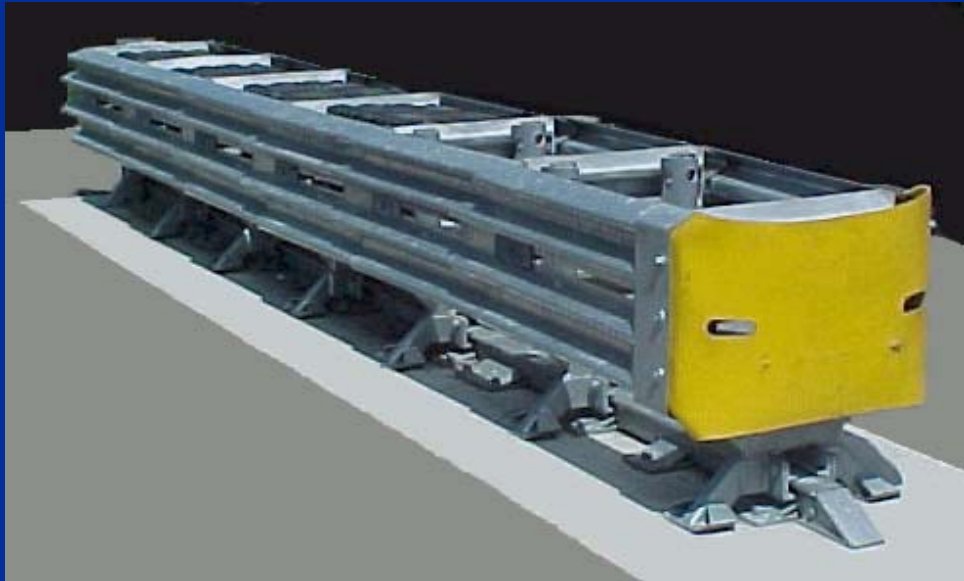


QuadGuard[®] CEN



*Set a worldwide standard for crash cushions
reliability and effectiveness.*



ENERGY ABSORPTION
SYSTEMS, INC.

A Quixote Company
Saving Lives By Design

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Installation Manual

System Overview

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Important Introductory Notes

Proper installation of the QuadGuard CEN 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 CEN, please call Energy Absorption Systems' Customer Service Department:

USA: 1-888-323-6374

ENGLAND: 44-1473-221-105

The QuadGuard CEN is a highly efficient, redirective, non-gating crash cushion for hazards ranging in width from 610 mm [24"] to 2285 mm [90"] in width. It consists of crushable, energy-absorbing cartridges surrounded by a framework of Quad-Beam™ panels.

Crash Performance

The QuadGuard CEN has successfully passed the European Standard EN 1317-:2000 tests. For a list of the tests, see the Limitations & Warnings section of this manual.

During head-on impacts, the QuadGuard CEN 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.

When reading this manual, please note the following:

WARNING!

Indicates a situation that will cause physical and/or property damage.

Caution: Indicates a situation that could possibly cause physical and/or property damage.

Note: Indicates a matter of interest or clarification.

Installation

Required Tools

Documentation

- Manufacturer's Installation Manual
- Manufacturer's Drawing Package

Cutting equipment

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

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

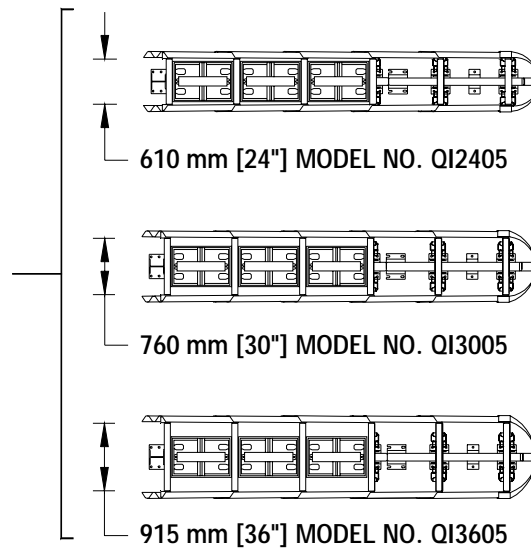
Miscellaneous

- 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

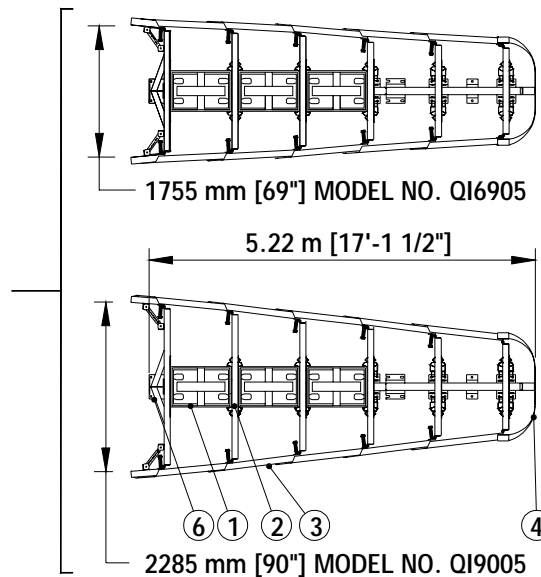
Note: The above list of tools is a general recommendation. The actual number of tools required will depend on specific site conditions and the complexity of the installation.

Installation (cont'd.)

QUADGUARD CEN
FOR NARROW HAZARDS



QUADGUARD CEN
FOR WIDE HAZARDS



KEY

- ① CARTRIDGE
- ② DIAPHRAGM
- ③ QUAD-BEAM™ FENDER PANEL
- ④ NOSE COVER
- ⑤ MONORAIL
- ⑥ BACKUP

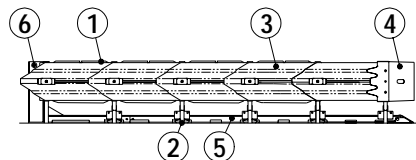


Figure 1

Plan & Elevation (5 bay System shown)

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 as shown in figure 2.

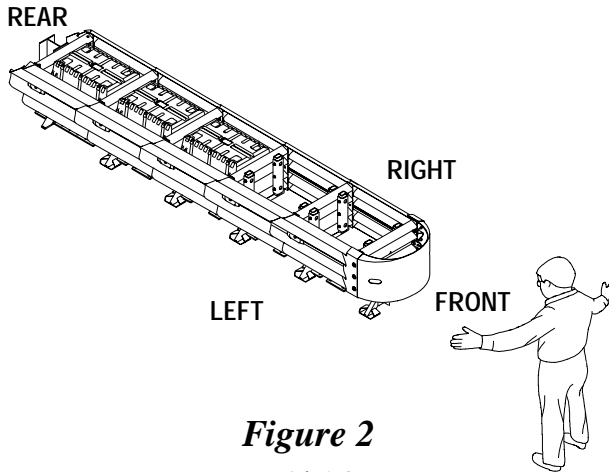


Figure 2
Left/Right

Counting The Number of Bays

One bay consists of one diaphragm and two fender panels. The nose section is not considered a bay. There are no cartridges in the front 2 bays of the System, therefore there will be 2 more bays than the number of cartridges for the System. To determine number of bays, count fender panels on one side (see figure 3).

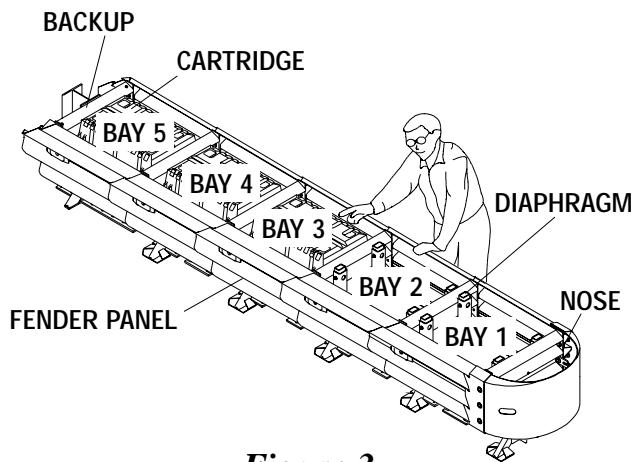


Figure 3
Number of Bays
(5 bay System shown)

Measuring The Width

The QuadGuard® CEN is available in 5 nominal widths:

1. 610 mm [24"]
2. 760 mm [30"]
3. 915 mm [36"]
4. 1755 mm [69"]
5. 2285 mm [90"]

The nominal width of the System is the width between side panels behind the backup (see figure 4).

The outside width of the System is approximately 150 mm to 230 mm [6" to 9"] wider than this measurement.

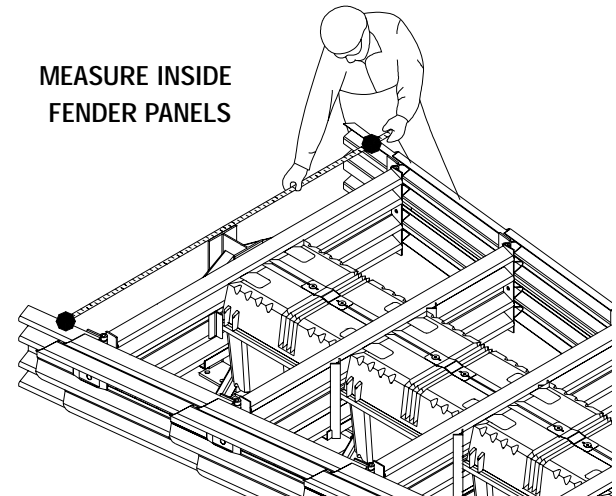


Figure 4
System Width

Installation (cont'd.)

Site Preparation/Foundation

A QuadGuard CEN 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 a non-reinforced minimum 28 MPa [4000 psi] concrete roadway (minimum 200 mm [8"] thick). Installation cross slope should not exceed 8% and should not vary more than 2% over the length of the System; the pad surface should 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.

Inspect Shipment

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

Installation Procedures

Note: *The drawing package supplied with the QuadGuard® CEN must be used with these instructions for proper assembly and should take precedence over these general instructions.*

1) Determine Transition Type

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 CEN. Refer to figures 5 through 10 and the drawing package to determine which type of panels are being installed.

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 CEN is shielding. Contact the Customer Service Department prior to installation if you have any questions.*

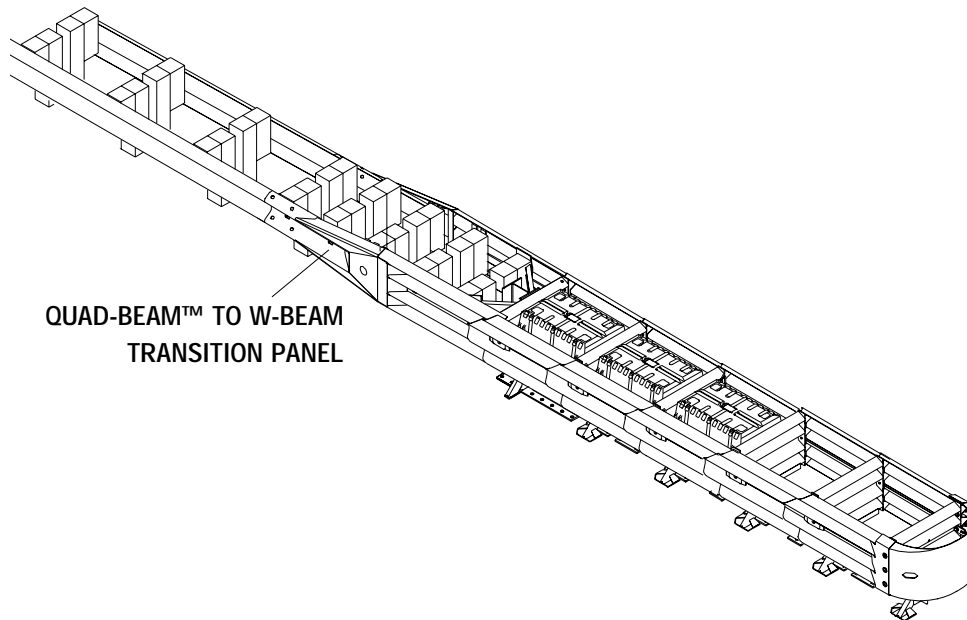


Figure 5

Transitioning the QuadGuard CEN

Installation (cont'd.)

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 CEN is shielding. Contact the Customer Service Department prior to installation if you have any questions.

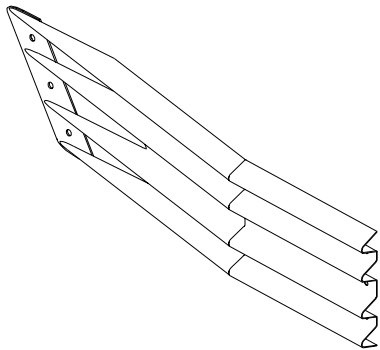


Figure 6

Quad-Beam to Safety Shape Barrier Transition Panel

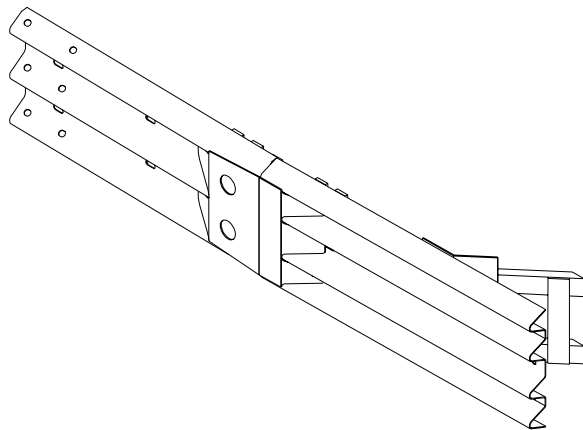


Figure 7

Quad-Beam to Thrie-Beam Transition Panel



Figure 8

Side Panel

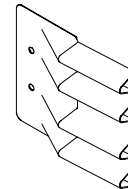


Figure 9

Quad-Beam™ End Shoe

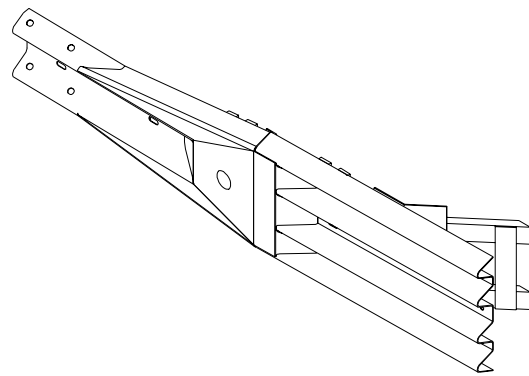


Figure 10

Quad-Beam to W-Beam Transition Panel

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 11. 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.

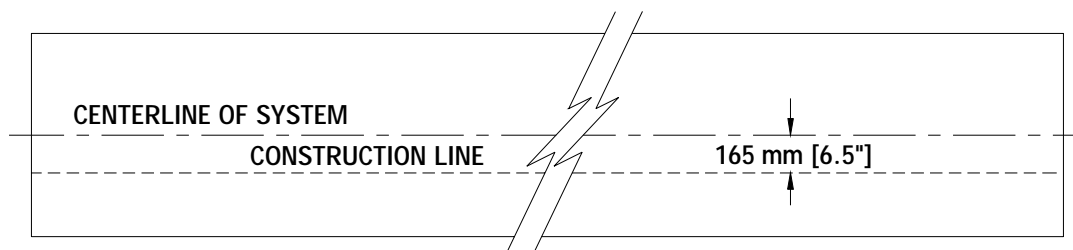


Figure 11
(Top view of concrete pad)
Locating Construction Line

3) Anchor the Backup and Monorail

Refer to figures 12 through 14 (showing backup and monorail installation). Also refer to the drawing package, and "MP-3 Polyester Anchoring System" on page 25.

Locate tension strut backup and monorail on pad with side of monorail on the construction line (see figure 13). 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 25).

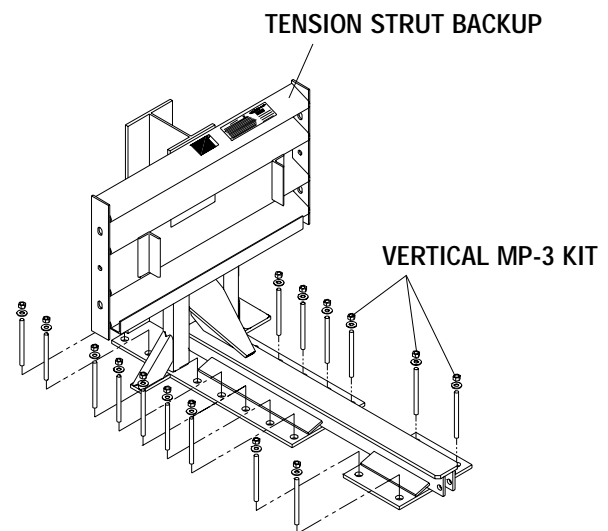


Figure 12
Anchoring Tension Strut Backup to Foundation

Installation (cont'd.)

A. Tension Strut Backup Installation

Locate tension strut backup and monorail on pad with side of monorail on the construction line (see figure 13). Verify that any applicable transition panels fit properly before anchoring backup. Drill 140 mm [5 1/2"] deep anchor holes in the pad using the backup as a template. Do not drill through pad. Anchor the backup to the concrete pad using the MP-3® vertical kits provided. See "MP-3 Polyester Anchoring System Instructions" included with this manual.

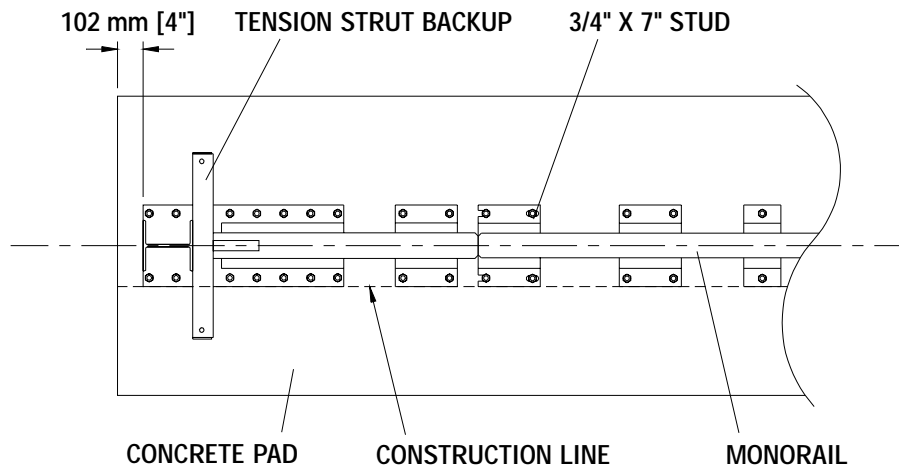


Figure 13
Anchoring the System

B. Monorail installation

Locate the monorail using the monorail assembly drawings. Drill 140 mm [5 1/2"] deep anchor holes using the monorail as a template (see figure 13). Do not drill through pad. Anchor each monorail section using the MP-3 vertical kits provided. Refer to figure 14 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.

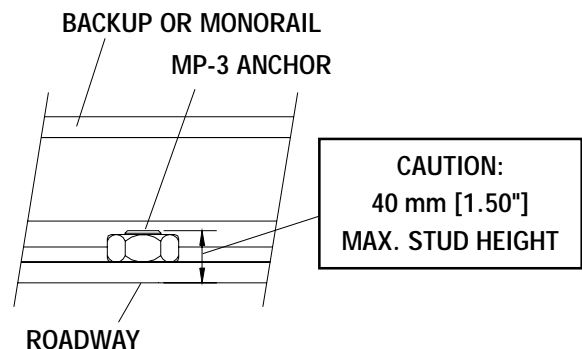


Figure 14
Proper Stud Height

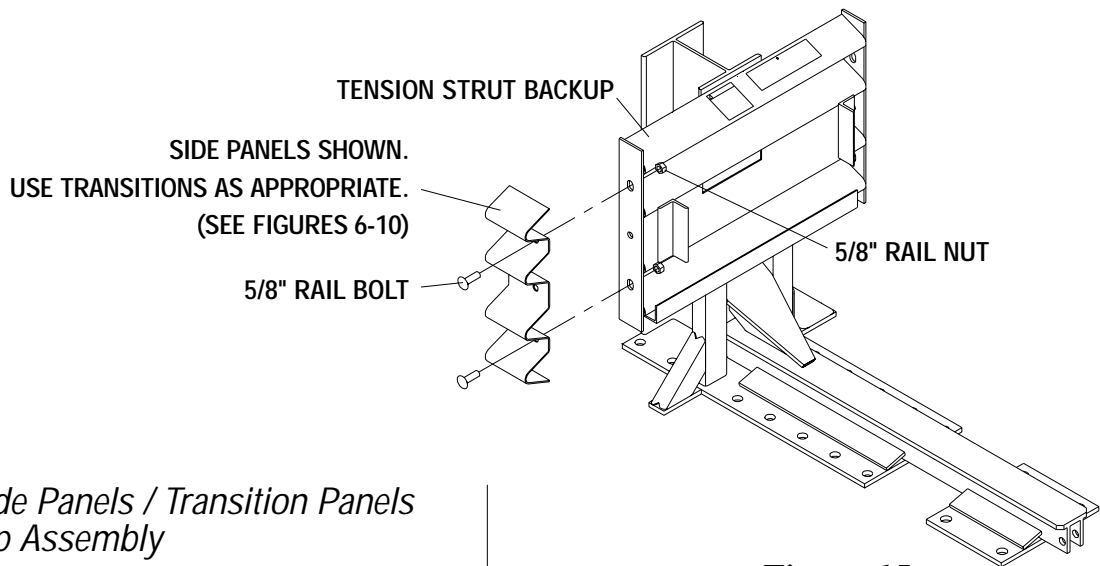


Figure 15

Side Panel/Transition Panel Installation for Narrow Applications

4) Install Side Panels / Transition Panels to Backup Assembly

Attach the transition panel or side panel as appropriate to each side of the backup. Refer to figures 15 and 16, and the drawing package for more information.

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

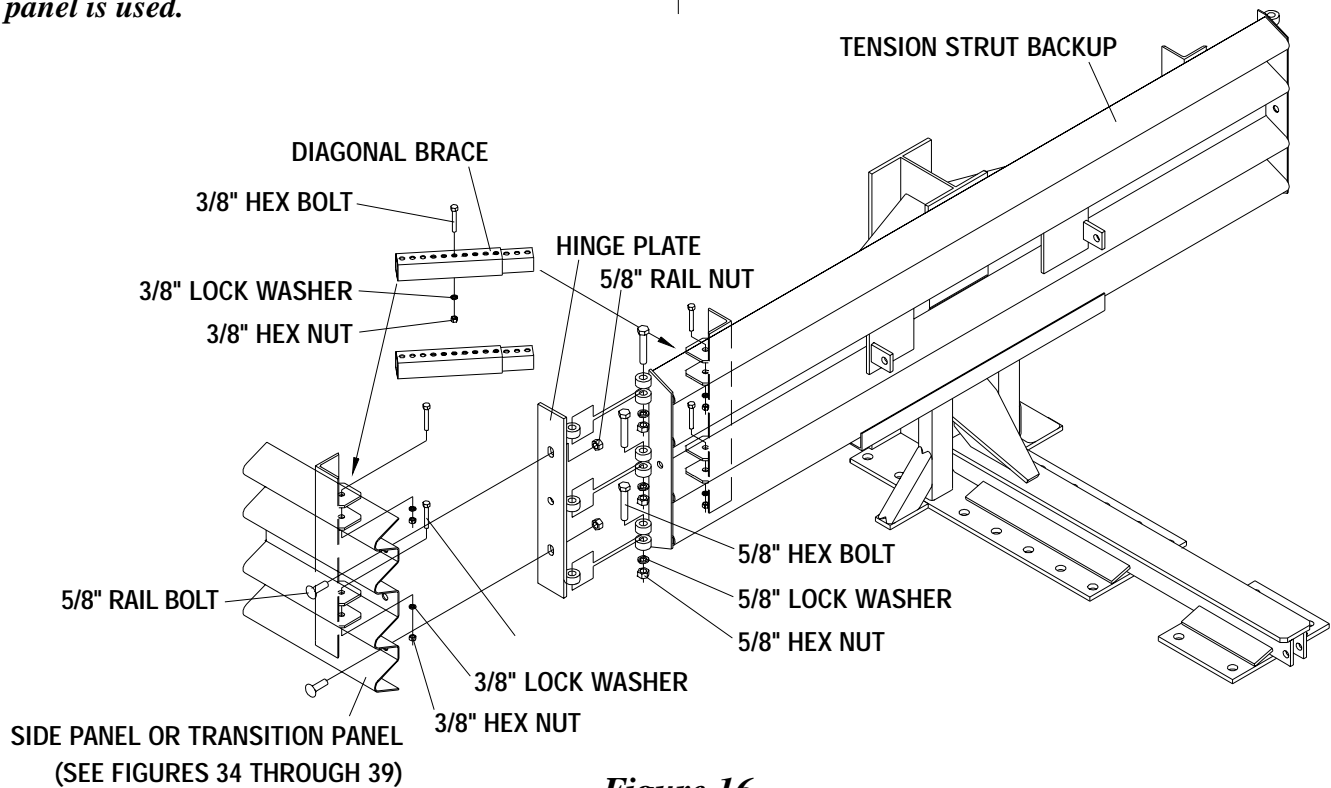


Figure 16

Side Panel/Transition Panel Installation for Wide Applications

Installation (cont'd.)

5) Install Monorail Guides

Attach monorail guides to the diaphragms as shown in figure 17, and the diaphragm assembly drawing.

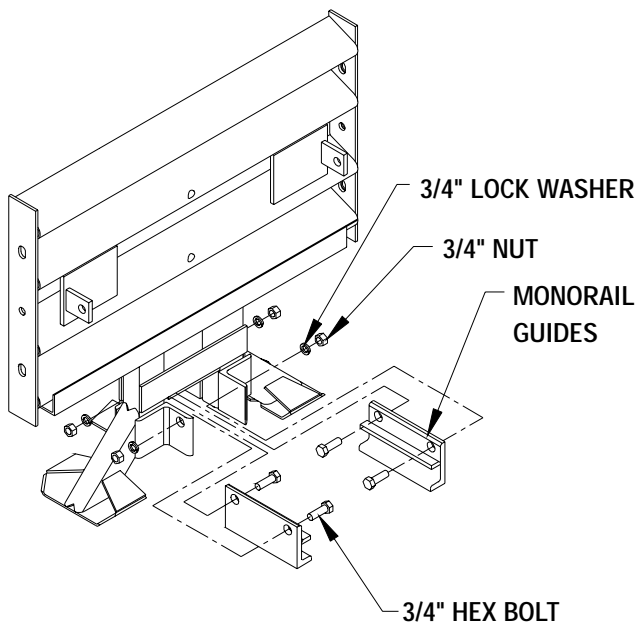


Figure 17
Monorail Guides

6A) Install Diaphragms (Narrow Systems)

Orient a diaphragm so that the front face of the Quad-Beam™ shape faces toward the nose of the System as shown in figure 18. Slide the diaphragm onto the monorail. 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 915 mm [36"] in front of the backup. Refer to figure 19 for the proper location. Orient and slide all other diaphragms onto the monorail and position each as shown in figure 19. The diaphragm spacing shown in figure 19 allows the System to be assembled. Once the System is assembled, the diaphragms will be moved to their final locations.

6B) Install Diaphragms (Wide Systems)

Orient diaphragms so that the front face of the Quad-Beam shape faces toward the nose of the System as shown in figure 18. The widest diaphragm should 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 then slide the diaphragm forward to approximately 915 mm [36"] in front of the backup. Refer to figure 19 for the proper location. Orient and slide all other diaphragms onto the monorail and position each as shown approximately 915 [36"] in front of the previous diaphragm. Refer to figure 19.

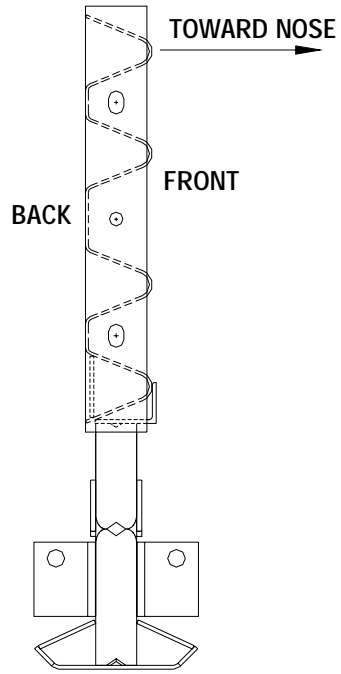


Figure 18
Diaphragm Orientation

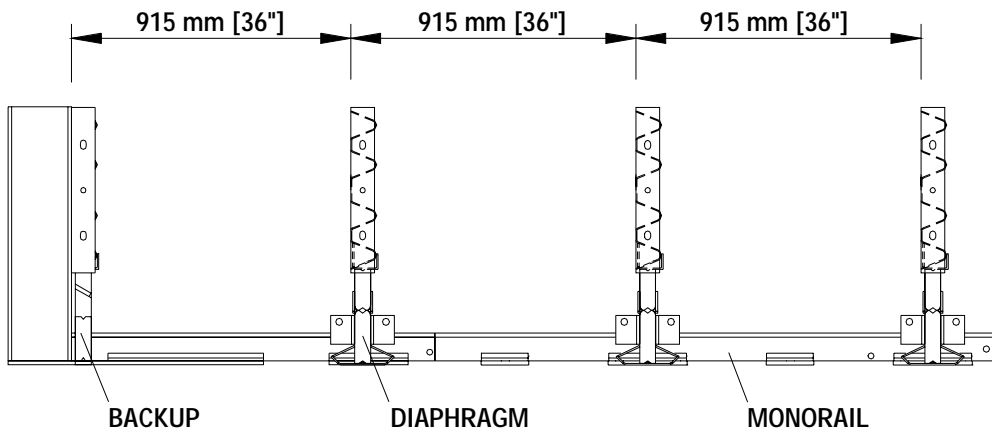


Figure 19
Initial Diaphragm Spacing

Installation (cont'd.)

7) Attach Bumper Assemblies

Bays 1 and 2 of all Systems are outfitted with bumper assemblies as shown in figure 20.

First Diaphragm

On the first diaphragm, the bumper assemblies are attached to the rear of the diaphragm only.

Attach bumper assemblies to the first diaphragm by orienting each bumper assembly with the small holes facing the rear of the diaphragm as shown in figures 21 and 22. Next, insert 1/2" x 5" hex bolts through the front of first diaphragm and small hole on each bumper assembly. Fasten with 1/2" x 1 3/8" flat washers and nuts. Torque to 37 Nm [20 ft-lbs].

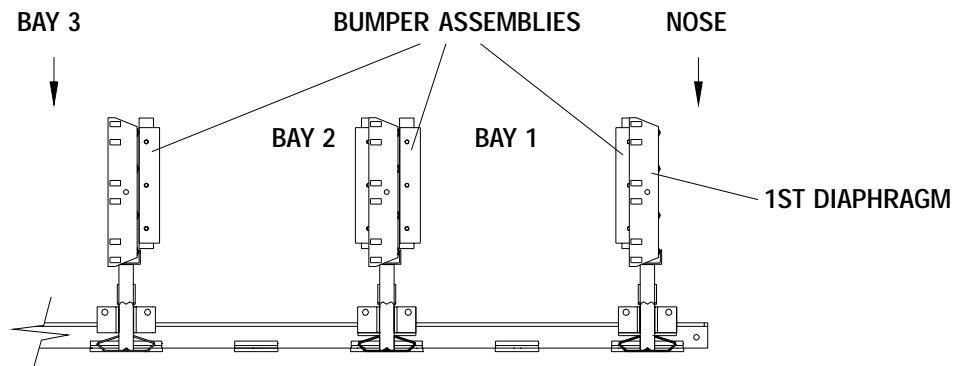


Figure 20
Bumper Assemblies

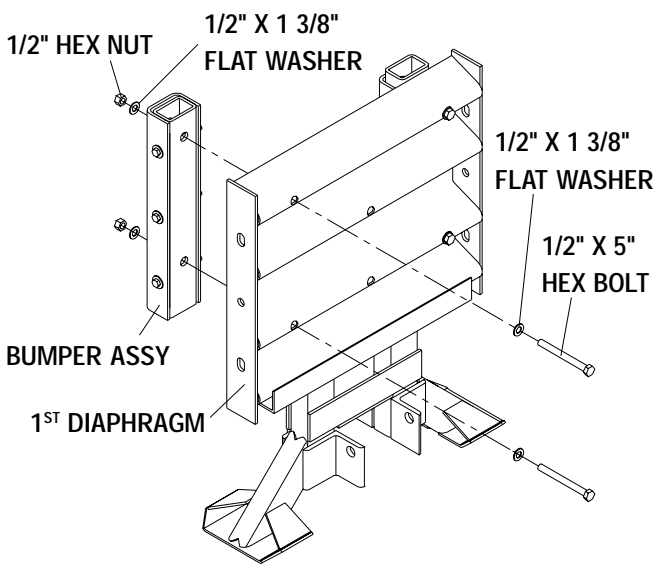


Figure 21
First Diaphragm Bumper Assembly Attachment
for Narrow Systems

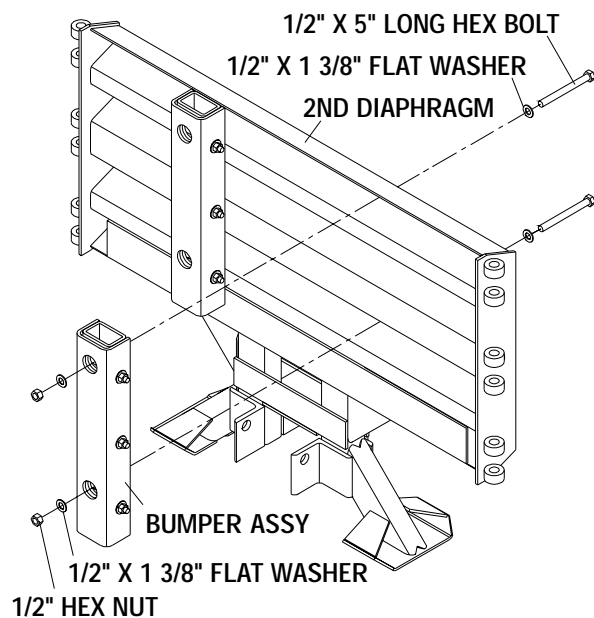


Figure 22
First Diaphragm Bumper Assembly Attachment
for Wide Systems

Second Diaphragm

On the second diaphragm, the bumper assemblies are attached to the front and rear of the diaphragm.

Orient bumper assemblies front and rear with the small holes facing the second diaphragm and fasten with 1/2" x 5" hex bolts, 1/2" x 1 3/8" flat washers, and 1/2" nuts as shown in figures 23 and 24. Torque to 37 Nm [20 ft-lbs].

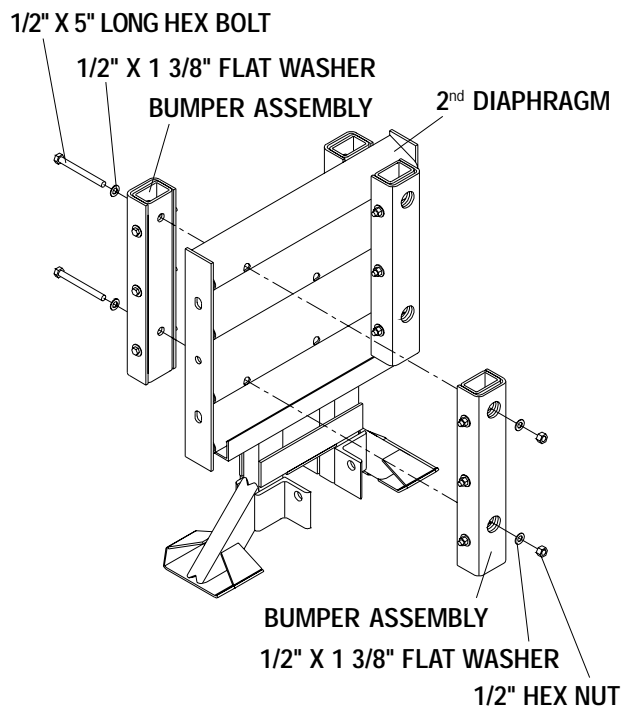


Figure 23
*Second Diaphragm
Bumper Assembly Attachment
for Narrow Systems*

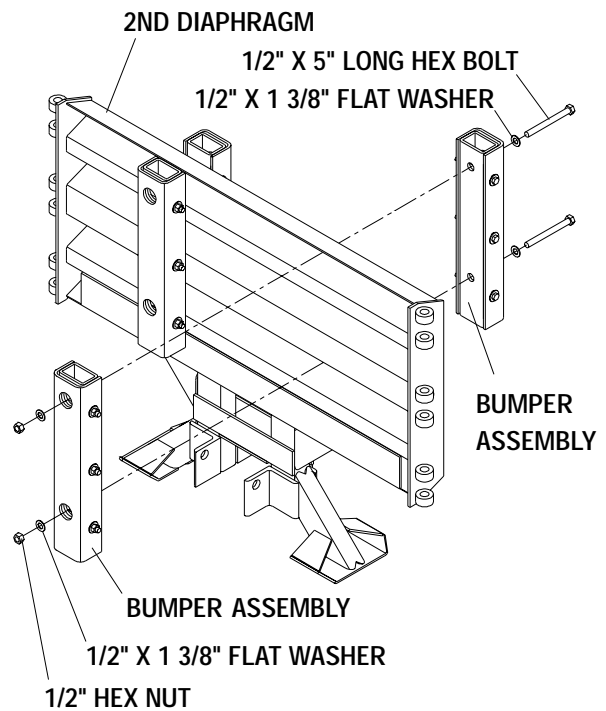


Figure 24
*Second Diaphragm
Bumper Assembly Attachment
for Wide Systems*

Installation (cont'd.)

Third Diaphragm

On the third diaphragm, the bumper assemblies are on the front side of the diaphragm only.

Orient bumper assemblies with the small holes facing the front of the third diaphragm and, using the top holes, fasten with 1/2" x 3" long hex bolts, 1/2" x 1 3/8" flat washers, and 1/2" nuts as shown in figures 25 and 26.

Note: This bracket is not necessary for 610 mm [24"] Systems.

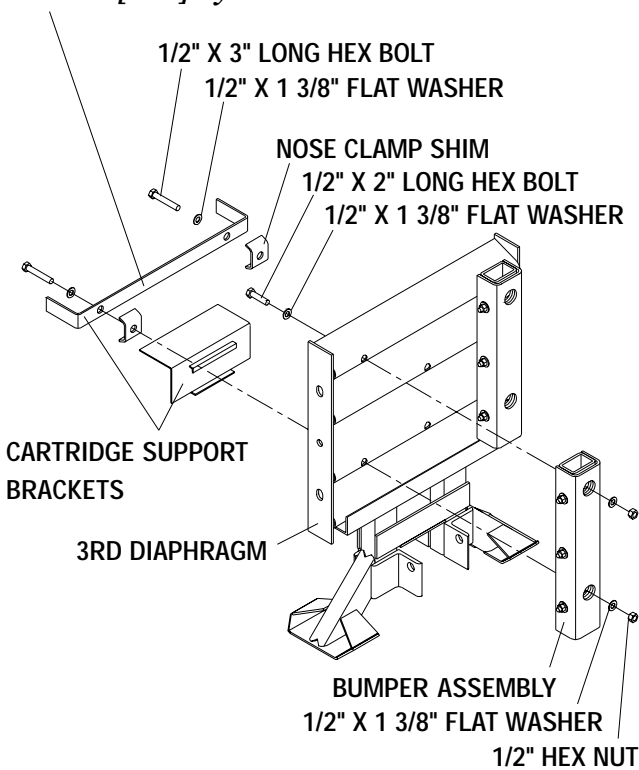


Figure 25

Third Diaphragm Bumper Assembly Attachment for Narrow Systems

Orient cartridge support bracket and nose clamp shims against the rear of the third diaphragm, over the lower holes as shown. Fasten to the diaphragm and bumper assemblies with 1/2" x 3" long hex bolts, 1/2" x 1 3/8" flat washers, and 1/2" nuts. Torque to 37 Nm [20 ft-lbs].

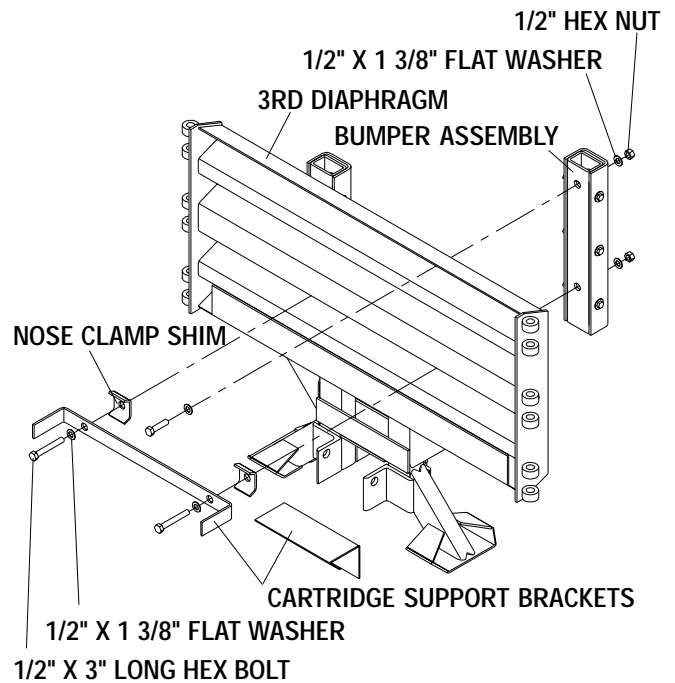


Figure 26

Third Diaphragm Bumper Assembly Attachment for Wide Systems

11) Install Fender Panels (Narrow Systems)

Caution: Do not mix the 5/8" rail nuts (large) with the 5/8" hex nuts (small). The rail nuts are tapped oversize. See figure 27.

Starting at the last bay, install left and right fender panels as shown in figure 28. Attach the front of each fender panel to the diaphragm in front using two rail bolts and nuts per side. Use only the top and bottom holes, leave the center hole open until the next fender panel is installed.

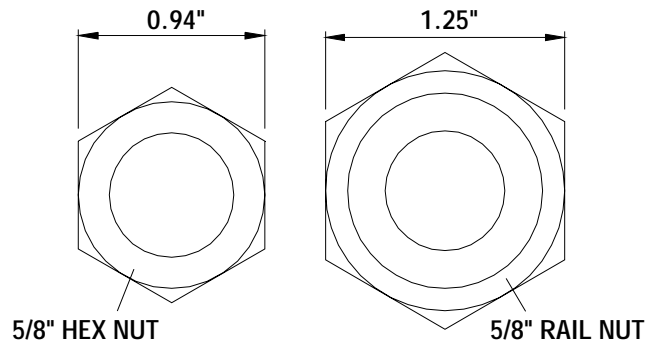
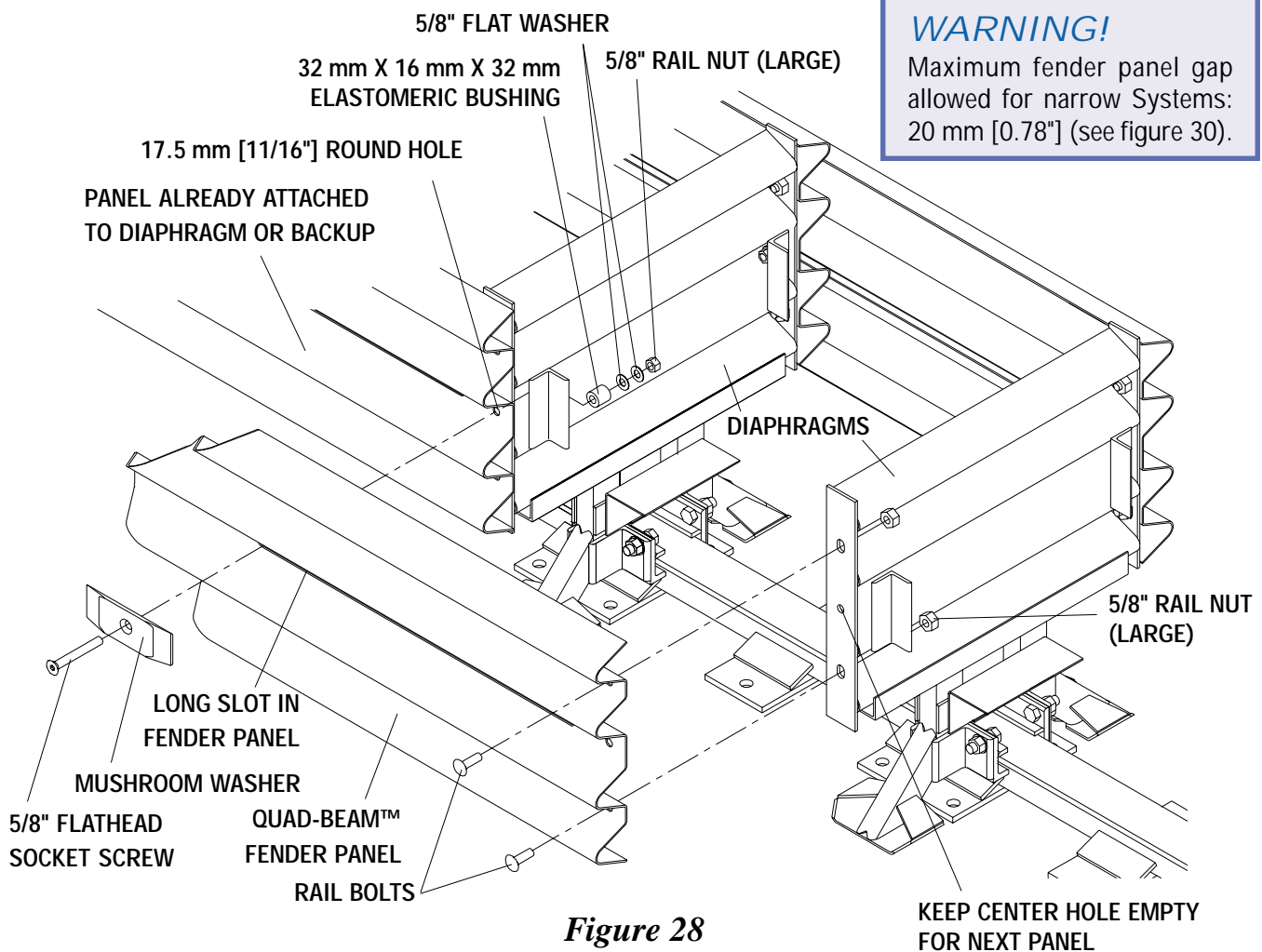


Figure 27

Rail Nuts are Oversize



WARNING!
Maximum fender panel gap allowed for narrow Systems: 20 mm [0.78"] (see figure 30).

Figure 28

*Fender Panel Assembly
for Narrow Systems*

Installation (cont'd.)

Attach mushroom washer assemblies as shown in figure 28, but do not torque at this time.

Be sure mushroom washer lays flat against the fender panel as shown in figure 29. Standoff on washer must be seated completely through slot.

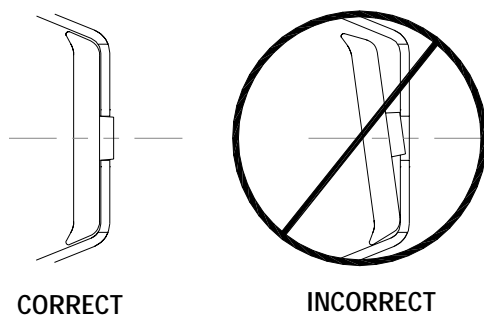


Figure 29

Mushroom Washer Orientation

11) Install Fender Panels (Wide Systems)

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

Install hinge plates on each fender panel as shown in figure 32.

Caution: Do not mix the 5/8" rail nuts (large) with the 5/8" hex nuts (small). The rail nuts are tapped oversize. See figure 31.

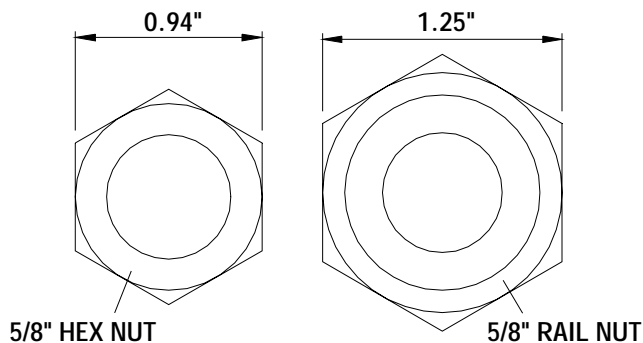


Figure 31

Rail Nuts are Oversize

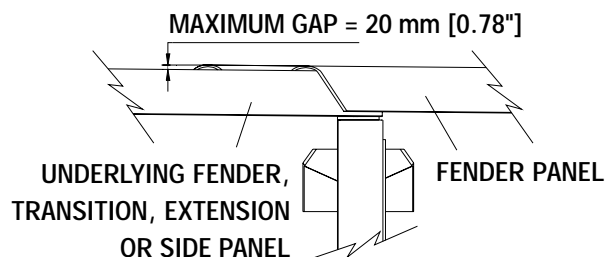


Figure 30

Fender Panel Gap for Narrow Systems

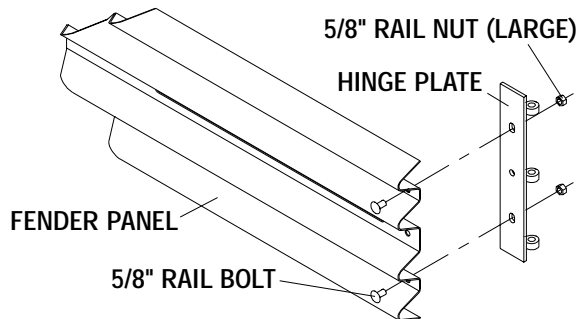


Figure 32

Fender Panel Assembly for Wide Systems

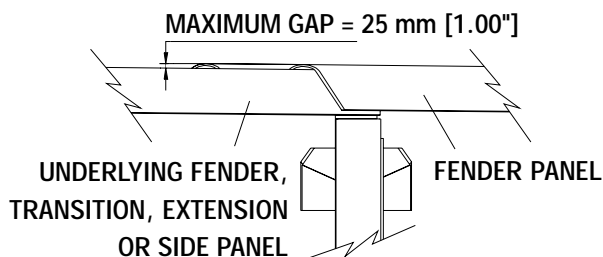


Figure 33

Fender Panel Gap for Wide Systems

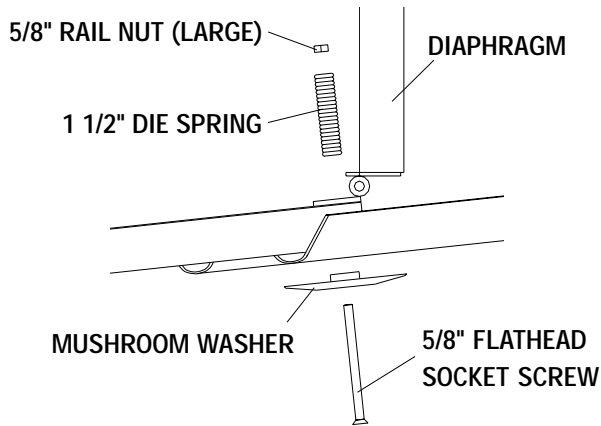


Figure 34
Mushroom Washer Attachment
for Wide Systems

Starting at the last bay, install left and right fender panels as shown in figure 35. 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 34 and 35 but do not torque at this time.

Be sure mushroom washer lays flat against the fender panel as shown in figure 29. Standoff on washer must be seated completely through slot.

WARNING!

Maximum fender panel gap allowed for wide Systems: 25 mm [1.00"] (see figure 33).

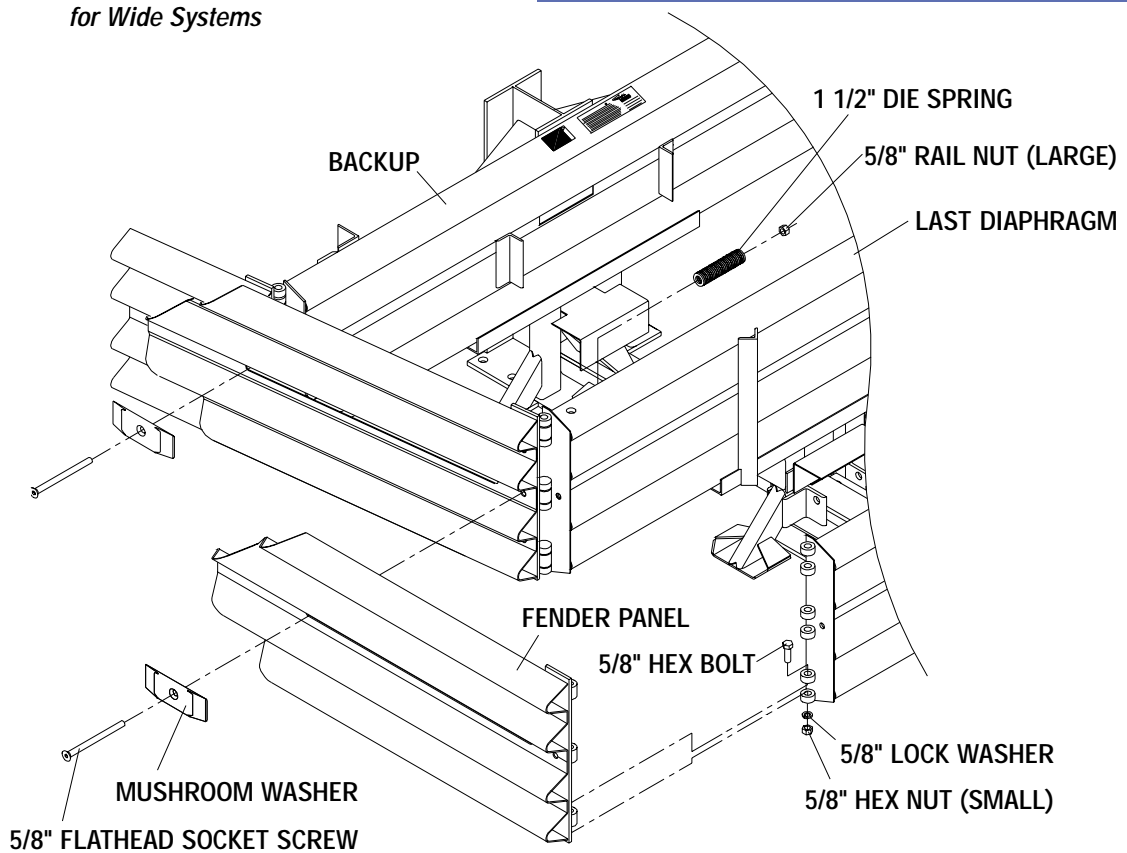


Figure 35
Fender Panel Assembly
for Wide Systems

Installation (cont'd.)

Check diaphragm spacing to ensure 915 mm [36"] between rear faces of consecutive diaphragms as shown in figures 36 and 37.

Narrow Systems: Once the proper spacing has been achieved, the bushing should be compressed 1 mm to 3 mm [1/16" to 1/8"] to complete the assembly. One to four washers should be used to accomplish this. Do not over compress the elastomeric bushing! Do not tighten nut more than two turns after washer(s) begin to compress bushing.

Wide Systems: Once the proper spacing has been achieved, torque the mushroom washer assembly nuts to 80 Nm [60 ft-lbs.] 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 procedure.

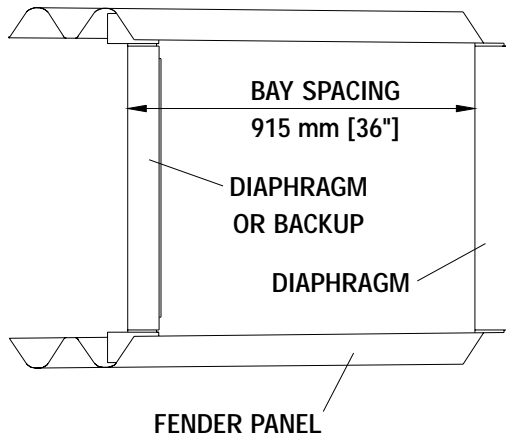


Figure 36

*Proper spacing between bays
(Narrow System shown)*

12) Install End Cap

Install end cap to the monorail as shown in figure 38 and the monorail assembly drawing.

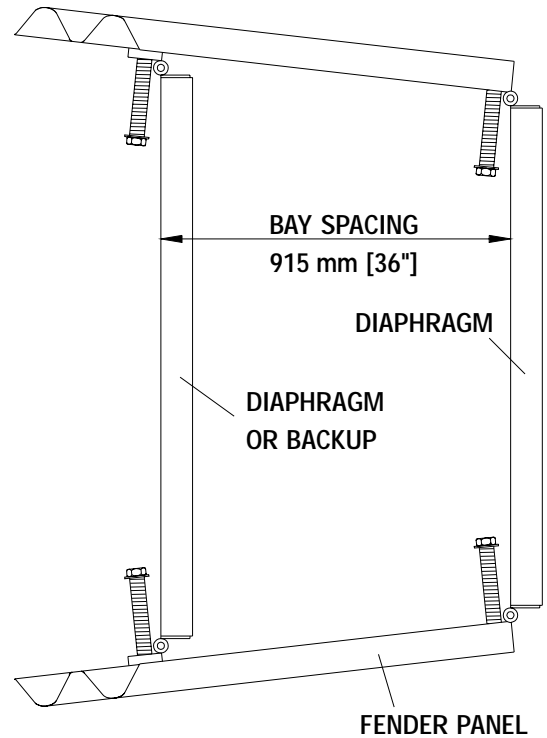


Figure 37

*Proper spacing between bays
(Wide System shown)*

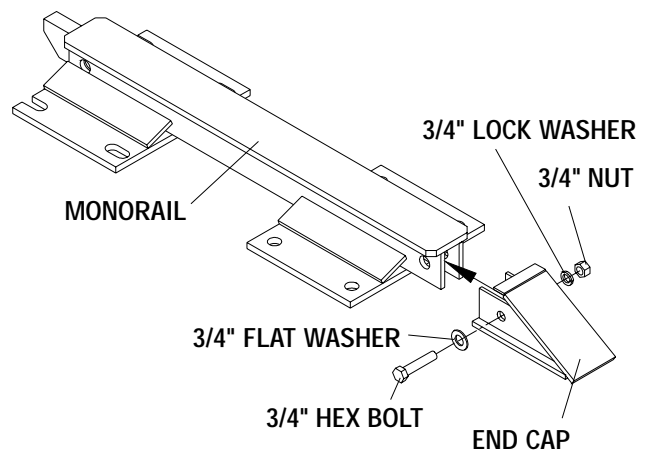


Figure 38

End cap assembly

13) Install Cartridge Support Brackets

Note:
610 mm [24] wide Systems do not have side support brackets.

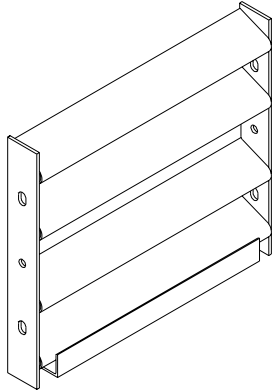


Figure 39

610 mm [24] wide Diaphragm

760 mm [30"] and 915 mm [36"] wide Systems have side support brackets welded to the diaphragms.

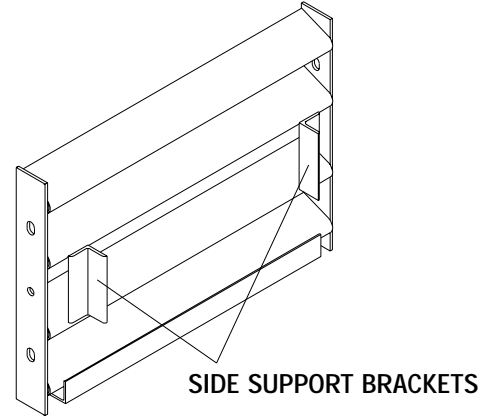


Figure 40

760 mm [30"] and 915 mm [36"] wide Diaphragm

Attach cartridge support bracket to backup and all diaphragms that support cartridges as shown in figures 41 through 44, and the diaphragm assembly drawing.

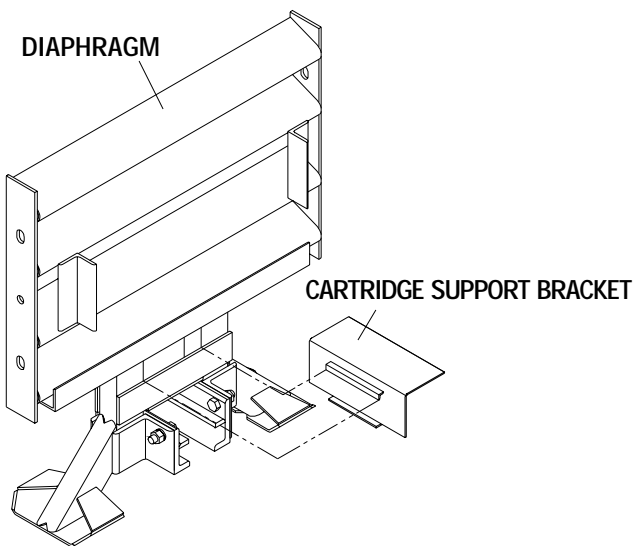


Figure 41

Cartridge Support Bracket Attachment

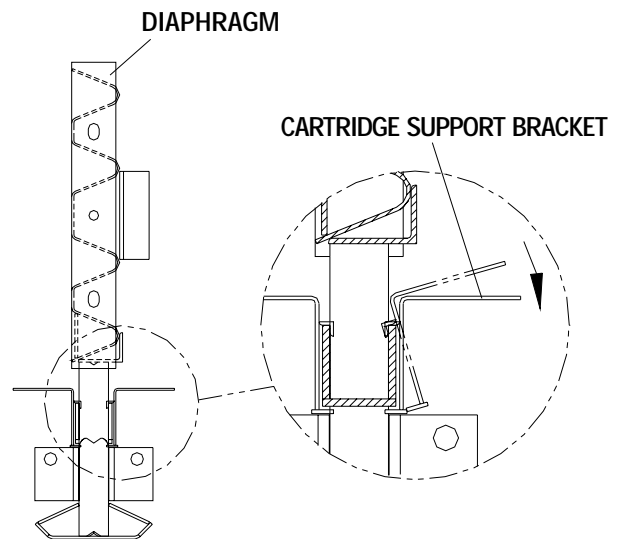


Figure 42

Cartridge Support Bracket Attachment
(Side View)

Installation (cont'd.)

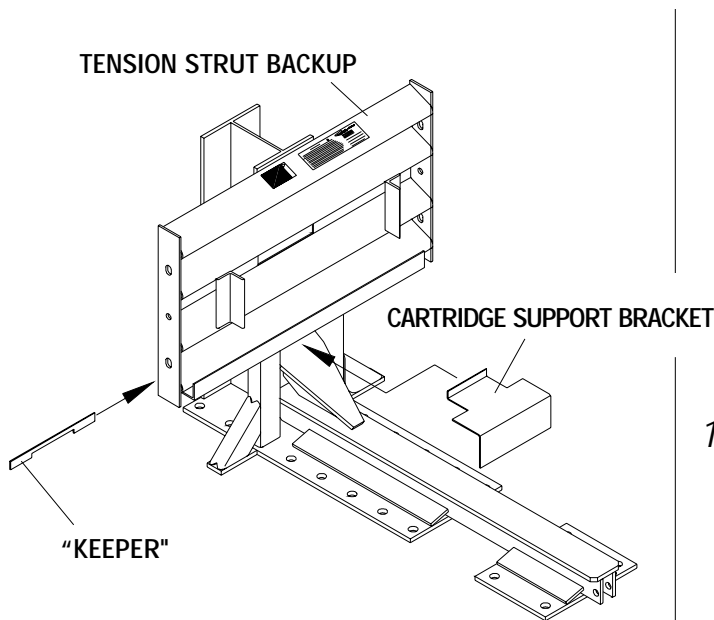


Figure 43

Cartridge Support Bracket Attachment to Tension Strut Backup

14) Install Nose

Attach the nose belt to the fender panels using six 5/8" x 5" long hex bolts, twenty 5/8" flat washers, and eighteen 5/8" hex nuts, through the belt clamps as shown in figures 45 and 46, and the nose assembly drawing.

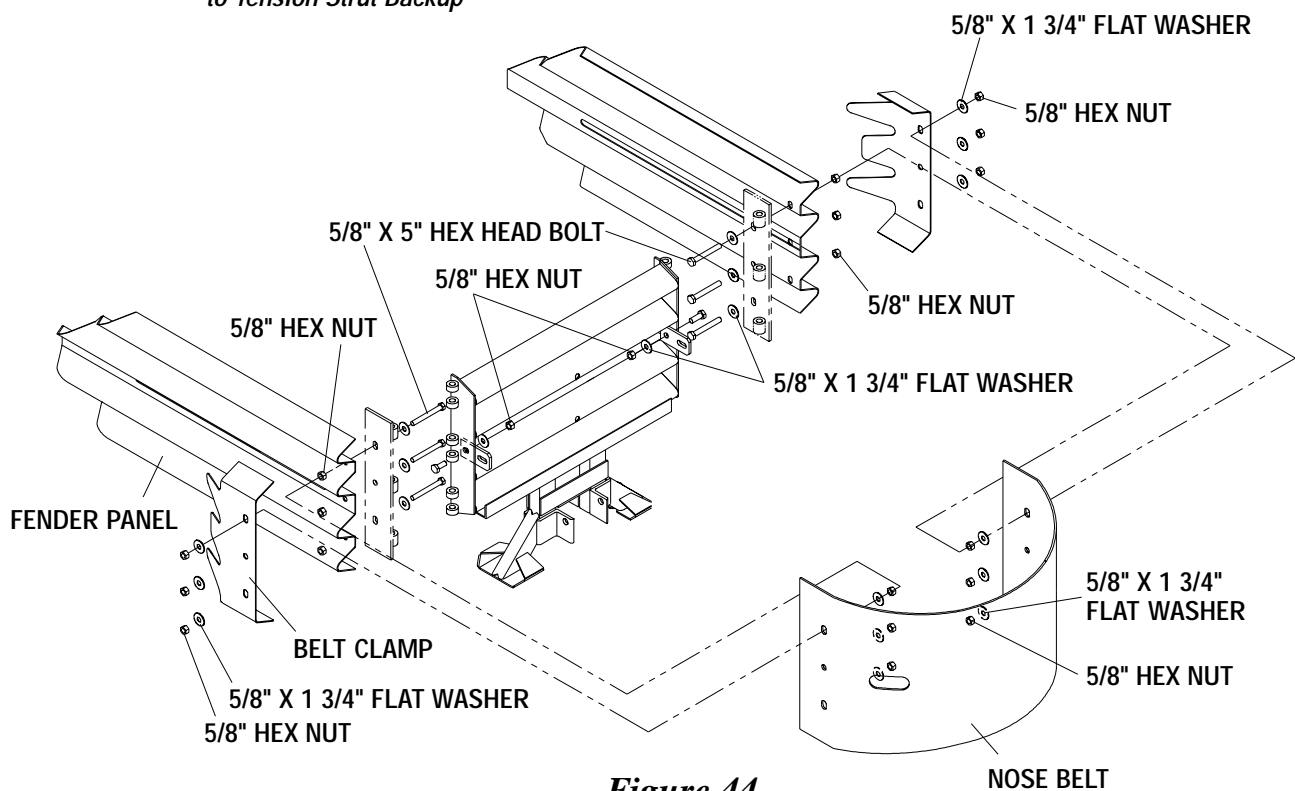


Figure 44

Attach Nose Belt to Fender Panels

Install the flat washers so that they are flush with the outside humps of the fender panels as shown in figure 45.

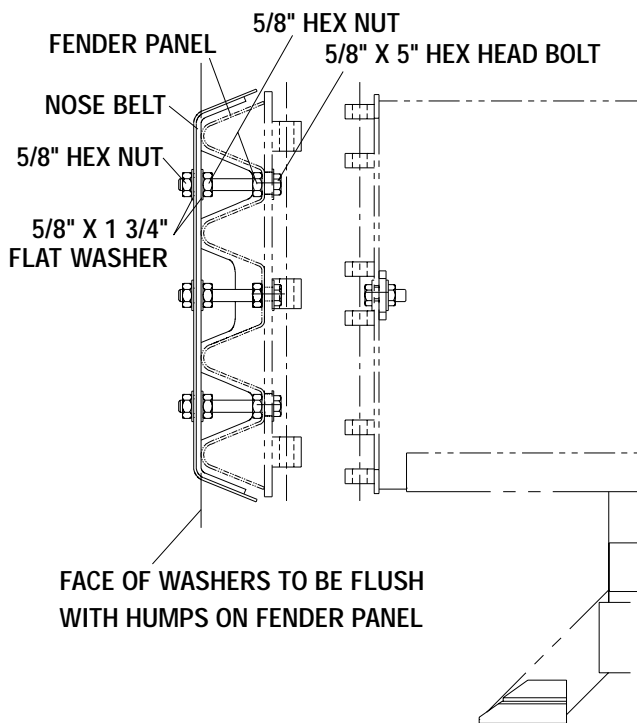


Figure 45

15) *Checking The System Assembly*

At this point recheck to ensure that all fasteners are properly tightened throughout the System (anchor bolts, etc.). See table A. Check all Fender Panels. If they do not fit tightly against the underlying panel, System realignment may be necessary. See figure 30 for narrow systems and figure 33 for wide systems.

WARNING!

Anchor Studs....	Torqued to 165 Nm [120 ft-lbs] Should NOT protrude above nuts (see figure 14)
All Other Bolts...	Tightened
Fender Panel.....	Maximum gap allowed: Narrow - 20 mm [0.78"] Wide - 25 mm [1.00"]

Installation (cont'd.)

16) Cartridge Installation

To complete the assembly of a QuadGuard CEN, place a type E Cartridge in each bay except the front two bays (see figures 46 and 47).

WARNING!

Placing cartridges in the nose or first & second bays may result in unacceptable crash performance as described in European Standard EN 1317:2000.

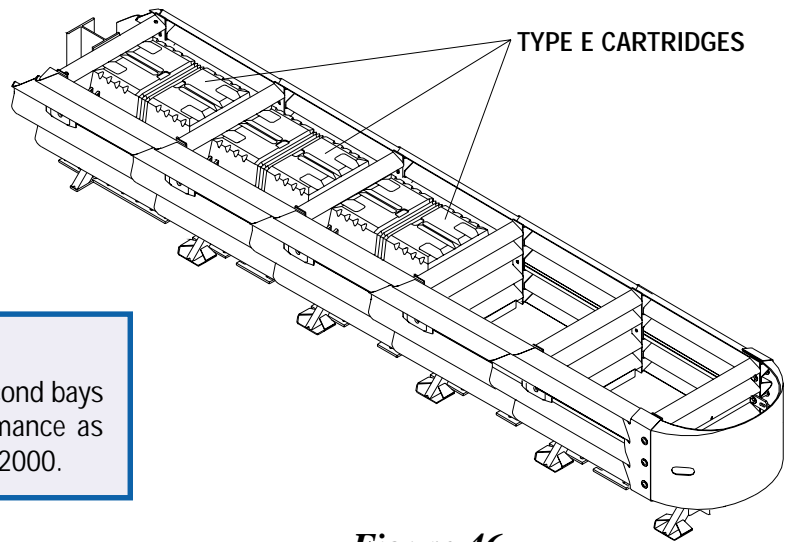


Figure 46

*Completed QuadGuard CEN for Narrow Hazards
(5 Bay System Shown)*

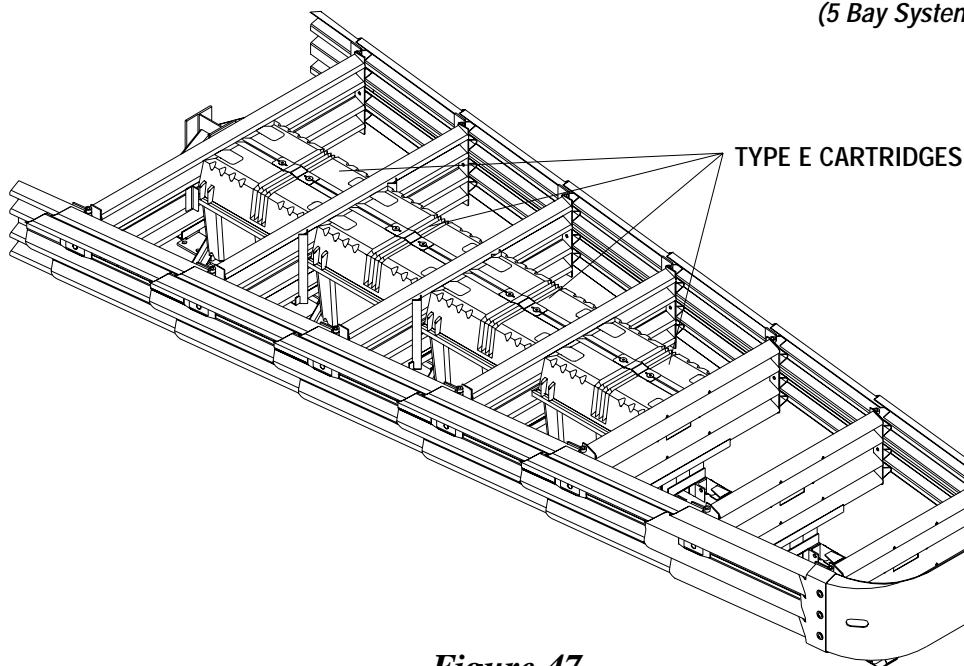


Figure 47

*Completed QuadGuard CEN for Wide Hazards
(6 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 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.

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.

1) Prepare the concrete pad

The anchor bolts (Studs) that anchor the QuadGuard[®] CEN 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

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

3/4" Dia. Stud length	Concrete bit size	Minimum Depth	Recommended Torque
6 1/2"	22 mm [7/8"]	125 mm [5"]	165 Nm [120 ft-lbs]
7"			
7 1/2"	22 mm [7/8"]	140 mm [5 1/2"]	165 Nm [120 ft-lbs]
8 1/2"			
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.

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).

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		No	With
(C)	(F)	Promoter	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.

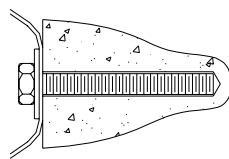
4) **Add the washers and nuts**

Put washer and nut on stud leaving nut flush with end of stud. See figure 48.

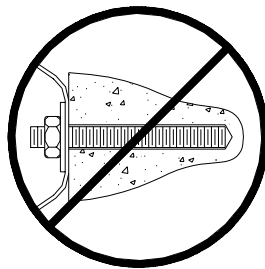
5) **Insert Studs into holes**

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. Torque to 165 Nm [120 ft-lbs.].



CORRECT



INCORRECT

Figure 48

MP-3 Horizontal Installation

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.

Maintenance and Repair

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

Estimated time for Maintenance

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

Life Expectancy

Environment

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

Impacts

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

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

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

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

Recycling Information

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

Steel should be sold as scrap to a local metal recycler.

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

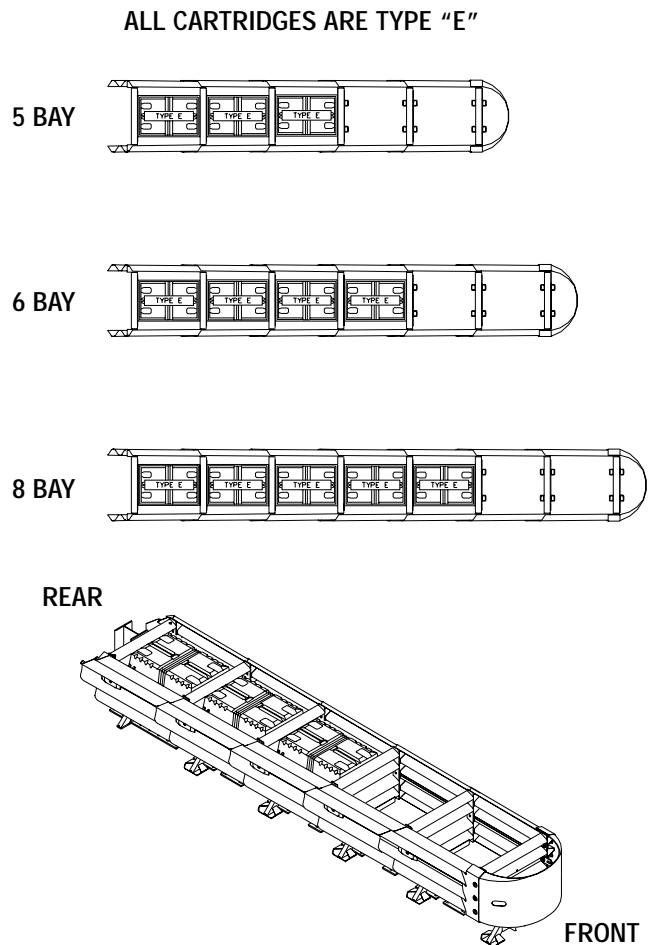


Figure 49

Typical Cartridge Placement

Caution: Placing cartridges in the nose or first & second bays may result in unacceptable crash performance as described in European Standard EN 1317:2000.

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.

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.

Caution:

Refer to cartridge placement, figure 49.

- 3) Be sure the nose belt is in place.
- 4) Note the location and condition of the QuadGuard CEN 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. The maximum gap allowed for narrow systems is 20 mm [0.78"] (see figure 30). For wide systems, the maximum gap allowed is 25 mm [1.0"] (see figure 36).

- 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.

Caution:

Refer to cartridge placement, figure 49.

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

Maintenance and Repair (cont'd)

Post-Impact Instructions

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.

If the System is anchored to asphalt, it should be relocated to fresh, undisturbed asphalt after each impact to insure adequate future impact performance. The 460 mm [18"] threaded rods should then be installed.

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 fashion 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.
6. Attach 10 mm [3/8"] grade 40 chain to pullout brackets on first diaphragm (see figure 50). Attach both ends of chain to a heavy vehicle (such as a 1 ton pickup).

WARNING!

Stand clear in case the chain breaks or becomes disconnected.

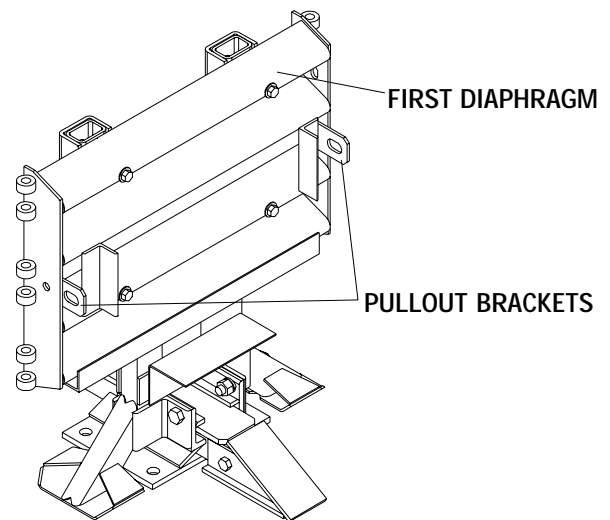


Figure 50

*Pullout Bracket Locations
(Nose belt not shown for clarity)*

Pull the QuadGuard CEN 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. Frequently, 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 51.

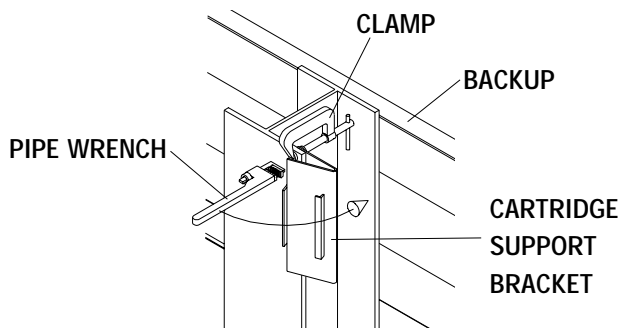


Figure 51

Straighten Cartridge Support Bracket

WARNING!

Anchor Studs.... Torqued to 165 Nm [120 ft-lbs]
Should NOT protrude above nuts
(see figure 14)

All Other Bolts... Tightened

Fender Panel..... Maximum gap allowed:
Narrow - 20 mm [0.78"]
Wide - 25 mm [1.0"]

- 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 52).

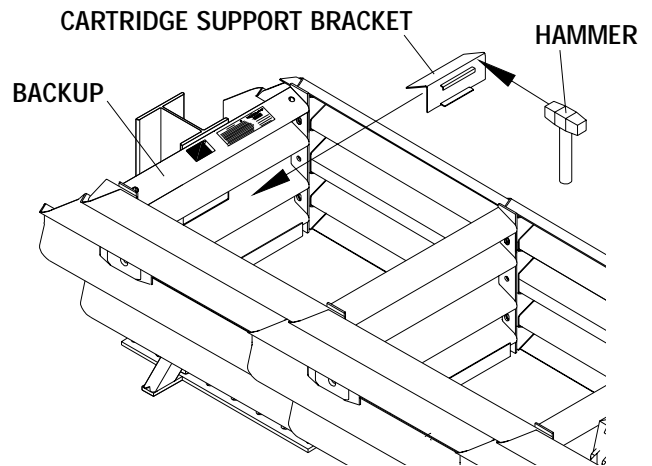


Figure 52

Form Cartridge Support Bracket

10. Check gaps between fender panels. On the bidirectional side of the System, the maximum gap allowed for these overlapping parts (including fender panels overlapping panels behind the System) is 20 mm [0.78"] for narrow systems (see figure 30). For wide systems, the maximum gap allowed is 25 mm [1.0"] (see figure 33).

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.

11. Replace all crushed cartridges. Refer to figures 46, 47 and 49 for proper cartridge placement.
12. Check the torque of all bolts on the System (see table on this page for torque specifications).
13. Check to be certain that the site is free from any debris. The QuadGuard CEN is once again ready for use.

Maintenance and Repair (cont'd)

Parts Ordering Procedure

Make a list of all damaged parts using part descriptions shown in figure 53 or 54.

Circle the appropriate System attributes below. This information is necessary to receive the proper parts.

System width: 610 mm [24"], 760 mm [30"], 915 mm [36"], 1755 mm [69"], 2285 mm [90"]

Backup type: Tension strut, Concrete

Transition panel(s) on which side? Left, Right, Both, None

Transitioning to: W-beam guardrail, Thrie beam guardrail, Safety shape barrier, Vertical face wall

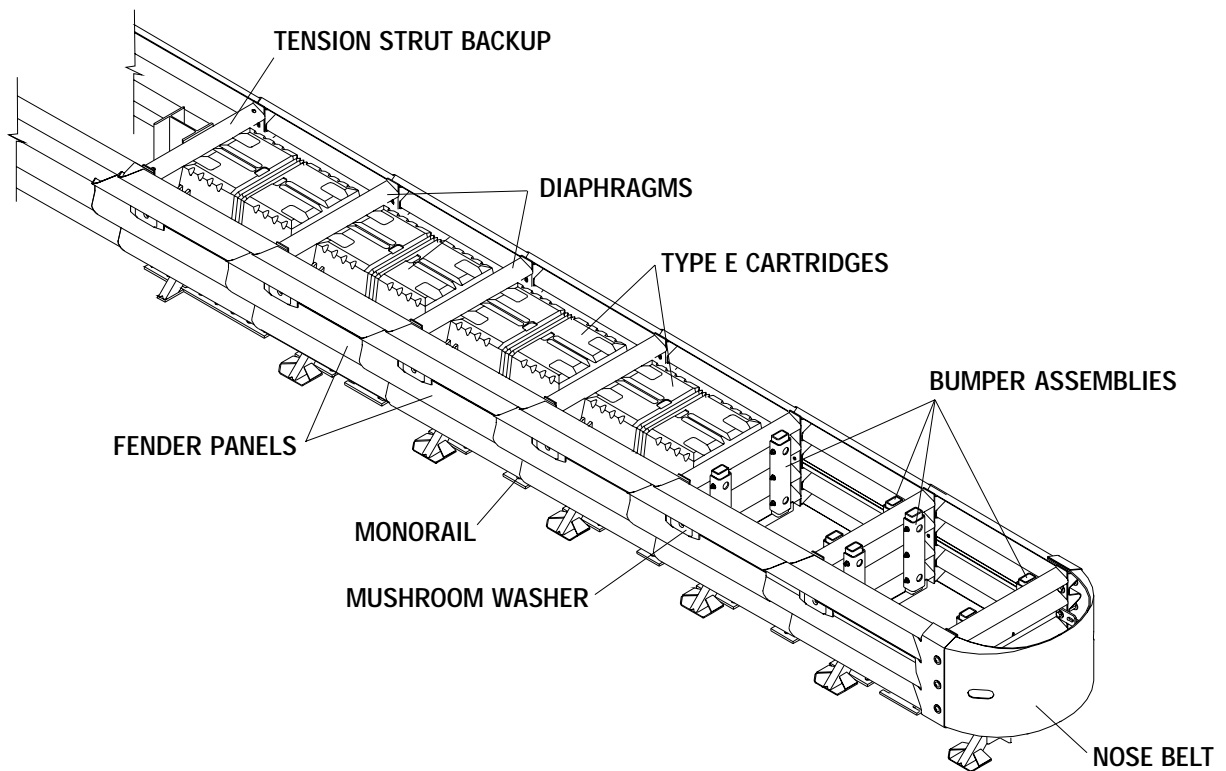


Figure 53

QuadGuard® CEN Components (for narrow hazards)

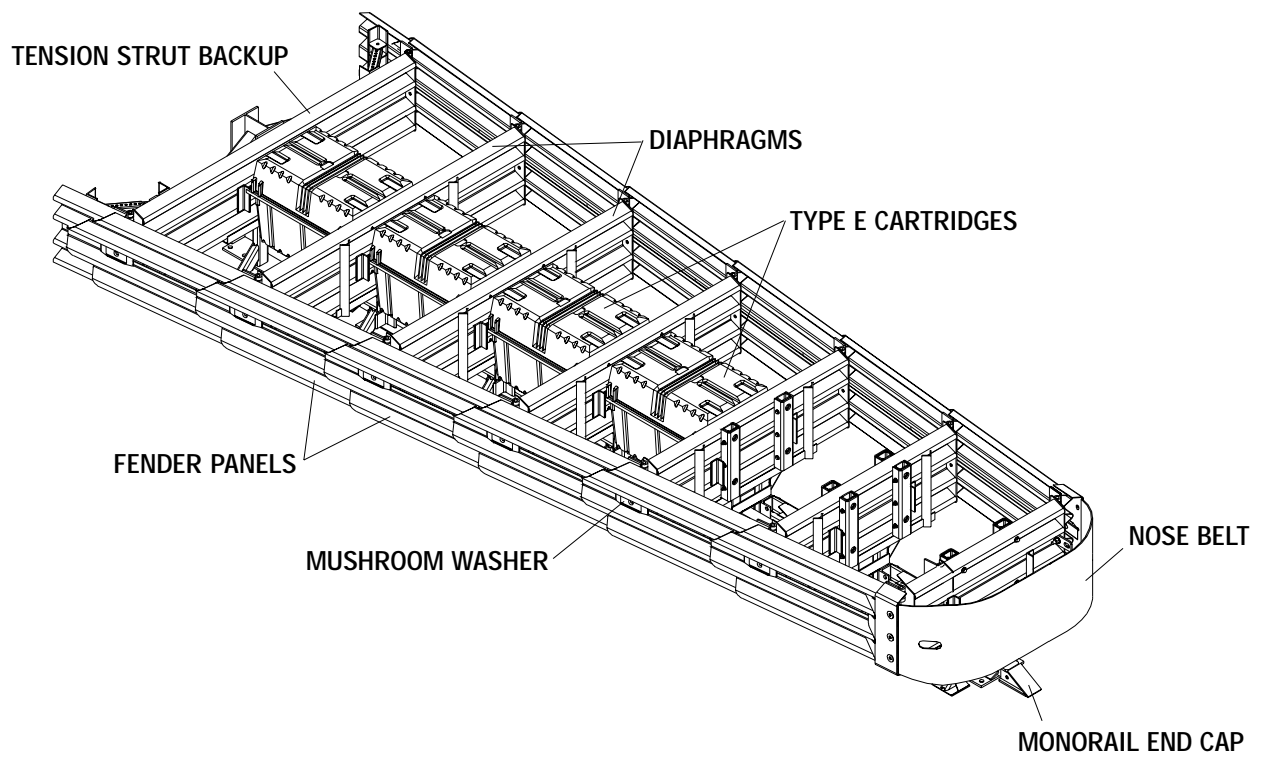


Figure 54
QuadGuard® CEN Components (for wide hazards)

Limitations and Warnings

The QuadGuard CEN has been tested and evaluated in accordance with European Standard EN 1317:2000. The impact conditions tested are intended to represent a wide range of in-service impact conditions, but do not encompass all possible in-service impact conditions.

The following full-scale crash tests have been conducted on the QuadGuard CEN, and in each test all evaluation criteria specified in European Standard EN 1317:2000 were met. Properly installed and maintained, the QuadGuard CEN is capable of performing its functions of stopping or containing and redirecting impacting vehicles in accordance with European Standard EN 1317:2000 for the impact conditions listed in table C.

PERFORMANCE LEVEL	TEST NO.	VEHICLE MASS (KG)	IMPACT SPEED (KM/H)	IMPACT ANGLE & IMPACT POINT
110	Parent model at minimum taper/width -QI2408Y			
	TC 1.1.100	900	100	0 deg. head-on, centre
	TC 1.3.110	1500	110	0 deg. head-on, centre
	TC 2.1.100	900	100	0 deg. 1/4 vehicle offset
	TC 3.3.110	1500	110	15 deg. nose, (centre)
	TC 4.3.110	1500	110	15 deg. redirect at L/3
	TC 5.3.110	1500	110	165 deg. redirect at L/2
	Maximum taper/width model-QI9008Y			
	TC 1.1.100	900	100	0 deg. head-on, centre
	TC 4.3.110	1500	110	15 deg. redirect at L/3
100	Minimum taper/width model-QI2406Y			
	TC 1.2.100	1300	100	0 deg. head-on, centre
	Maximum taper/width model-QI9006Y			
	TC 4.2.100	1300	100	15 deg. redirect at L/3
80	Minimum taper/width model-QI2405Y			
	TC 1.2.80	1300	80	0 deg. head-on, centre
	Maximum taper/width model-QI9005Y			
	TC 4.2.80	1300	80	15 deg. redirect at L/3

Table C

Summary of QuadGuard CEN tests

Impact conditions which differ from those described in European Standard EN 1317:2000 may yield results different from those encountered in testing. In particular, impact conditions in excess of specified impact severity, or existence at the site of curbs or cross slopes in excess of 8%, may yield impact performance which does not meet the evaluation criteria of European Standard EN 1317:2000.

Notes

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