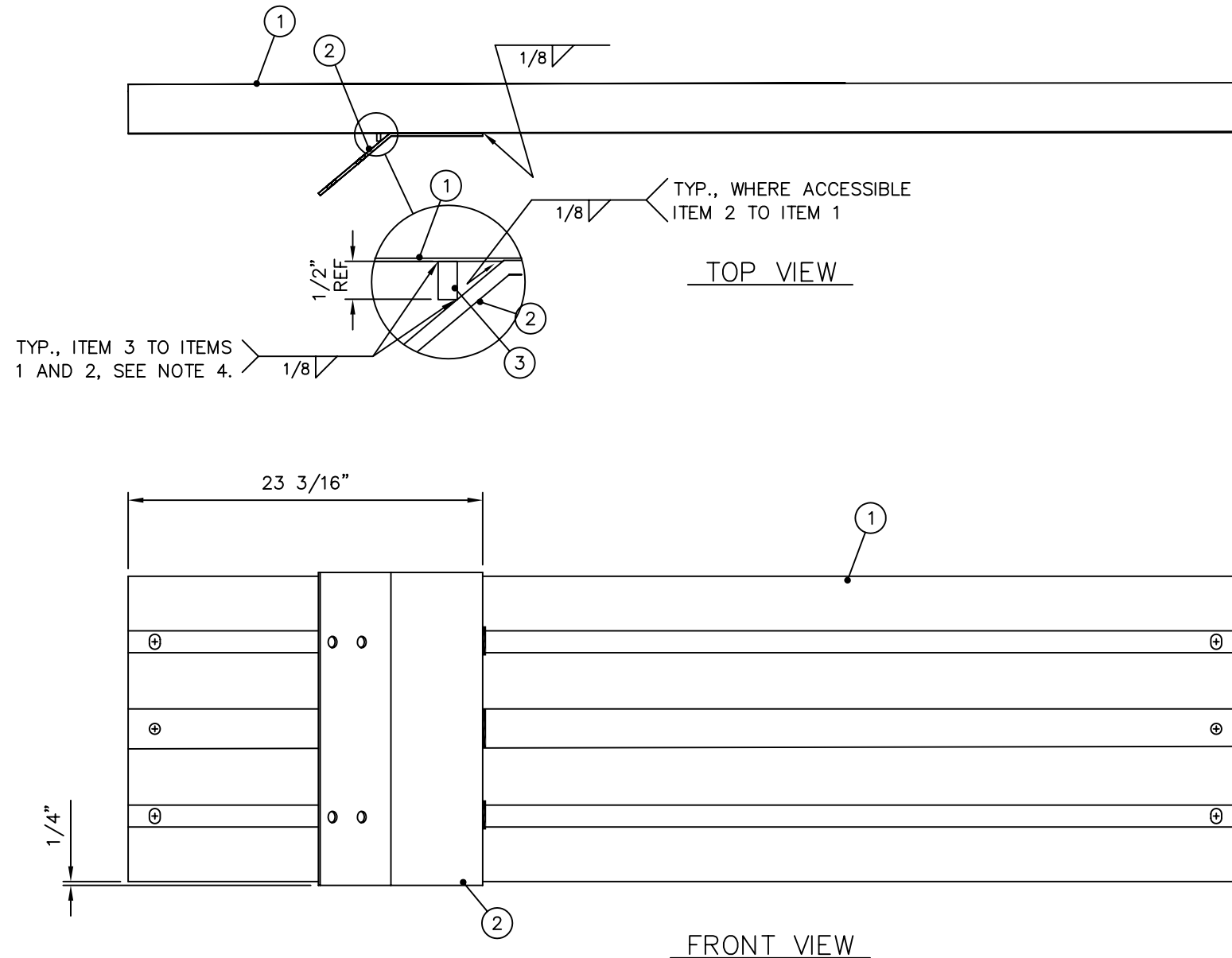
NEXT ASSEMBLY:
60-24-29

MATERIAL:
SEE PARTS DRAWINGS

TOL ANGULAR: $\pm 1^\circ$
TOL LINEAR: $\pm 1/16"$
UNLESS OTHERWISE NOTED.

PARTS LIST

ITEM	STOCK NO.	DESCRIPTION	REQ'D
1	6024292-0000	PANEL,QB,73,W/HOLES	1.00
2	2516531-0000	FTB ST 3/16X12X20 1/2	1.00
3	2508191-0000	FTB ST 1/4X1 1/2X1/2	2.00
88	GALV.	GALVANIZING	113.21



- NOTES:
1. REMOVE ALL BURRS AND SHARP EDGES AND WELD SPATTER.
 2. HOLE DIAMETERS TO BE $\pm 1/32"$.
 3. HOT DIP GALVANIZE AFTER FABRICATION PER ASTM A-123.
 4. WELD ITEM 3 TO ITEMS 1 & 2 AFTER ITEM 2 HAS BEEN WELDED TO ITEM 1.

PART NO. 6024291-0000

DRAWN: S. CHAFFIN	DATE: 10/20/04
DESIGNED:	DATE:
CHECKED: JME	DATE: 10/21/04
APPROVED: A. FRANKLIN	DATE: 10/21/04
Q.C. S. TRAGESER	DATE: 10/21/04
CAD FILE: 6024291-0000.dwg	



ENERGY ABSORPTION SYSTEMS, INC.
ENGINEERING AND RESEARCH DEPARTMENT

EXTENSION PANEL,QB,73,G

SCALE 1:10	DWG. 6024291-0000	SHEET 1 of 1	REV -
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