

QuadGuard® II

Assembly Manual



TRINITY
HIGHWAY

Ahead of the Curve™

QuadGuard® II

Assembly Manual



2525 Stemmons Freeway
Dallas, Texas 75207



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

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

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

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Customer Service Contacts

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

Energy Absorption Systems, Inc. dba Trinity Highway

Telephone:	(888) 323-6374 (USA) (312) 467-6750 (International)
E-mail:	product.info@trin.net
Website:	www.trinityhighway.com

Important Introductory Notes

Proper assembly of the QuadGuard® II system is critical to achieve performance that has been evaluated and accepted by the Federal Highway Administration (FHWA) per NCHRP Report 350. These instructions should be read in their entirety and understood before assembling QuadGuard® II system. These instructions are to be used only in conjunction with the assembly of QuadGuard® II system and are for standard assemblies only as specified by the applicable highway authority. If you need additional information, or have questions about the QuadGuard® II system, please contact the highway authority that has planned and specified this assembly and, if needed, contact Trinity Highway's Customer Service Department. This product must be assembled in the location specified by the appropriate highway authority. If there are deviations, alterations, or departures from the assembly protocol specified in this Manual, the device may not perform as it was tested and accepted.

This system, like other Trinity Highway systems, has been crash tested pursuant to NCHRP Report 350 mandated criteria



Important: DO NOT use any component part that has not been specifically crash tested and/or approved for this system during the assembly or repair of this system.

This product has been specified for use by the appropriate highway authority and has been provided to that user who has unique knowledge of how this system is to be assembled. No person should be permitted to assist in the assembly, maintenance, or repair of this system that does not possess the unique knowledge described above. These instructions are intended for an individual qualified to both read and accurately interpret them as written. These instructions are intended only for an individual experienced and skilled in the assembly of highway products that are specified and selected by the highway authority.

A manufacturer's drawing package will be supplied by Trinity Highway upon request. Each system will be supplied with a specific drawing package unique to that system. Such drawings take precedence over information in this Manual and shall be studied thoroughly by a qualified individual who is skilled in interpreting them before the start of any product assembly.



Important: Read safety instructions thoroughly and follow the assembly directions and suggested safe practices before assembling, maintaining, or repairing the QuadGuard® II system. Failure to follow this warning can result in serious injury or death to workers and/or bystanders. It further compromises the acceptance of this system by the FHWA. Please keep up-to-date instructions for later use and reference by anyone involved in the assembly of the product.



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

Safety Rules for Assembly

*** Important Safety Instructions ***

This Manual must be kept in a location where it is readily available to persons who are skilled and experienced in the assembly, maintenance, or repair of the QuadGuard® II system. Additional copies of this Manual are immediately available from Trinity Highway by calling (888) 323-6374 or by email at product.info@trin.net. Please contact Trinity Highway if you have any questions concerning the information in this Manual or about the QuadGuard® II system. This Manual may also be downloaded directly from the website listed below.

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

Safety measures incorporating traffic control devices specified by the highway authority must be used to provide safety for personnel while at the assembly, maintenance, or repair site.

Safety Symbols

This section describes the safety symbols that appear in this QuadGuard® II Manual. Read the Manual for complete safety, assembly, operating, maintenance, repair, and service information.

Symbol

Meaning



Safety Alert Symbol: Indicates Important, Caution, Warning, or Danger. Failure to read and follow the Important, Caution, Warning, or Danger indicators could result in serious injury or death to the workers and/or bystanders.

Warnings and Cautions

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



Danger: Failure to comply with these warnings could result in increased risk of serious injury or death in the event of a vehicle impact with a system that has not been accepted by the Federal Highway Administration (FHWA).



Warning: Do not assemble, maintain, or repair the QuadGuard® II system until you have read this Manual thoroughly and completely understand it. Ensure that all Danger, Warning, Caution, and Important statements within the Manual are completely followed. Please call Trinity Highway at (888) 323-6374 if you do not understand these instructions.



Warning: Safety measures incorporating appropriate traffic control devices specified by the highway authority must be used to protect all personnel while at the assembly, maintenance, or repair site.



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



Warning: Do NOT modify the QuadGuard® II system in any way.



Warning: Ensure that the QuadGuard® II system and delineation used meet all federal, state, specifying agency, and local specifications.



Warning: Ensure that your assembly meets all appropriate Manual on Uniform Traffic Control Devices (MUTCD) and local standards.



Warning: Ensure that there is proper site grading for the QuadGuard® II system placement as dictated by the state or specifying agency, pursuant to Federal Highway Administration (FHWA) acceptance.



Warning: Use only Trinity Highway parts on the QuadGuard® II system for assembly, maintenance, or repair. **The assembly or comingling of unauthorized parts is strictly PROHIBITED.** The QuadGuard® II and its component parts have been accepted for state use by the FHWA. However, a comingled system has not been accepted within the applicable criteria.



Important: Trinity Highway makes no recommendation whether use or reuse of any part of the system is appropriate or acceptable following an impact. It is the sole responsibility of the local highway authority and its engineers to make that determination. It is critical that you inspect this product after assembly is complete to make certain that the instructions provided in this Manual have been strictly followed.



Warning: Ensure that this assembly conforms with the guidance provided by the AASHTO Roadside Design Guide, including, but not limited to, those regarding placement on or adjacent to curbs.

Limitations and Warnings

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

The QuadGuard® II system has been approved by FHWA as meeting the requirements and guidelines of NCHRP Report 350. These tests typically evaluate product performance defined by Report 350 involving a range of vehicles on roadways, from lightweight cars (approx. 820 kg [1800 lb.]) to full size pickup trucks (approx. 2000 kg [4400 lb.]). A product can be certified for multiple Test Levels. The QuadGuard® II is certified to the Test Level(s) as shown below:

Test Level 2: 70 km/h [43 mph]

Test Level 3: 100 km/h [62 mph]

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

Trinity Highway neither represents nor warrants that the impact results of these federally established test criteria prevent or reduce the severity of any injury to person(s) or damage to property. These tests only demonstrate the occurrence of certain results following an impact within NCHRP Report 350 criteria. Every departure from the roadway is a unique event.

The QuadGuard® II system is intended to be assembled, delineated, and maintained within specific state and federal guidelines. It is important for the highway authority specifying the use of a highway product to select the most appropriate product configuration for its site specifications. The customer should be careful to properly select, assemble, and maintain the product. Careful evaluation of the site lay out, vehicle population type; speed, traffic direction, and visibility are some of the elements that require evaluation in the selection of a highway product. For example, curbs could cause an untested effect on an impacting vehicle.

After an impact occurs, the debris from the impact should be removed from the area immediately and the specified highway product should be evaluated and restored to its original specified condition or replaced as the highway authority determines as soon as possible.

System Overview

The QuadGuard® II is a potentially reusable, re-directive, non-gating crash cushion for roadside obstacles ranging in width from 610 mm to 3200 mm (24" to 126"). It consists of energy-absorbing cartridges surrounded by a framework of Quad-Beam™ Panels. Again, the decision as to whether this product is reusable after impact rests within the sound discretion of the trained engineer, experienced in highway products, who is working at the direction of the local DOT, or appropriate highway authority, which specified and now owns the product.

The QuadGuard® II system utilizes two types of cartridges in a “staged” configuration to address both lighter cars and heavier, high center-of-gravity vehicles. Its modular design allows the system length to be tailored to the design speed of a site. See the QuadGuard® II Product Manual to determine the appropriate number of Bays for a given speed.

Impact Performance

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

During head-on impact testing, within NCHRP Report 350 criteria, the QuadGuard® II has been shown to telescope rearward to absorb the energy of impact. When impacted from the side, within the applicable NCHRP 350 criteria, it has been shown to redirect the vehicle back toward its original travel path and away from the roadside obstacle.

QuadGuard® II Foundation/Anchoring

Concrete Installations

For concrete installations, the QuadGuard® II system should be installed only on an existing or freshly placed and cured concrete base (28 MPa [4000 psi] minimum). Orientation of the concrete base and the attenuator must comply with the project plans or as otherwise determined by the resident project engineer or appropriate highway authority.

Recommended dimension and reinforcement specifications for new concrete pads can be found on the standard drawings.

Asphalt Installations

For asphalt installations in construction zones, QuadGuard® II system may only be assembled with a Tension-Strut Backup. Assemblies on asphalt must provide a minimum of 76 mm [3"] layer of asphalt over a minimum of 76 mm [3"] layer of Portland Cement concrete, 152 mm [6"] layer of asphalt over 152 mm [6"] layer of subbase, or 203 mm [8"] layer of asphalt with no subbase. 460 mm [18"] threaded rods, installed with the two-part MP-3® grout, must be used for these foundations.



Important: Systems mounted on asphalt must be replaced and mounted on fresh, undisturbed asphalt if more than 10% of anchors are found to be loose, broken, or show signs of pull out. If 10% or fewer anchors are damaged, replace the damaged anchors in the existing asphalt. Anchor bolts used on systems mounted on asphalt must be inspected every 6 months. See Post Impact Instructions and Maintenance and Repair instructions in the QuadGuard® II Assembly Manual for details.

The QuadGuard® II system may be installed on any of the following foundations using the specified anchorage:

Foundation A: Concrete Pad or Roadway

Foundation: 150 mm [6"] minimum depth Portland Cement Concrete (P.C.C.)

Anchorage: MP-3® with 180 mm [7"] studs 140 mm [5 1/2"] embedment

Foundation B: Asphalt over P.C.C.

Foundation: 76 mm [3"] minimum asphalt concrete (A.C.) over 76 mm [3"] minimum P.C.C.

Anchorage: Length of anchor required is 460 mm [18"] 420 mm [16 1/2"] embedment

Foundation C: Asphalt over Subbase

Foundation: 150 mm [6"] minimum A.C. over 150 mm [6"] minimum Compacted Subbase (C.S.)

Anchorage: MP-3® with 460 mm [18"] studs 420 mm [16 1/2"] embedment

Foundation D: Asphalt Only

Foundation: 200 mm [8"] minimum A.C.

Anchorage: MP-3® with 460 mm [18"] studs - 420 mm [16 1/2"] embedment

Foundation Specifications

For Foundations A, B, C and D mentioned above:

A. C. (Asphalt Concrete)

AR-4000 A. C. (per ASTM D3381 '83) 3/4" Maximum, Medium (Type A or B) aggregate

Sieve Size	Operating Range (%) Passing
1"	100
3/4"	95-100
3/8"	65-80
No. 4	49-54
No. 8	36-40
No. 30	18-21
No. 200	3-8



Caution: Walk-up inspections are recommended at least once every six months for installations on asphalt.

P.C.C. (Portland Cement Concrete)

Stone aggregate concrete mix

4000 psi minimum compressive strength

(Sampling per ASTM C31-84 or ASTM C42-84a, testing per ASTM C39-84)

C.S. (Compacted Subbase)

150 mm [6"] minimum depth 95% compaction

Class 2 aggregate

Sieve Size	Moving Average % Passing
3"	100
2 1/2"	90-100
No. 4	40-90
No. 200	0-25

Recommended Tools

Documentation

- Manufacturer's Assembly Manual
- Manufacturer's Drawing Package

Cutting equipment

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

* Trinity Highway recommends using double-fluted drill bits to achieve optimum tensile strength when applying the MP-3[®] anchoring system.

Hammers

- Sledgehammer
- Standard hammer

Wrenches

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

Personal Protective equipment

- Safety Glasses
- Gloves
- Safety-toe shoes
- Apron for MP-3[®] application

Miscellaneous

- Traffic control equipment
- Lifting and moving equipment (A lifting device is preferred although a forklift can be used.) Minimum 5,000 lb. capacity required.
- Air Compressor (100 psi minimum) and Generator (5 kW)
- Long pry bar
- Drift pin 300 mm [12"]
- Center punch
- Tape measure 7.5 m [25']
- Chalk line
- Concrete marking pencil
- Nylon bottle brush for cleaning 7/8" drilled holes
- Rags, water, and solvent for touch-up

Note: The above list of tools is a general recommendation. Depending on specific site conditions and the complexity of the assembly specified by the appropriate highway authority, additional or fewer tools may be required. Decisions as to what tools are needed to perform the job are entirely within the discretion of the specifying highway authority and the authority's selected contractor performing the assembly of the system at the authority's specified site.

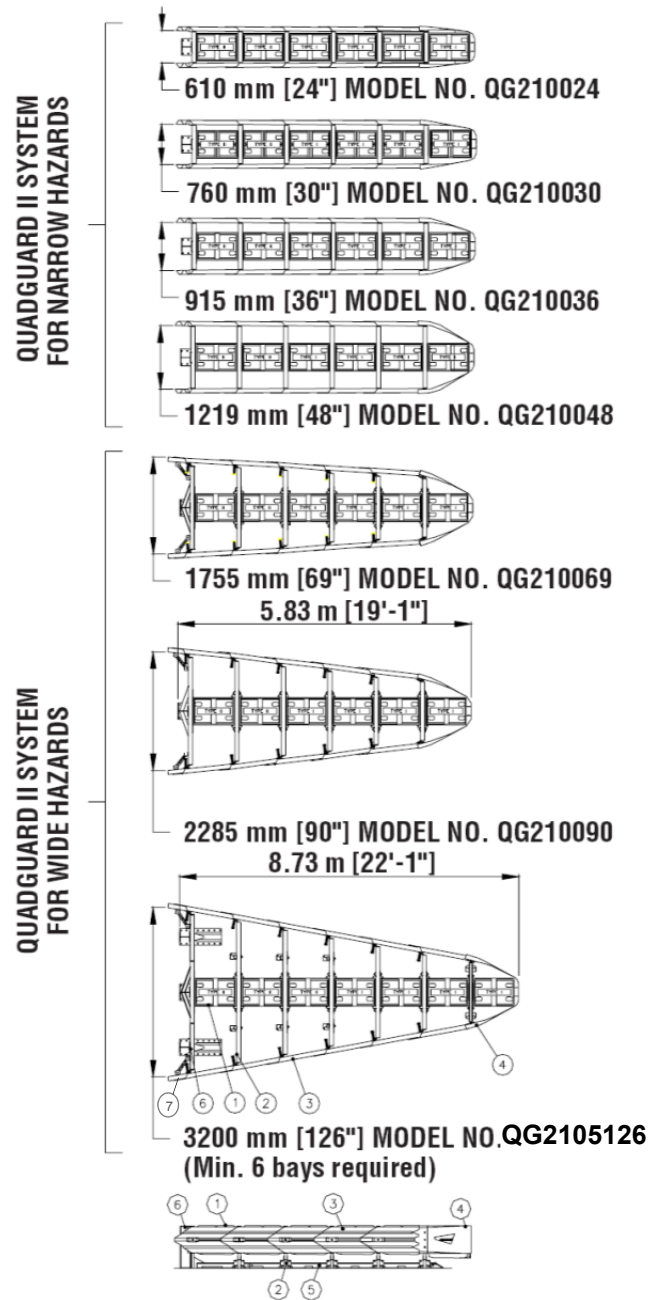


Figure 1 Plans & Elevation
(Five Bay systems with Tension Strut Backups shown, except as noted)

Key

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

How to Determine Left/Right

To determine left from right when ordering parts, stand in front of the system facing the roadside feature. Your left is the system's left and your right is the system's right.

Counting the Number of Bays

One Bay consists of one Cartridge, one Diaphragm, two Fender Panels, etc. The Nose section is not considered a Bay, though there is a Cartridge in the Nose of each system. Note that this means there will always be one more Cartridge in the system than the number of Bays in the system. To determine number of Bays, count Fender Panels on one side (see Figure 2). The Five-Bay system is shown.

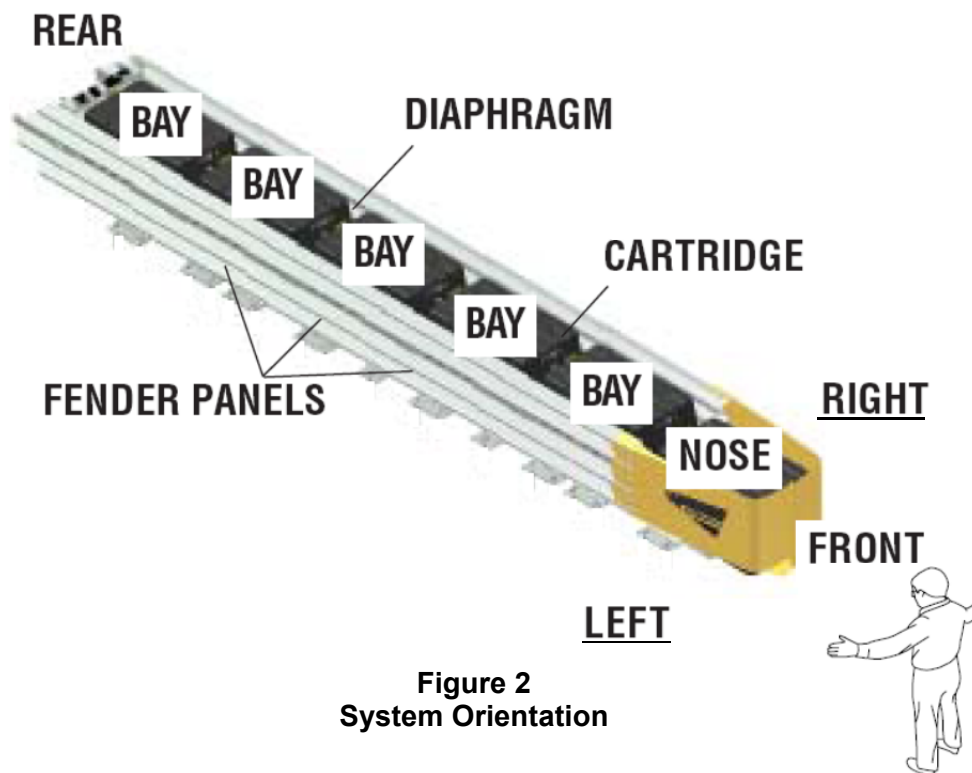


Figure 2
System Orientation

Measuring the Width

The QuadGuard® II system is available in seven nominal widths:

- 610 mm [24"]
 - 760 mm [30"]
 - 915 mm [36"]
 - 1219 mm [48"]
 - 1755 mm [69"]
 - 2285 mm [90"]
 - 3200 mm [126"]
- (Minimum 3 Bays Required)
- (Minimum 6 Bays Required)

The nominal width of a parallel system is the width of the diaphragm (see Figure 3).

The nominal width of a wide system is the width at the location shown in Figure 4.

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

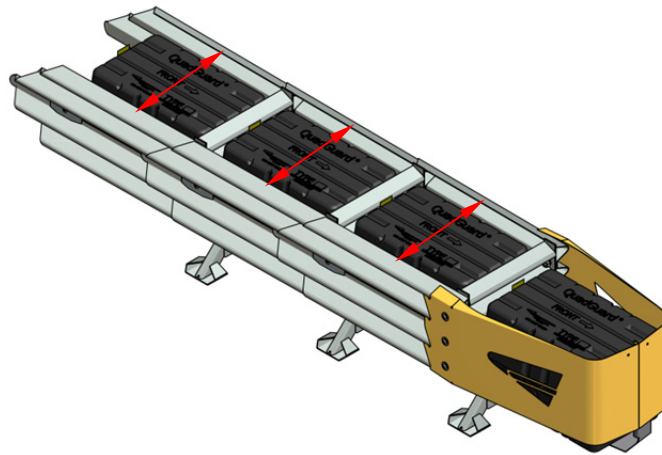


Figure 3
Width of Parallel system

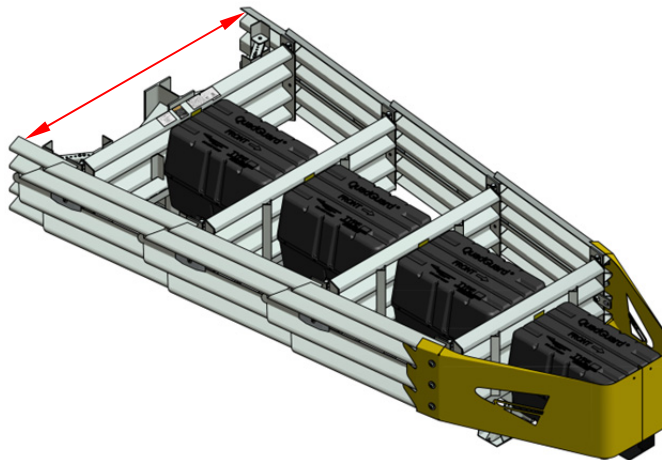


Figure 4
Width of Wide system

Narrow Systems

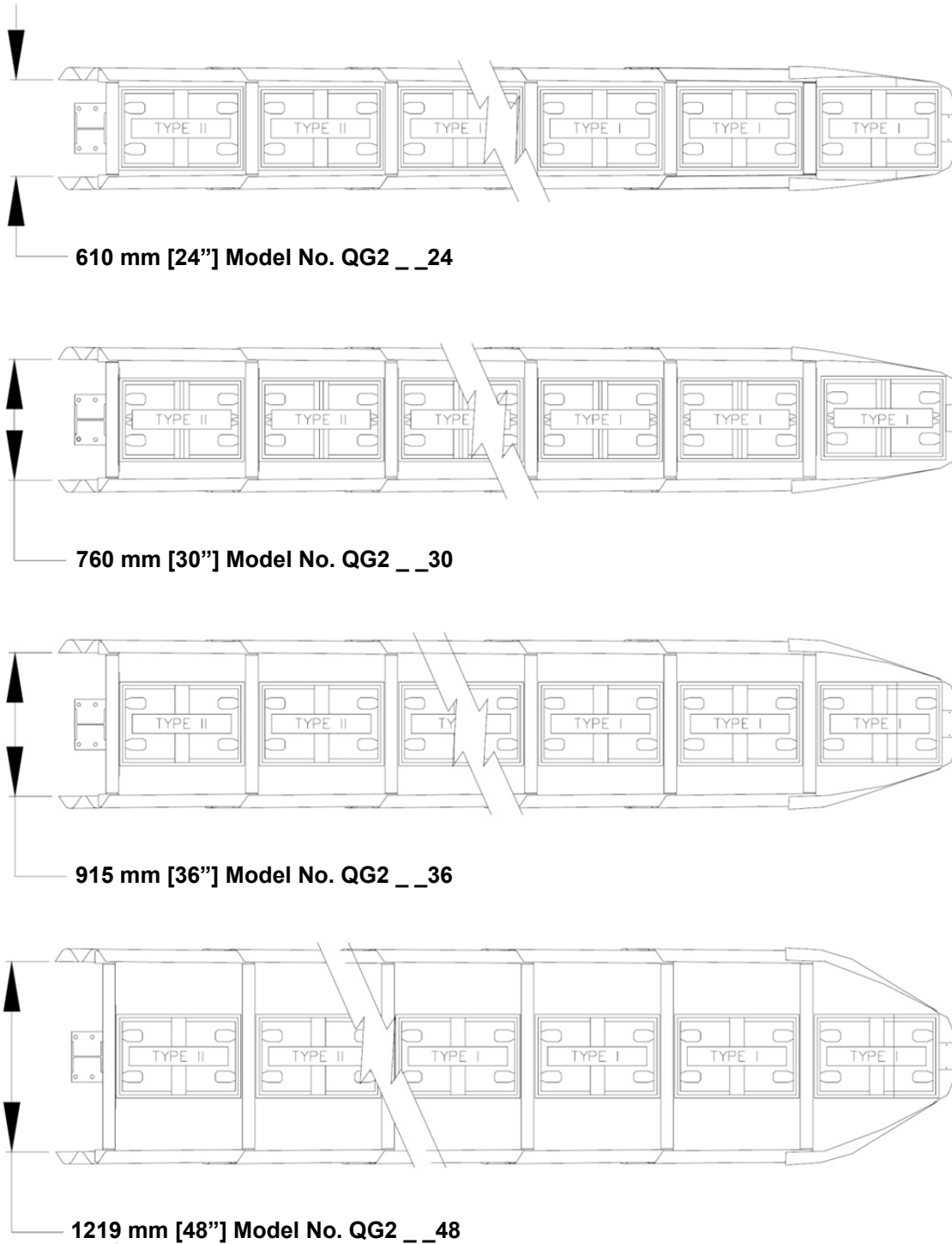


Figure 5
Narrow System and Model Numbers

Site Preparation/Foundation

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

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



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

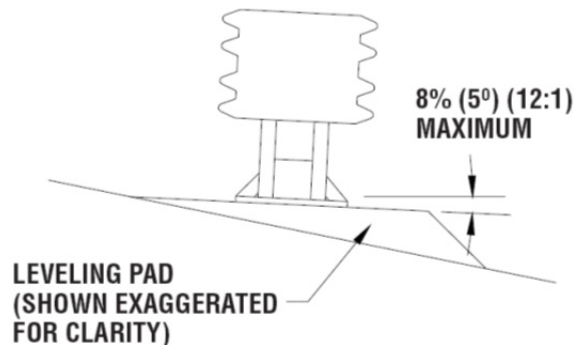


Figure 6
Cross-Slope



Warning: Location of the Backup in relation to nearby objects will affect the operation of the attenuator. Upon impact, the Fender Panels telescope rearward and extend beyond the rigid Backup as much as 876 mm [34.5"]. Position the Backup so that the rear ends of the last Fender Panels are a minimum of 760 mm [30"] forward of objects that would otherwise interfere with movement of the rearmost Fender Panels. Failure to comply with this requirement will result in impaired system performance offering motorists less protection and causing component damage.

Assembly

Inspect Shipping

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



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

1) Determine Backup & Transition Type

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

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

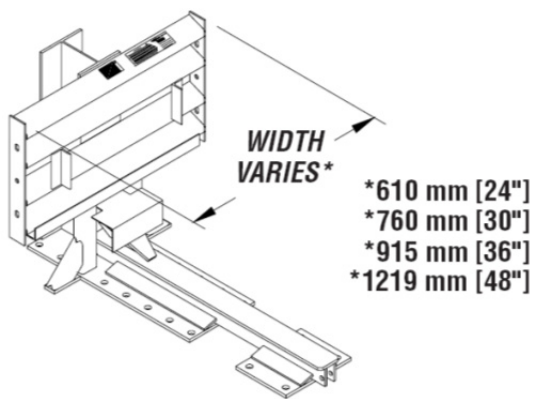


Figure 7
Tension Strut Backup

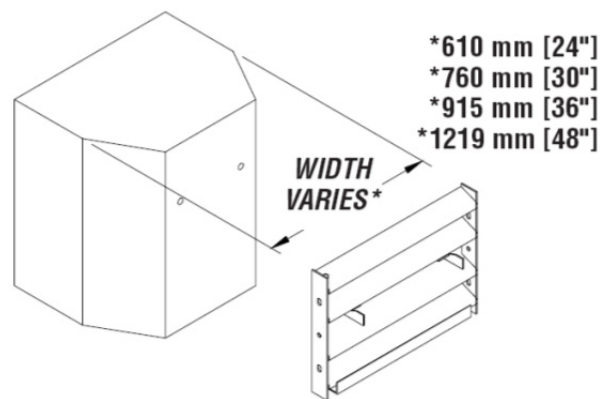


Figure 8
Concrete Backup

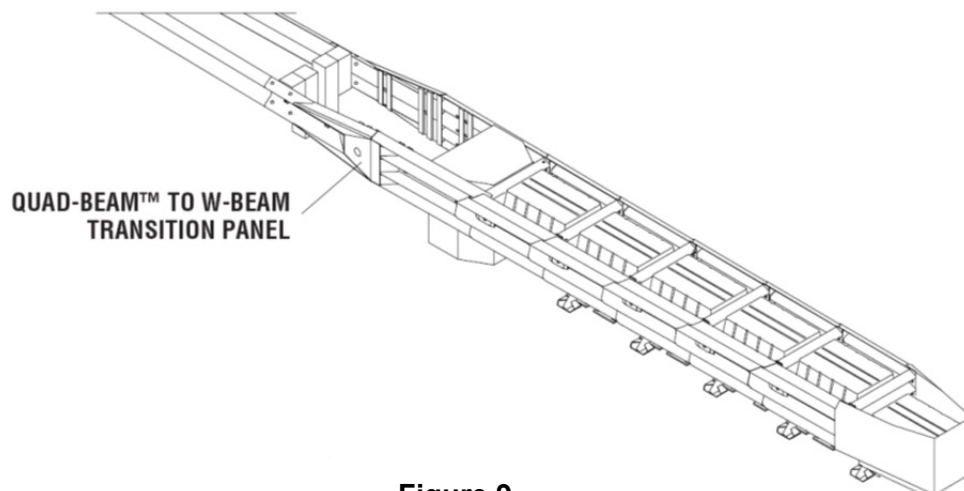


Figure 9
Transitioning the QuadGuard® II System

Transition Panel Types

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

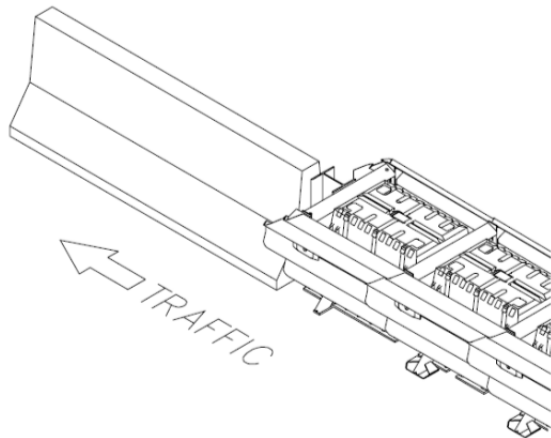


Figure 10
No Transition

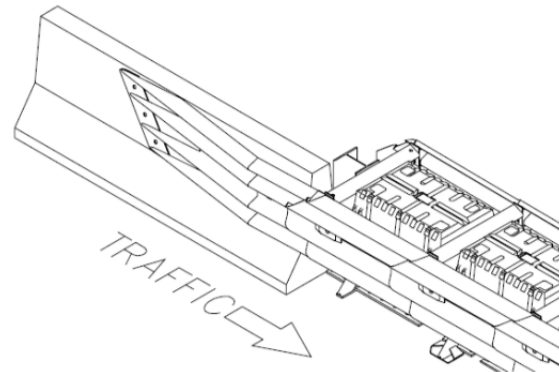


Figure 11
Quad-Beam™ to Safety Shape Barrier Transition Panel

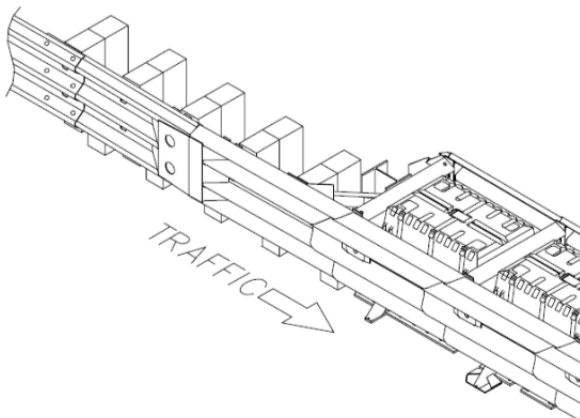


Figure 12
Quad-Beam™ to Thrie-Beam Transition Panel

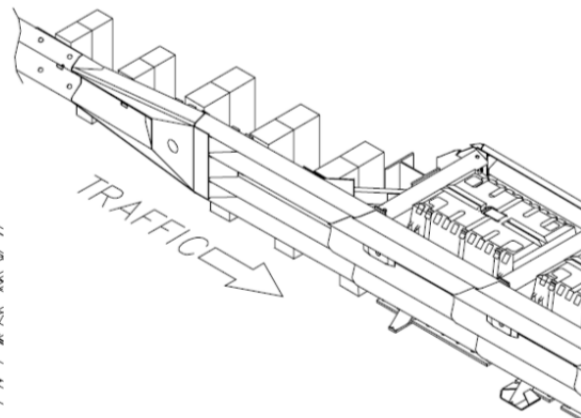


Figure 13
Quad-Beam™ to W-Beam Transition Panel

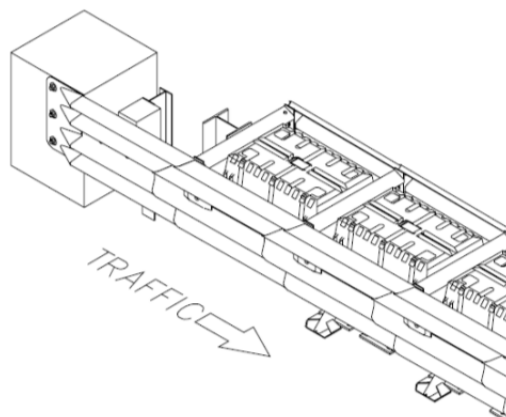


Figure 14
Quad-Beam™ End Shoe Transition Panel

2) Mark System Location

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

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



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



Figure 15
(Top view of concrete foundation)

3) Anchor the Backup

A) Concrete Backup Construction (Figure 16)

Locate Backup Face Plate using the Backup Assembly drawing. Verify that any applicable Transition Panels fit properly before anchoring the Face Plate. Drill anchor holes in the Concrete Backup using the Face Plate as a template. Anchor the Face Plate to the Concrete Backup using the MP-3[®] Anchoring system (horizontal kit) supplied with the QuadGuard[®] II system (See "MP-3[®] Polyester Anchoring System" section on p. 53).



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

B) Tension Strut Backup Assembly (Figure 17)

Locate Tension Strut Backup and Monorail on foundation with side of Monorail on the construction line (see Figure 20 on p. 22). Verify that any applicable Transition Panels fit properly before anchoring Backup. Drill anchor holes in foundation using the Backup as template. Anchor the Backup to the concrete foundation using the MP-3[®] Anchoring system (Horizontal kit) supplied with the QuadGuard II system (see "MP-3[®] Polyester Anchoring System" section on p. 53).

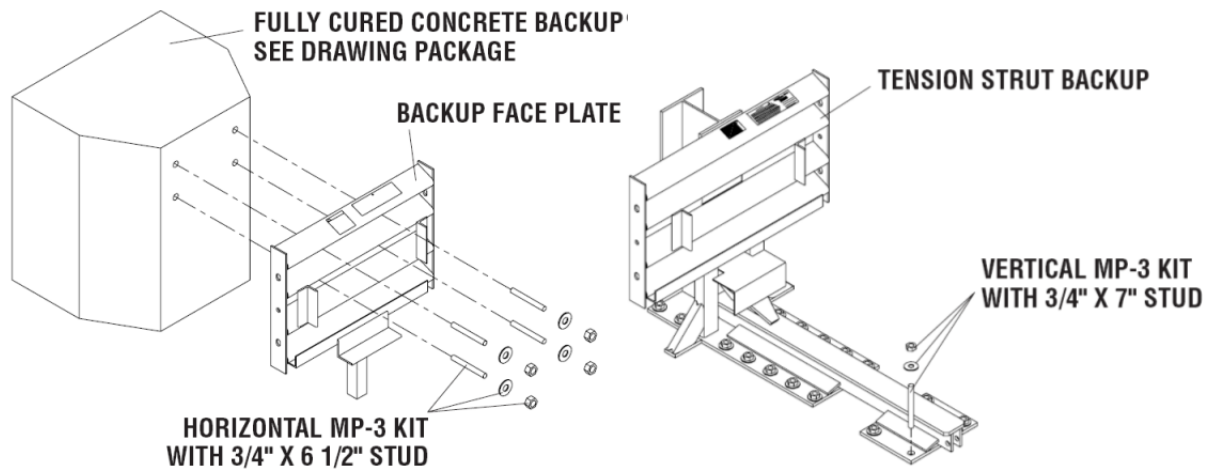


Figure 16
Anchoring Backup Face Plate to
Concrete Backup

Figure 17
Anchoring Tension Strut Backup
to Foundation

4) Anchor the Monorail

A) Monorail Construction for Concrete Backup (Figure 19)

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

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

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



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

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



Warning: Improper alignment at the Monorail Sections will prevent proper system collapse during impact.

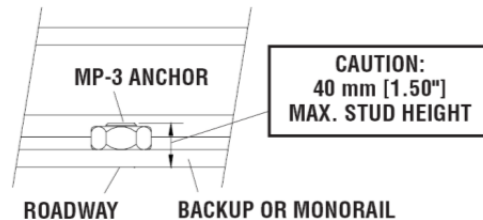


Figure 18
Proper Stud Height

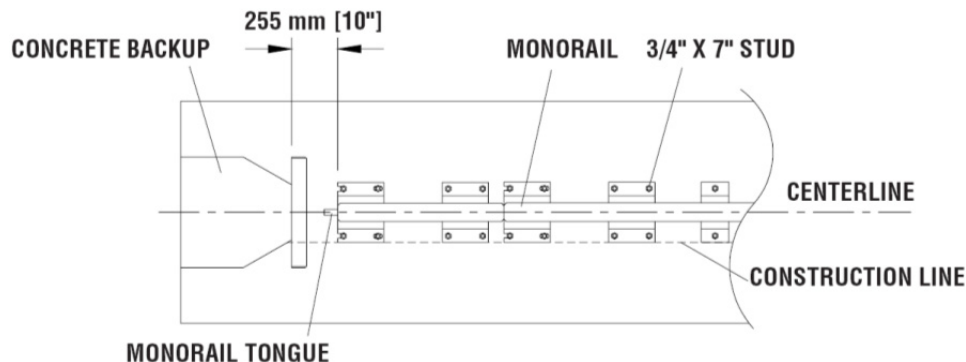


Figure 19
Monorail Location for Concrete Backup

B) Monorail Construction for Tension Strut Backup (Figure 20)

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

Orient the Monorail so that the Monorail tongues face the Backup (see Figure 19, p. 21).

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



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

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



Warning: Improper alignment at the Monorail splice joints will prevent proper system collapse during an impact.

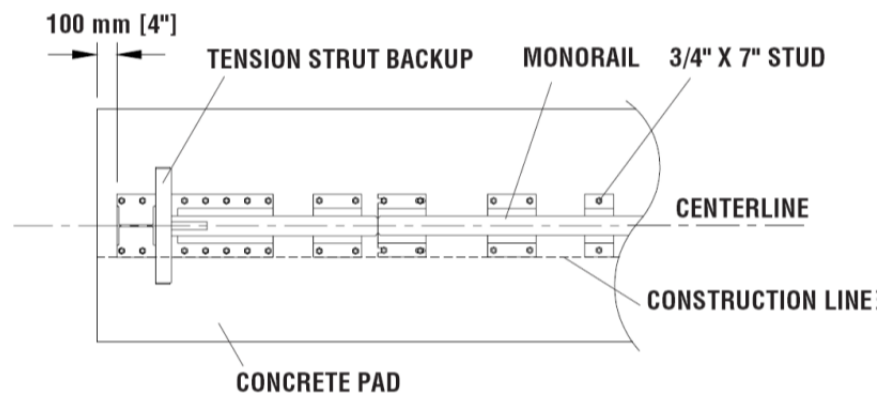
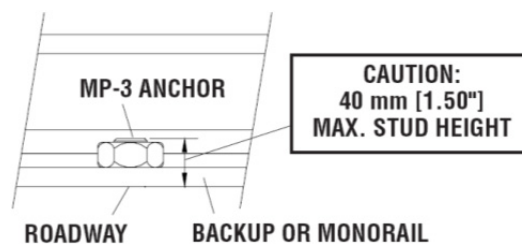


Figure 20
Backup and Monorail Location for Tension Strut Backup



Detail 20a
Proper Stud Height

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

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

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

Assembly tip:

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

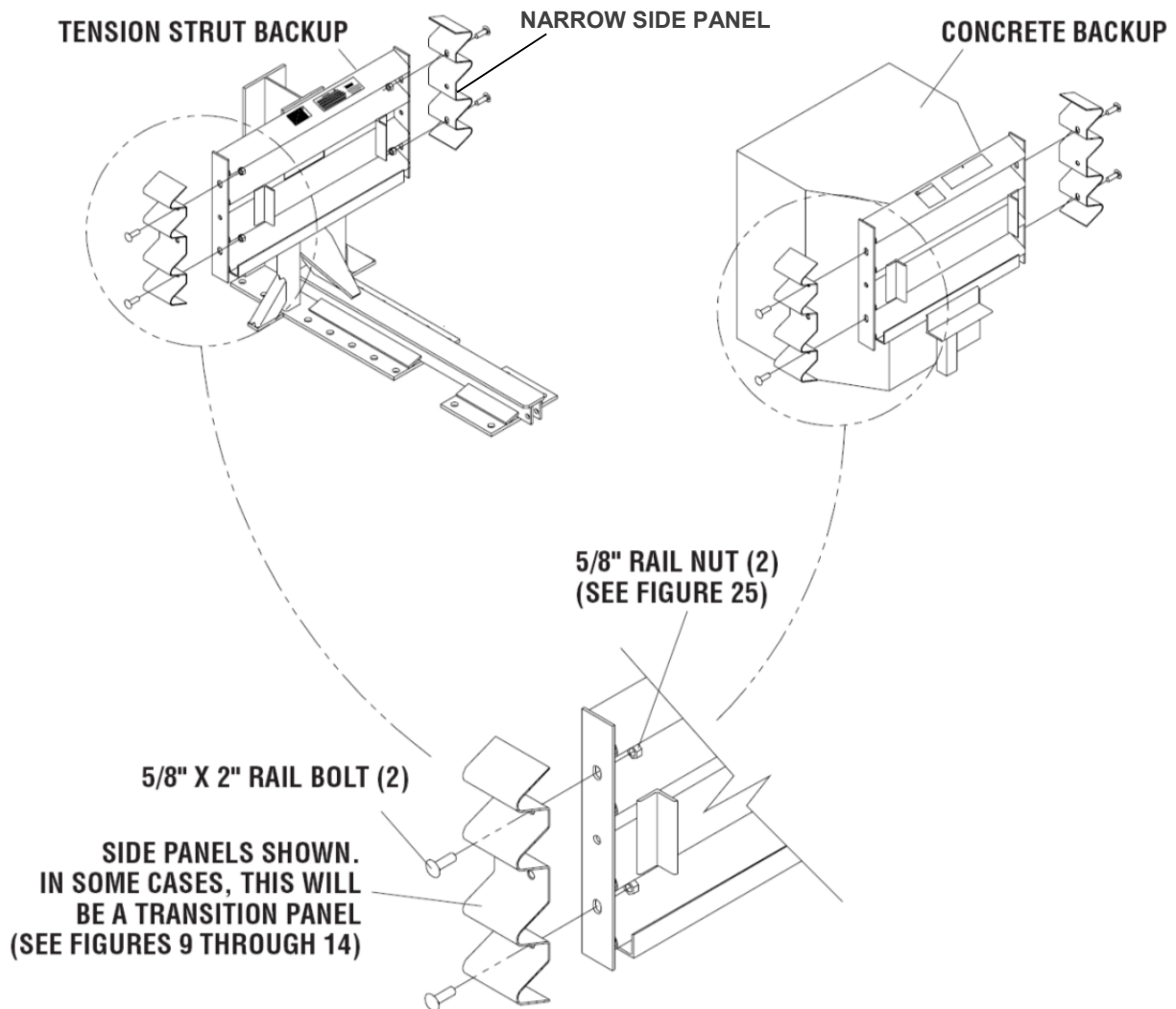


Figure 21
Side Panel/Transition Panel Attachment

6) Attach Monorail Guides

Attach Monorail guides to Diaphragm as follows:

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

Repeat process for each Diaphragm.

7) Attach Diaphragms

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

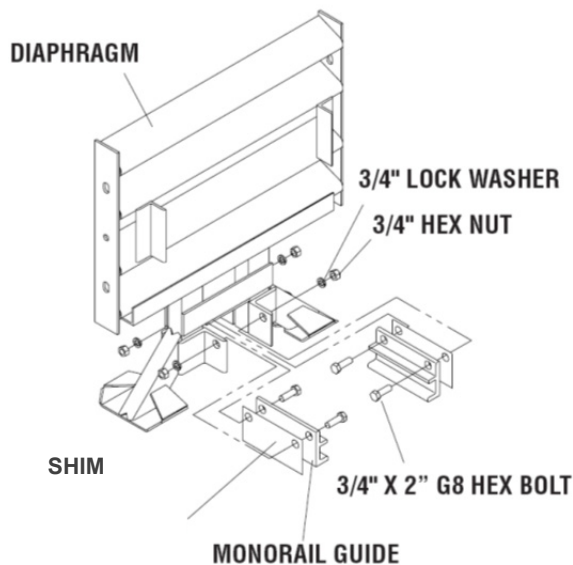


Figure 22
Monorail Guide Attachment

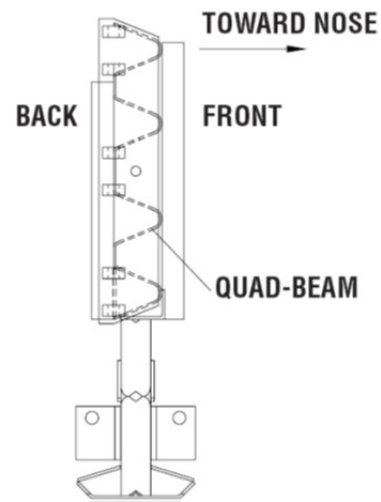


Figure 23
Diaphragm Orientation

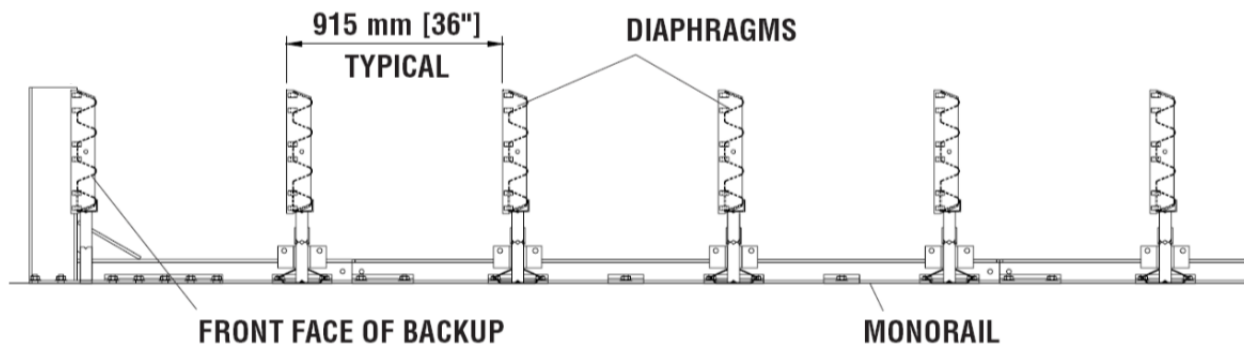


Figure 24
Diaphragm Spacing

8) Attach Fender Panels

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

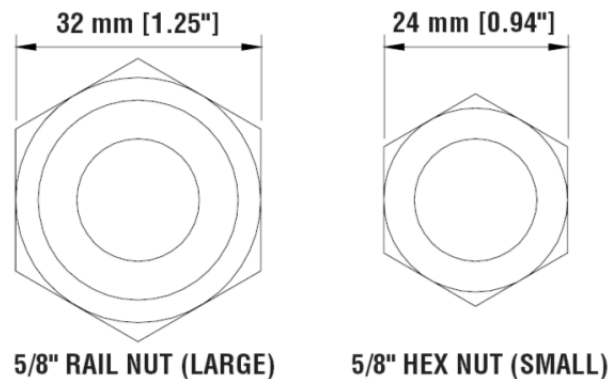


Figure 25
Rail Nuts are Oversize

Starting at the Backup, attach left and right Fender Panels shown on page 26 and Fender Panel Assembly drawing.

Step 1

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

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

Step 2

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

Step 3

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

Step 4

Attach the front of the Fender Panels to the next Diaphragm using two (2) rail bolts and large hex nuts per side. Use only the top and bottom holes; leave the center hole open until the next Fender Panel is attached.

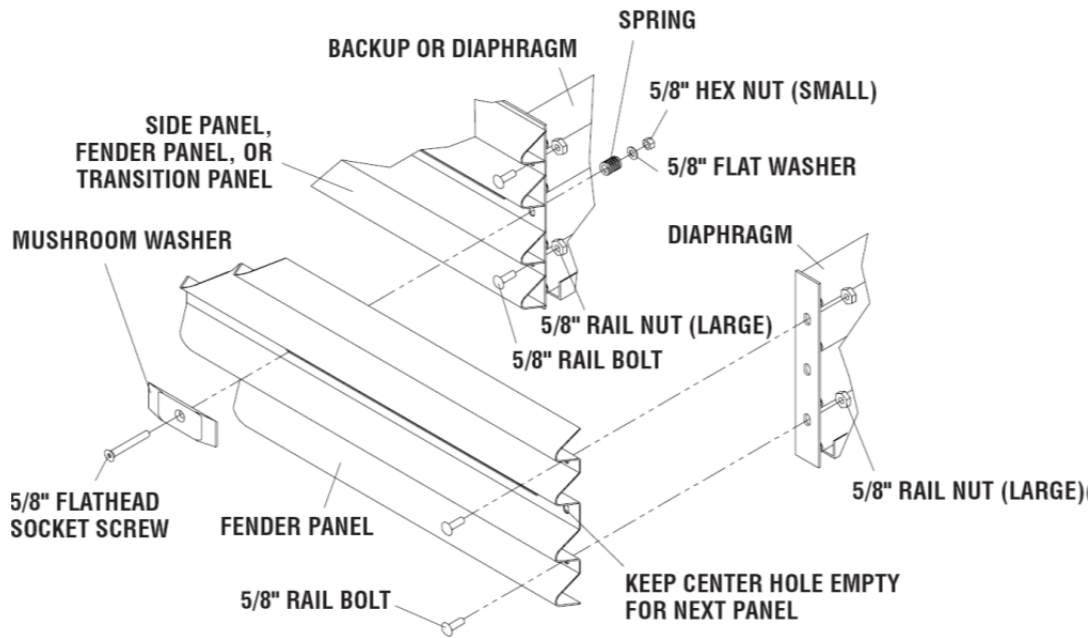
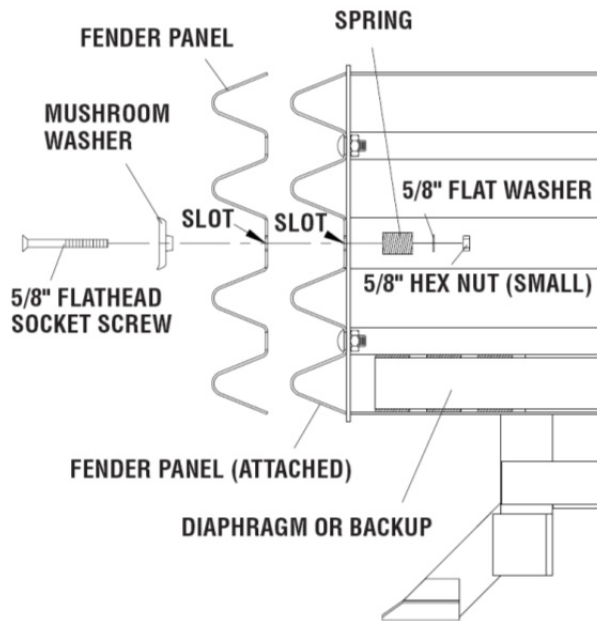


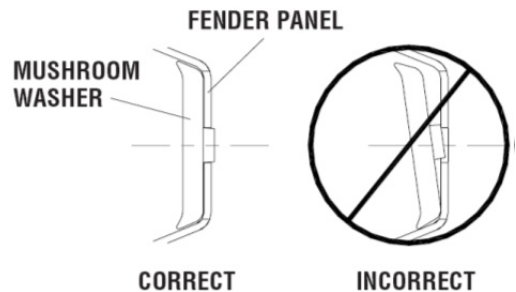
Figure 26
Fender Panel Assembly

Step 5

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



Detail 26a
Mushroom Washer Attachment



Detail 26b
Mushroom Washer Orientation

Step 6

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

Step 7

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

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

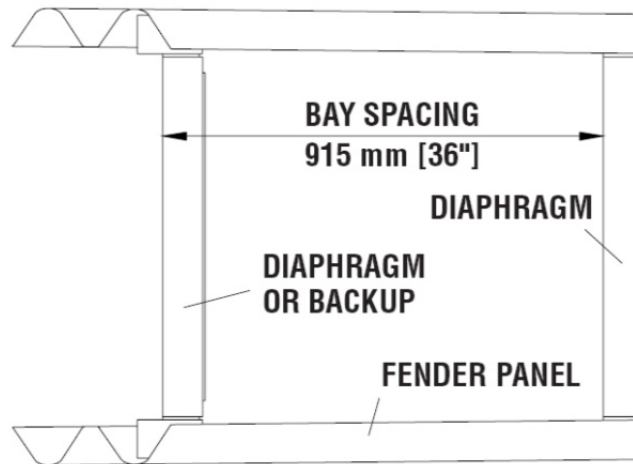


Figure 27
Proper Spacing Between Diaphragms

9) Attach End Cap

Using 5/8" x 3 1/2" G5 hex bolt, 5/8" hex nut and 5/8" lock washer, attach the End Cap to the front of the first Monorail segment, as shown in Figure 28 and Monorail Assembly drawing.

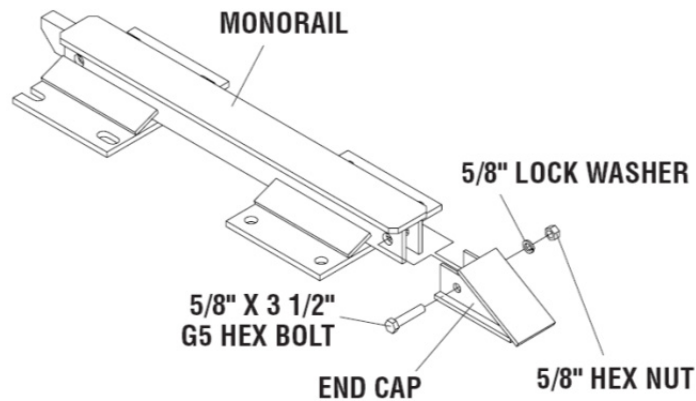


Figure 28
Monorail End Cap Assembly

10) Attach Cartridge Support Brackets

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

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

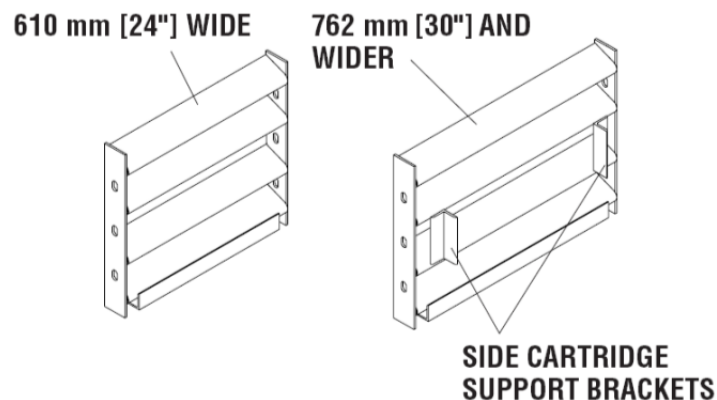


Figure 29
Side Cartridge Support Brackets

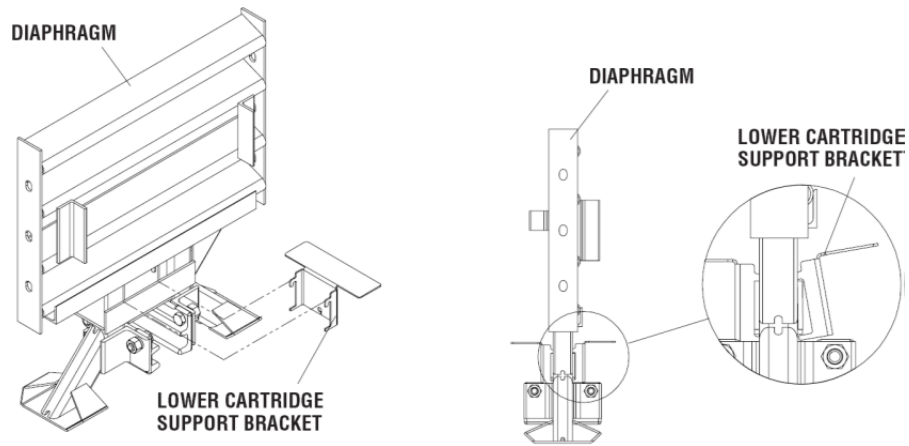


Figure 30
Lower Cartridge Support Bracket Assembly

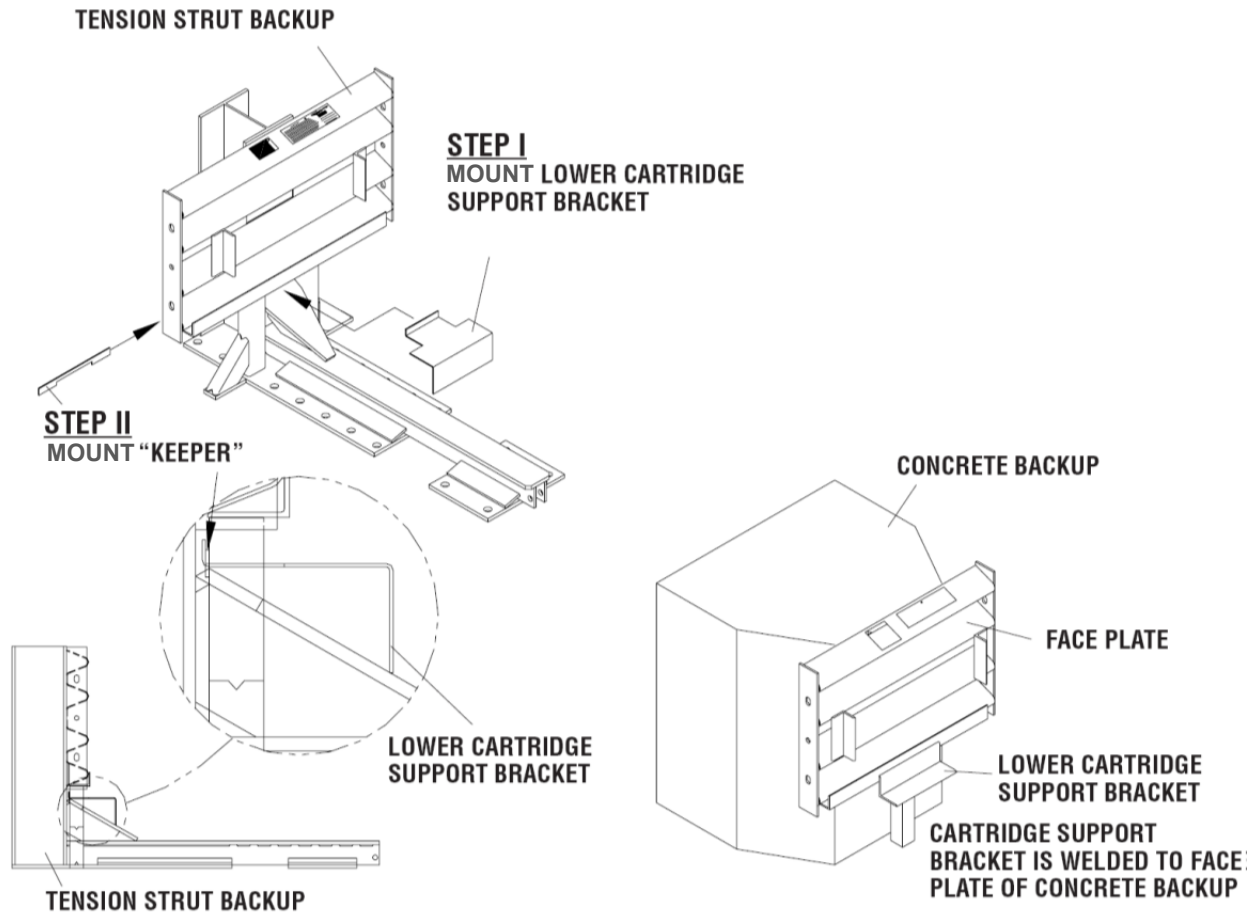


Figure 31
Lower Cartridge Support Bracket Assembly
(Tension Strut Backup)

Figure 32
Lower Cartridge Support Bracket
(Concrete Backup)

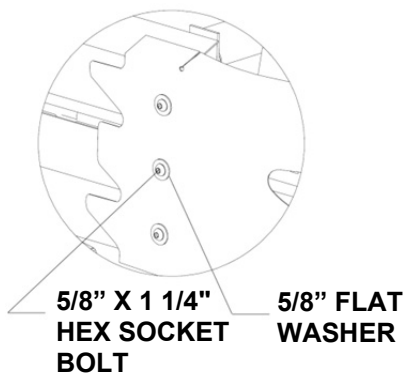
11) Attach Nose Assembly

Bolt the Nose directly to the front Diaphragm, as shown in Figures 33a through 33c and the Nose Assembly drawing, using six (6) threaded rods and four (4) rail nuts per rod.

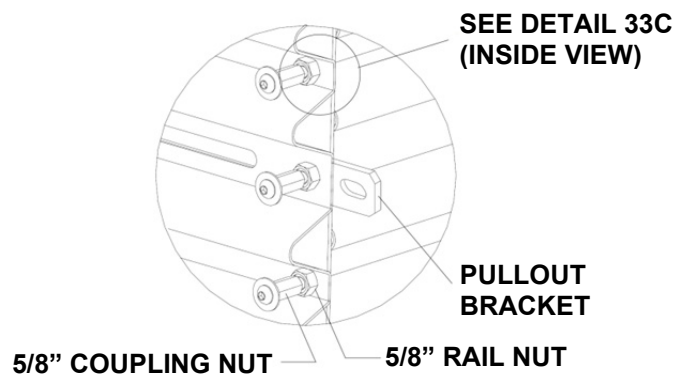
Place Pullout Brackets under center bolts.



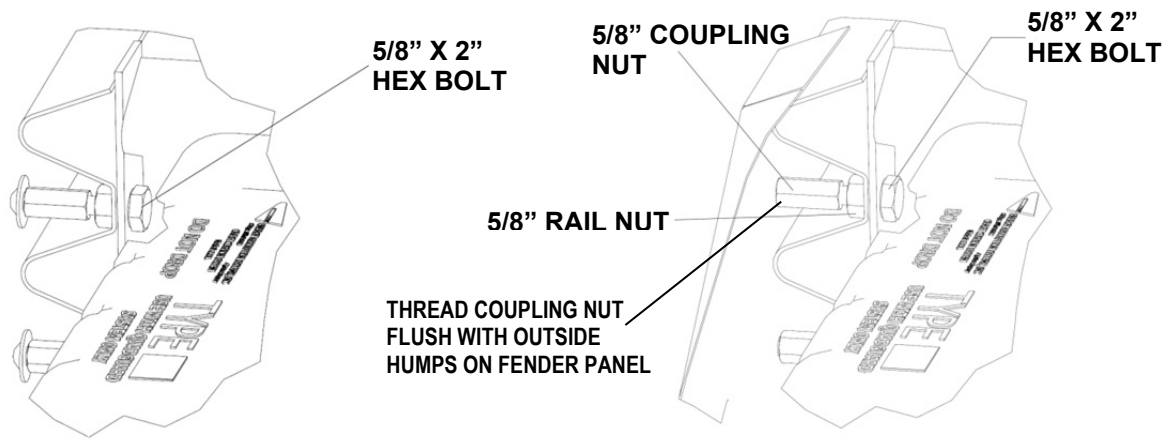
Figure 33



Detail 33a
Fastener Assembly

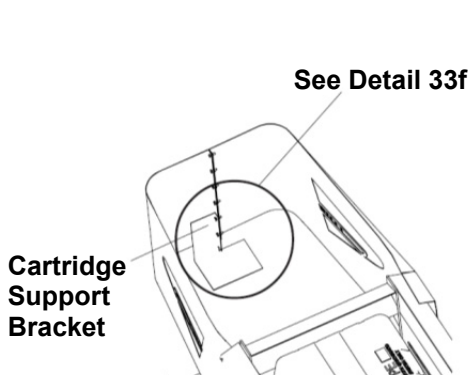


Detail 33b
Steel Nose not shown for Clarity

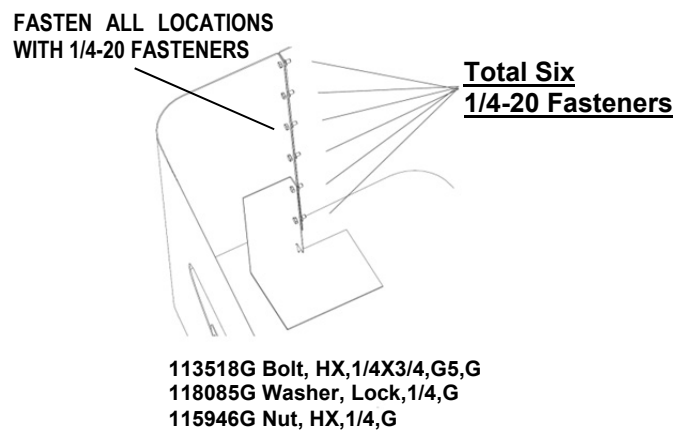


Detail 33c
End View with no Nose Cover

Detail 33d
End View: Nose Cover Cut Away

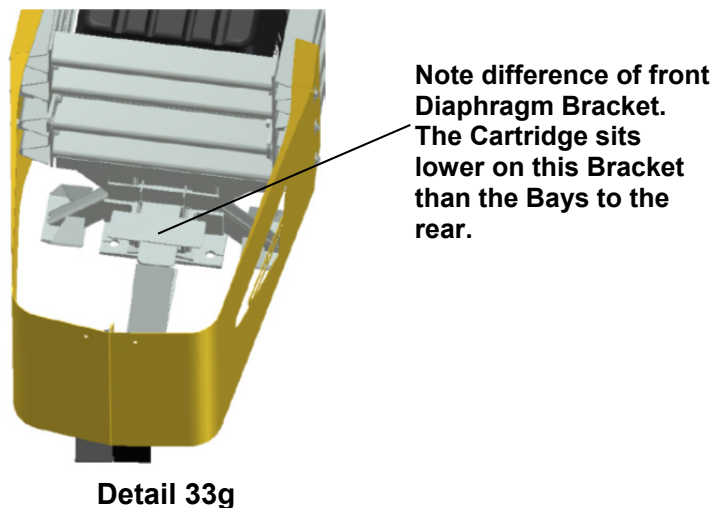


Detail 33e



Detail 33f

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



12) Checking the System Assembly

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



Warning:

Bolt Torque Requirements
Anchor Studs – see Table A, p. 53 May slightly protrude above nuts
Critical Clearances
Anchor Studs above nuts – see Figure 18, p. 21 Fender Panel Gap Narrow – 20 mm [0.78"] see below

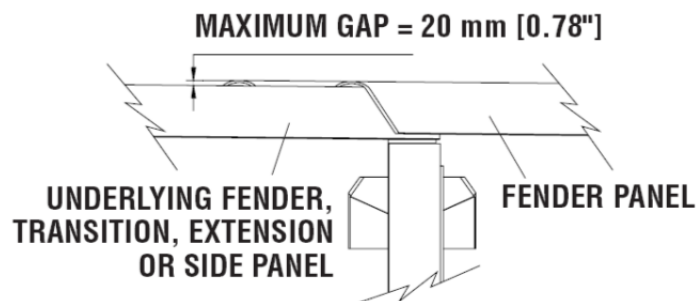


Figure 34
Fender Panel Gap for Narrow Systems

13) Cartridge Assembly

Be sure the Adjustable Cartridge Support in the Nose is attached correctly. See “Attach Nose Assembly” in Step 11 on page 30. The top surface of the Nose Cartridge should be horizontal.

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



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

I - TYPE I CARTRIDGE
 II - TYPE II CARTRIDGE

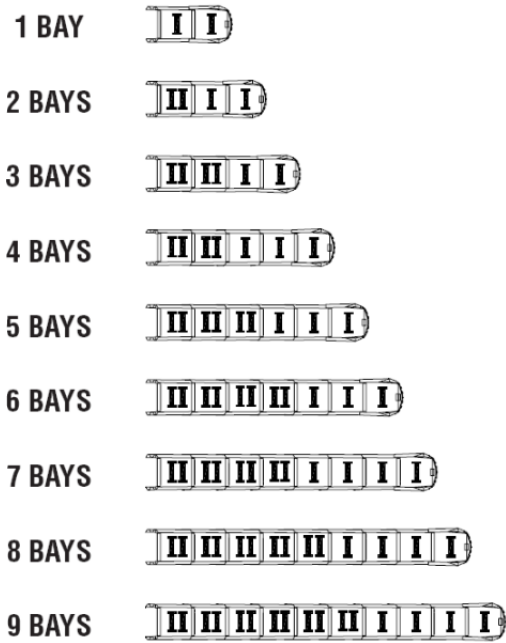
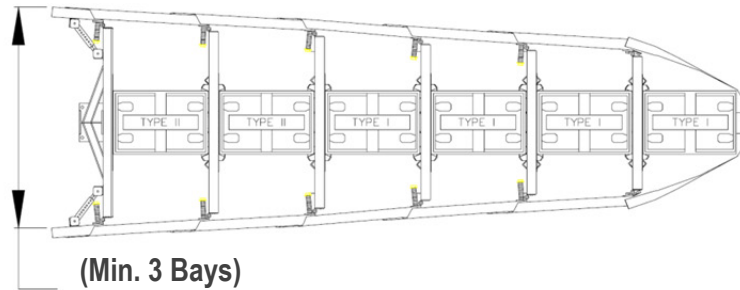


Figure 35
Cartridge Placement

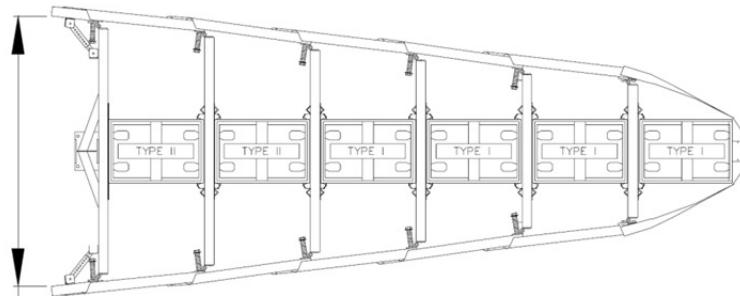


Figure 36
Typical Cartridge Layout 5 Bay System Shown

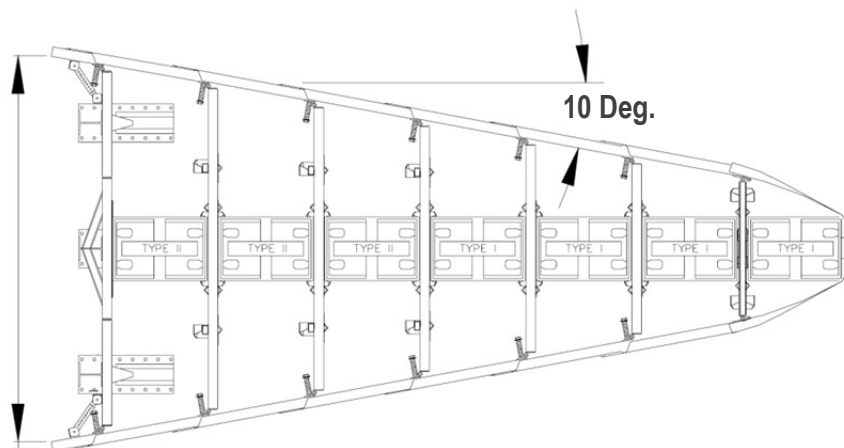
Wide Systems



(Min. 3 Bays)
1755 mm [69"] Model No. QG2 __ 69



(Min. 3 Bays)
2285 mm [90"] Model No. QG2 __ 90



Varies - (Min. 6 Bays)
3200 mm [126"] Model No. QG2 __ 126

Figure 37
Wide Systems and Model Numbers

Site Preparation/Foundation

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

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



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



Warning: Location of the Backup in relation to nearby objects will affect the operation of the attenuator. Upon impact, the Fender Panels telescope rearward and extend beyond the rigid Backup as much as 876 mm [34.5"] from their pre-impact location. Position the Backup so that the rear ends of the last Fender Panels are a minimum of 760 mm [30"] forward of objects that would otherwise interfere with movement of the rearmost Fender Panels. Failure to comply with this requirement is likely to result in system performance which has not been crash tested pursuant to NCHRP 350 criteria and may also cause component damage which will necessitate maintenance or replacement of the system.

Inspect Shipping

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

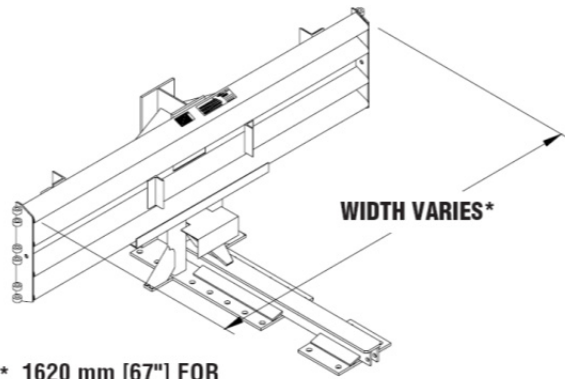
Assembly Procedures

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

1) Determine Backup and Transition Type

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

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



- * 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

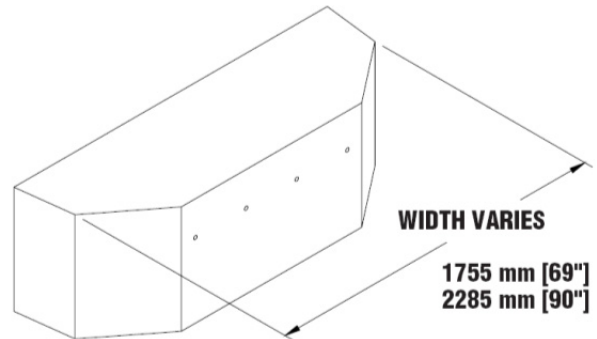


Figure 39
Concrete Backup

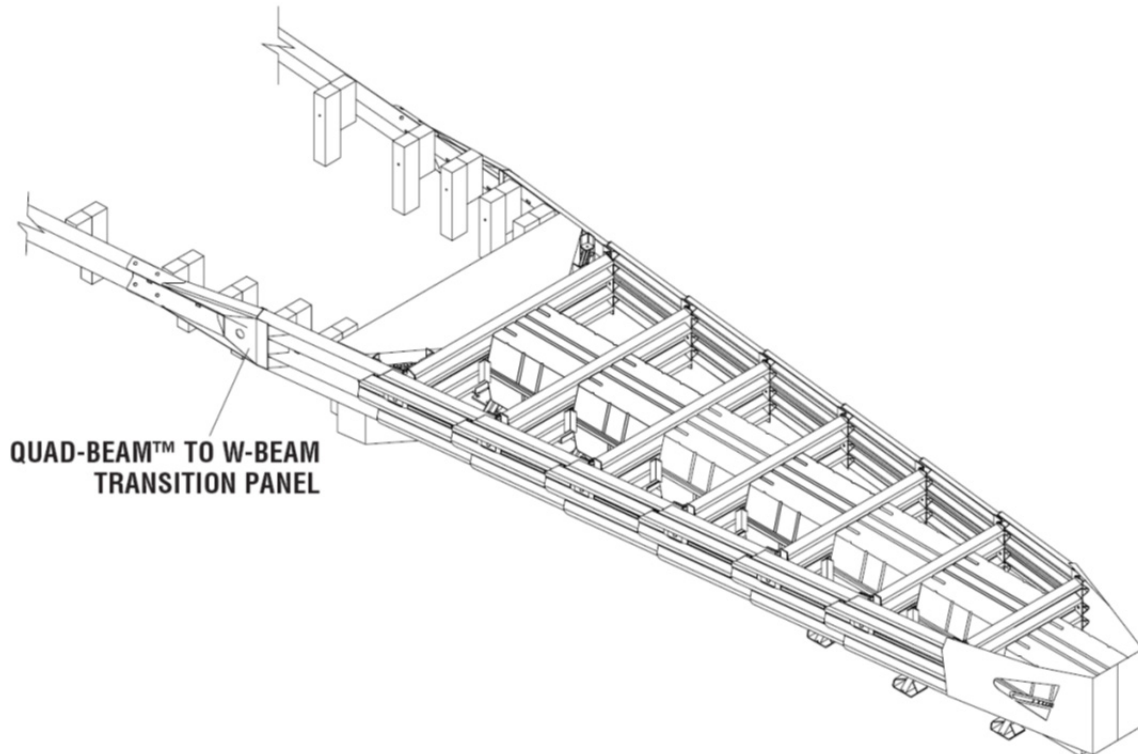


Figure 40
Transitioning the QuadGuard® II System

Transition Panel Types

Note: The proper Transition Panel or Side Panel must be used to perform as crash tested. The correct Panel(s) to use will depend on the direction of traffic and what type of barrier or roadside obstacle the QuadGuard® II system is shielding (see p. 18). Contact the Customer Service Department prior to deployment if you have any questions.

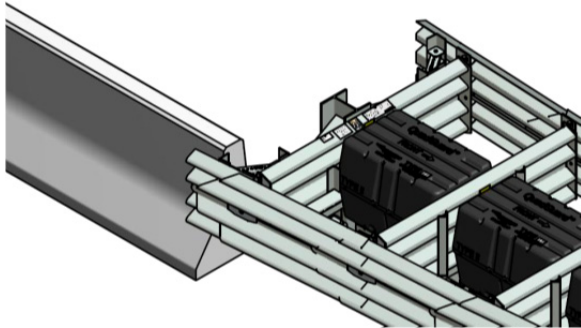


Figure 41
No Transition

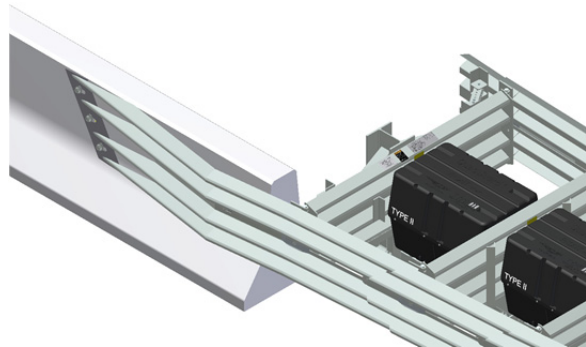


Figure 42
Quad-Beam™ to Safety Shape Barrier

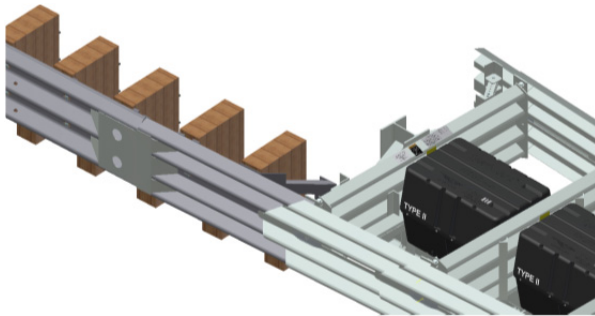


Figure 43
Quad-Beam™ to Thrie-Beam

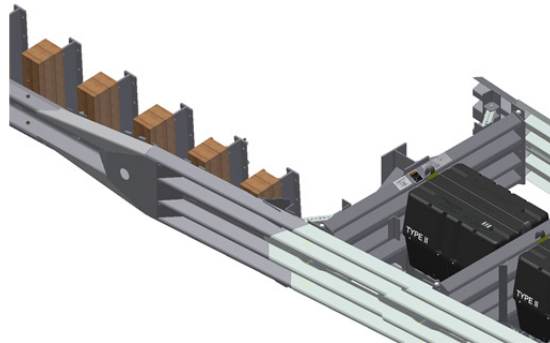


Figure 44
Quad-Beam™ to W-Beam

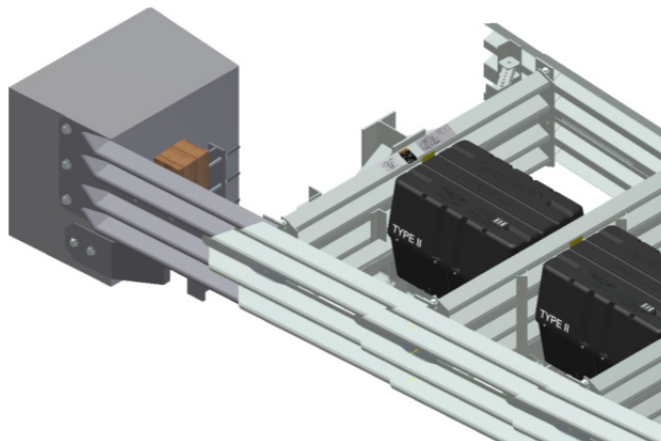


Figure 45
Quad-Beam™ End Shoe

2) Mark System Location

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

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



Warning: Location of system with respect to the roadside object 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 foundation)

3) Anchor the Backup

A) Concrete Backup Construction (Figure 47)

Locate Backup Face Plate using the Backup assembly drawing. Drill anchor holes in the Concrete Backup using the Face Plate as a template. Anchor the Face Plate to the Concrete Backup using the MP-3[®] Anchoring system (horizontal kit) supplied with the QuadGuard[®] II system (see "MP-3[®] Polyester Anchoring System" section, p. 53).



Warning: Every hole and slot in Backup and Monorail must have an MP-3[®] stud anchoring it.

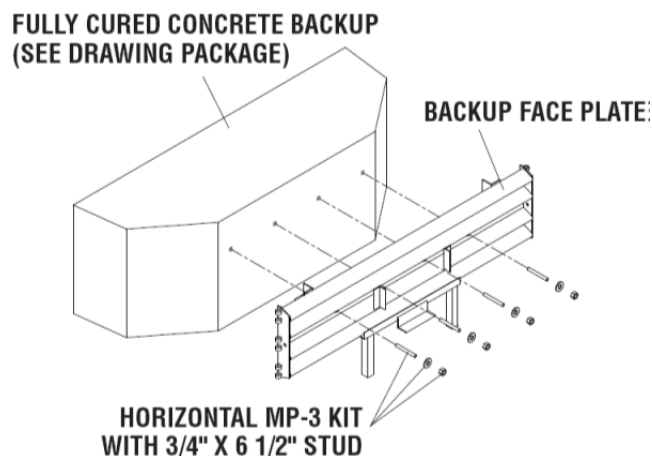


Figure 47
Anchoring Backup Face Plate to Concrete Backup

B) Tension Strut Backup Assembly

Locate the Tension Strut Backup and Monorail on foundation with side of Monorail on the construction line (see Figure 52, p. 42). Verify that any applicable Transition Panels fit properly before anchoring Backup. Drill anchor holes in foundation using the Backup as template. Anchor the Backup to the concrete foundation using the MP-3[®] Anchoring System (vertical kit) supplied with the QuadGuard[®] II system (see “MP-3[®] Polyester Anchoring System” section, p. 53).



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

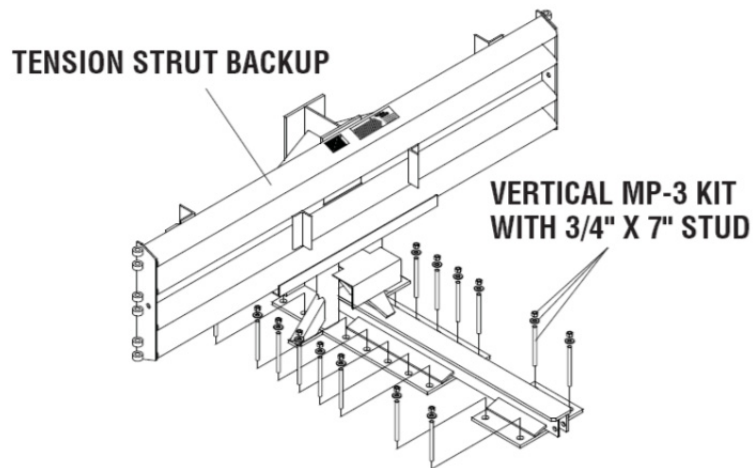


Figure 48
Anchoring Tension Strut Backup to Foundation

C) Extra-Wide Tension Strut Backup Assembly (Figure 49)

Locate the Extra-Wide Tension Strut Backup center section and Monorail on foundation with side of Monorail on the construction line (see Figure 52, p. 42).

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

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

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

Verify that any applicable Transition Panels fit properly before anchoring Backup. Drill anchor holes in foundation using the Backup as template. Anchor the Backup to the foundation using the MP-3[®] vertical kits supplied with the QuadGuard[®] II system (see MP-3[®] Polyester Anchoring System, p. 53).



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

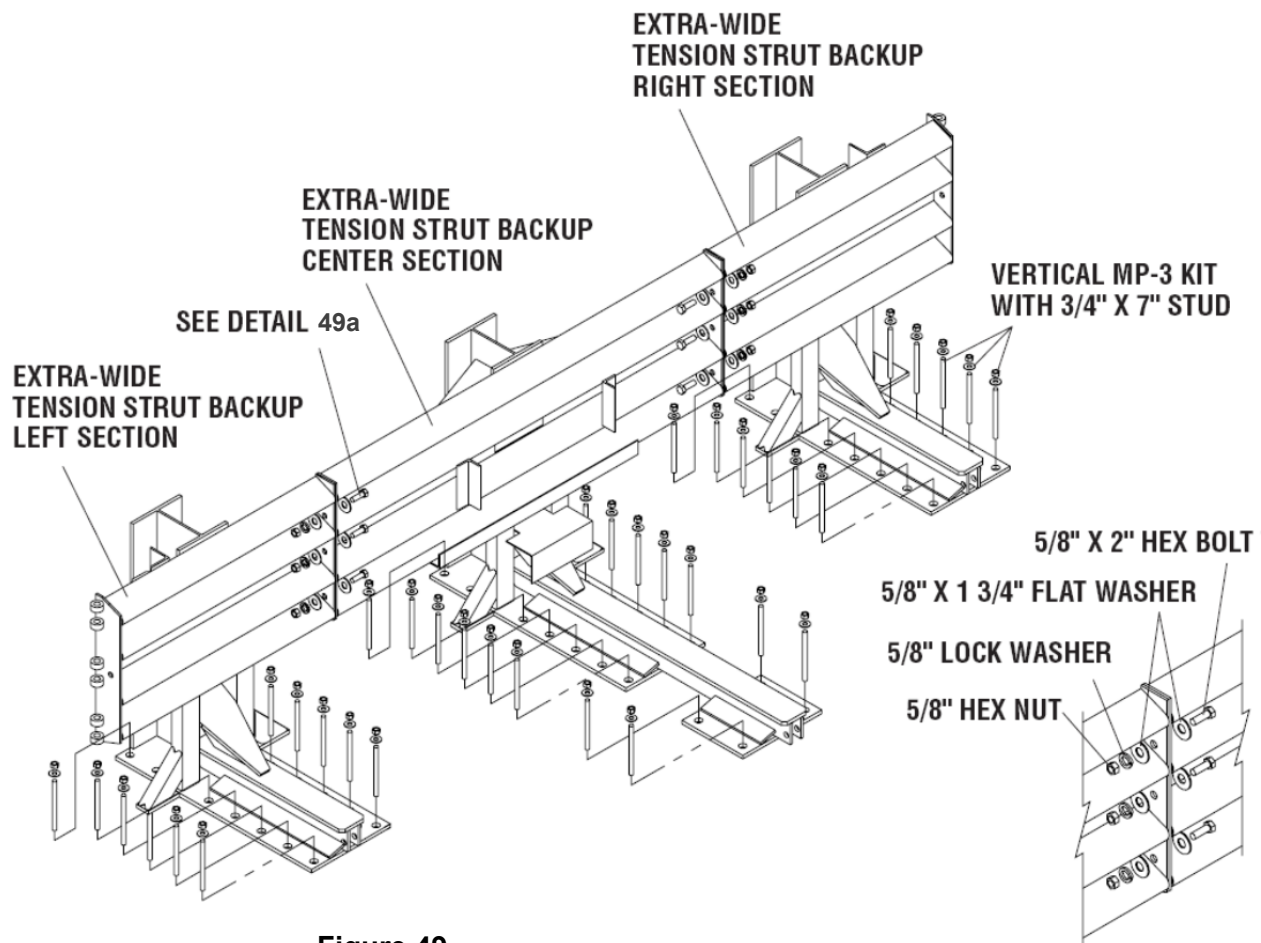


Figure 49
Anchoring Extra-Wide Tension Strut Backup to
Foundation See Drawing Package

Detail 49a

4) Anchor the Monorail

A) Monorail Construction for Concrete Backup

Locate Monorail on foundation with side of Monorail on the construction line and rear edge of Monorail 10" forward of front face of Concrete Backup. Orient the Monorail so that the Monorail tongues face Backup (see Figure 51).

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



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



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

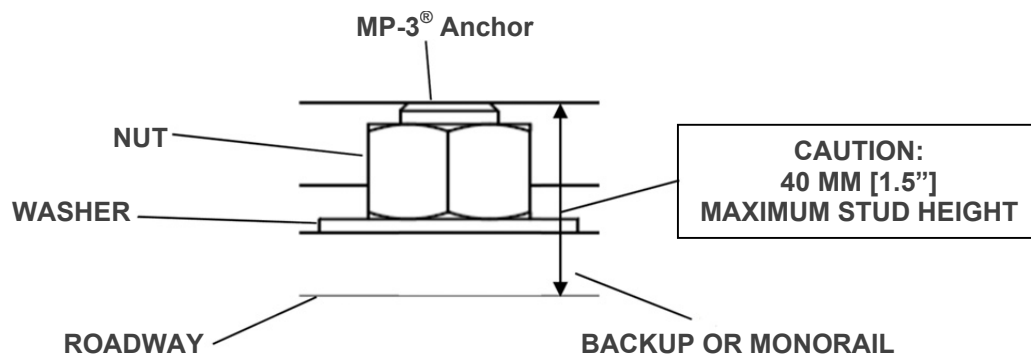


Figure 50
Proper Stud Height

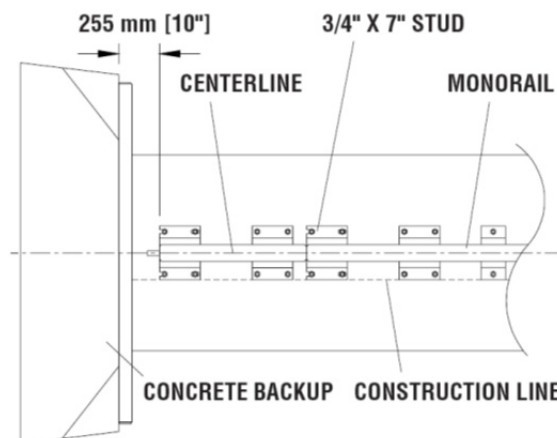


Figure 51
Monorail Location for Concrete Backup

B) Monorail Construction for Tension Strut Backup

Locate Monorail on foundation with side of Monorail on the construction line and rear edge of Backup 4" forward of edge of foundation. Orient the Monorail so that the Monorail tongues face the Backup (see Figure 52).

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

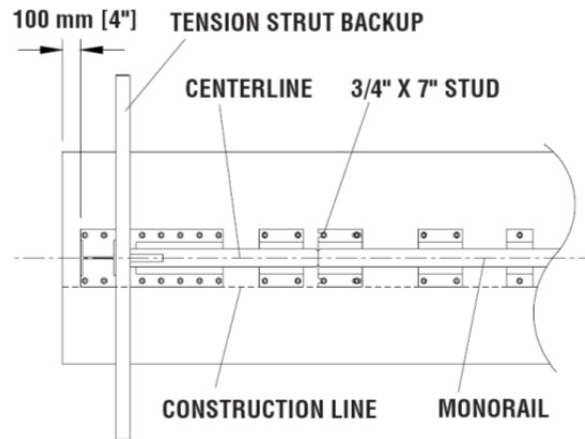


Figure 52
Backup and Monorail Location for Tension Strut Backup

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

- Attach Hinge Plate to the Transition Panel or Side Panel using 5/8" rail bolt and 5/8" rail nut (two places – top and bottom holes only).
- Attach Transition Panel or Side Panel assembly to side of Backup using 5/8" hex bolt, 5/8" lock washer and 5/8" hex nut (three places each side of Backup) (See Figure 53, p. 43).
- Attach diagonal brace to Fender Panel and Backup using 3/8" hex bolt, 3/8" lock washer and 3/8" hex nut (two (2) places per brace: four (4) places per side).
- Secure each diagonal brace with a 3/8" hex bolt; 3/8" lock washer, and 3/8" hex nut (two (2) places per brace) as shown in Figure 53.

Note: A Side Panel is not needed when a Transition Panel is used. Diagonal braces not used with some Transition Panels (see drawing package).

Assembly tip:

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

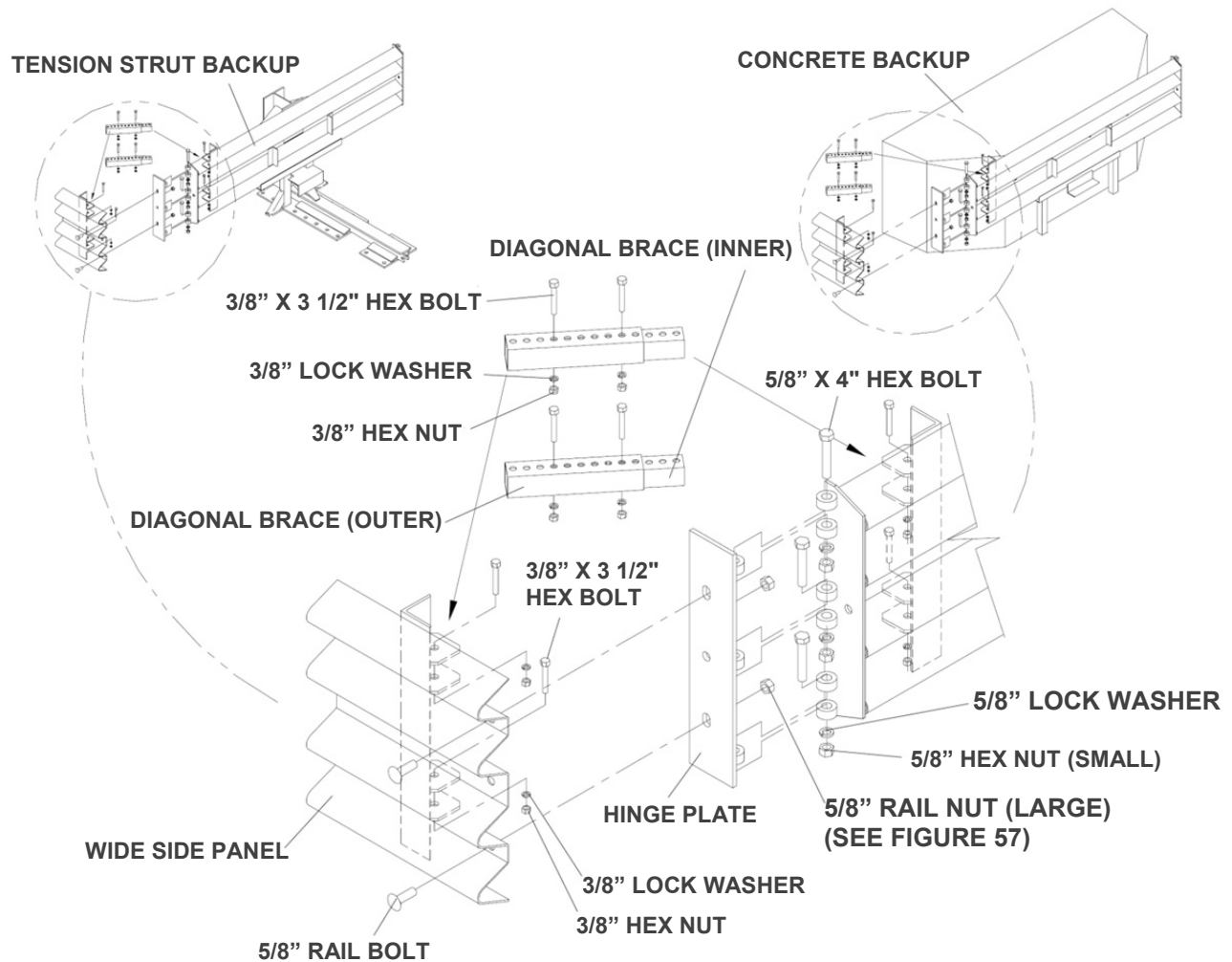


Figure 53
Side Panel/Transition Panel Attachment

6) Attach Monorail Guides

Attach Monorail guides to Diaphragm as follows:

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

Repeat process for each Diaphragm.

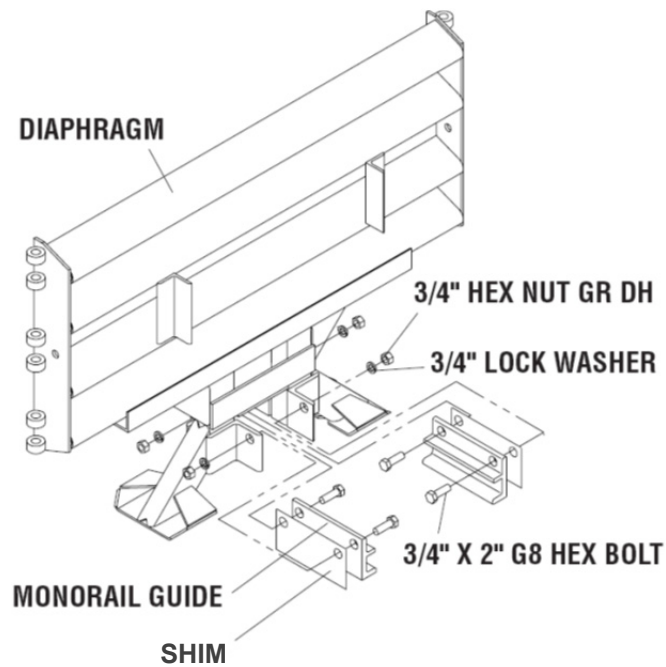


Figure 54
Monorail Guide Attachment

7) Attach Diaphragms

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

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

Orient and slide all other Diaphragms onto Monorail and position each approximately as shown in Figure 56.

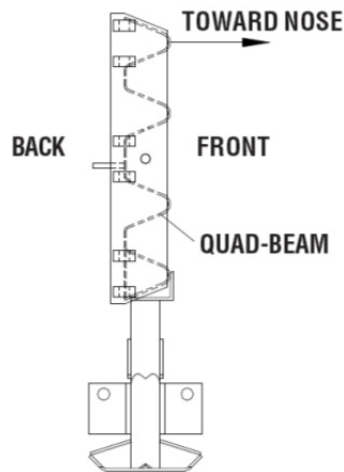


Figure 55
Diaphragm Orientation

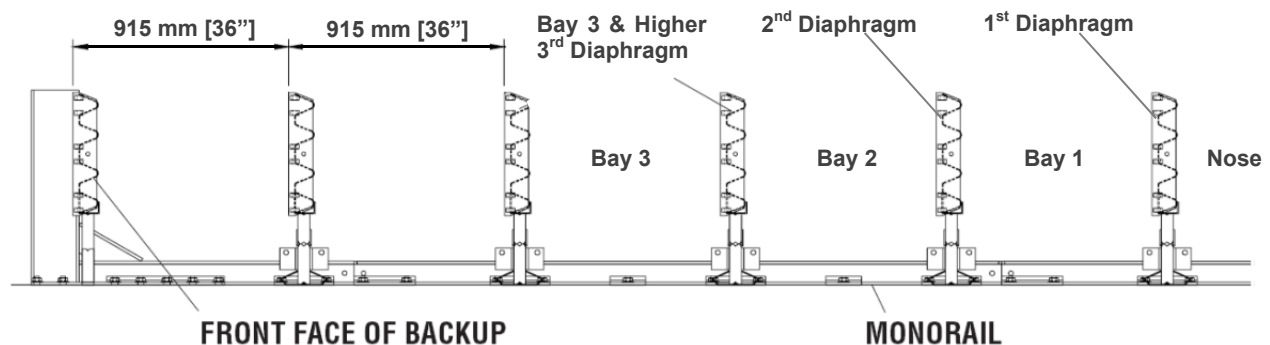


Figure 56
Diaphragm spacing

8) Attach Hinge Plate onto Fender Panels

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

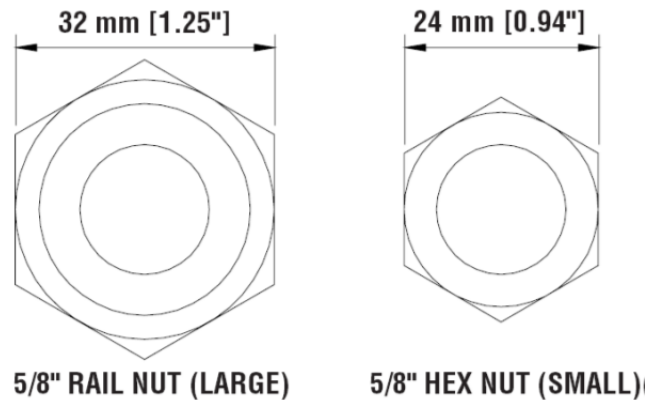


Figure 57
Rail Nuts are Oversize

Note: For proper impact performance, wide systems must use Hinge Plates.

Attach Hinge Plate on each Fender Panel using two (2) 5/8" rail bolts and two (2) 5/8" rail nuts, using top and bottom holes only, leaving the center-hole open as shown in Figure 58.

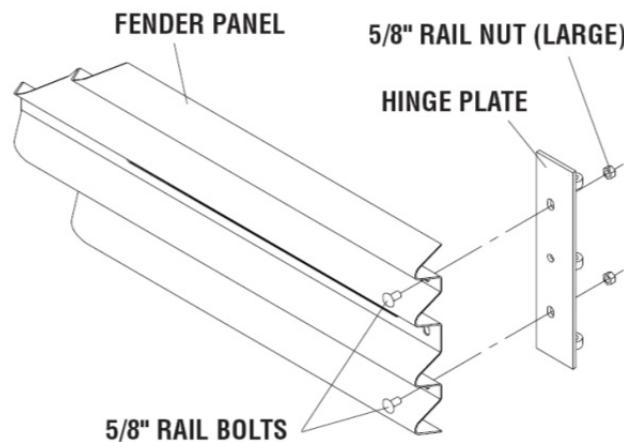


Figure 58
Hinge Plate Assembly

9) Attach Fender Panels

Starting at the Backup, attach left and right Fender Panels as shown in Figure 59.

Attach Mushroom Washer Assembly as shown in Figure 59 and Detail 59a, but do not torque at this time.

Step 1

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

Attach Mushroom Washer Assembly as shown in Figure 59 and Detail 59a and Detail 59b, 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

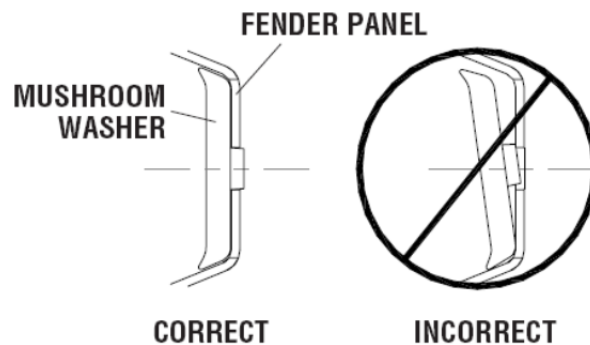
Use a drift pin to align the center hole of the Fender Panel with the center hole of the Diaphragm.

Step 4

Attach the front of the Fender Panels to the next Diaphragm using two (2) rail bolts and large hex nuts per side. Use only the top and bottom holes; leave the center hole open until the next Fender Panel is attached.

Step 5

Be sure Mushroom Washer lays flat against the Fender Panel as shown in Detail 59a. Standoff on Mushroom Washer must be seated completely through slot.



Detail 59a
Mushroom Washer Orientation

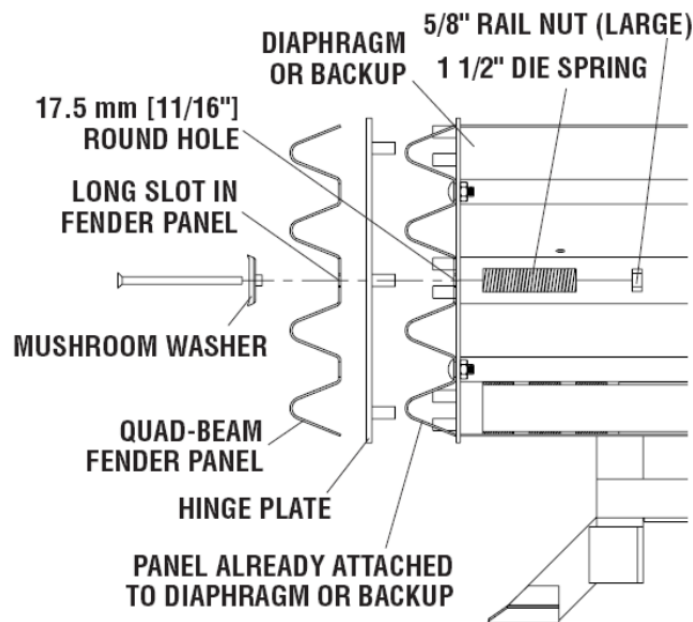


Figure 59
Mushroom Washer Attachment

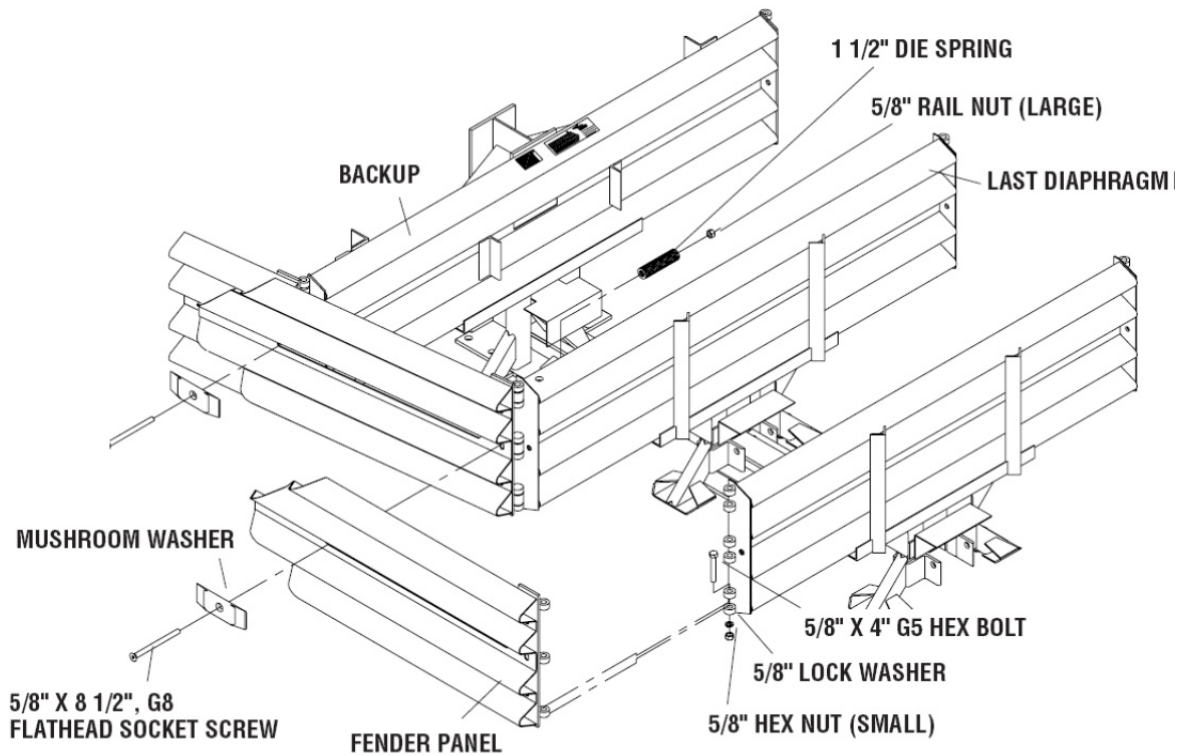


Figure 60
Fender Panel Assembly

Step 6

Check Diaphragm spacing to ensure 915 mm [36"] between rear faces of consecutive Diaphragms as shown in Figure 61 and Fender Panel Assembly drawing.

Step 7

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

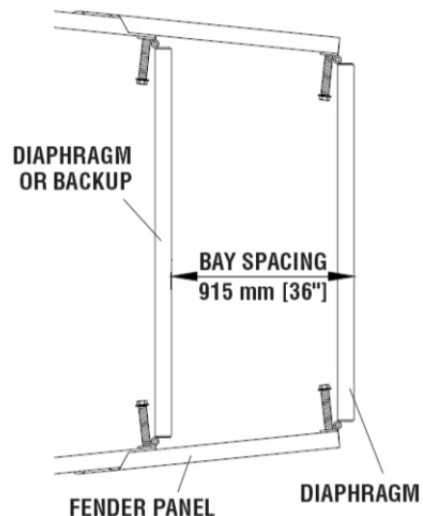


Figure 61
Proper Spacing Between Diaphragms

10) Attach End Cap

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

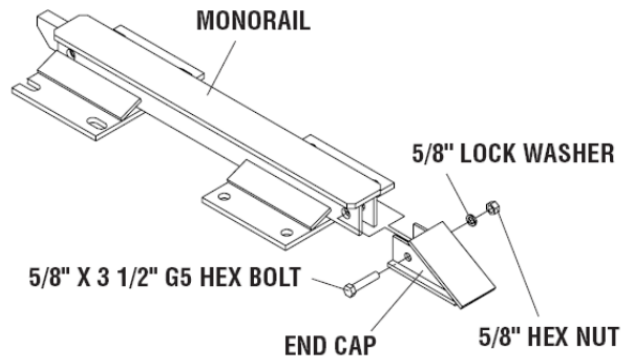


Figure 62
Monorail End Cap Assembly

11) Assemble Cartridge Support Brackets

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

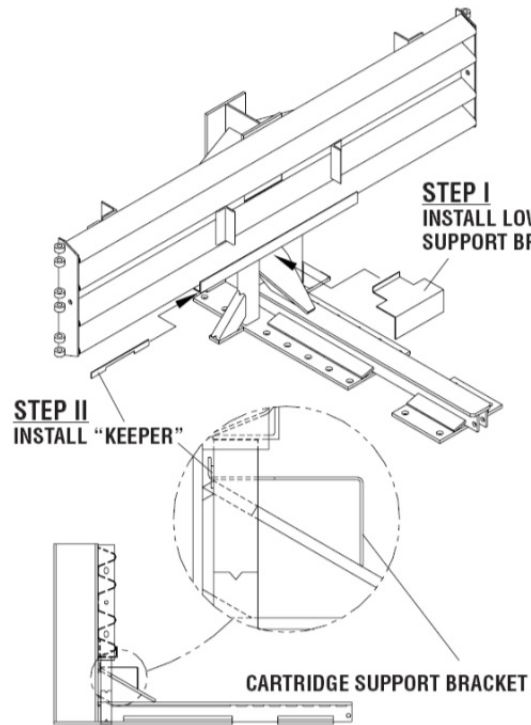
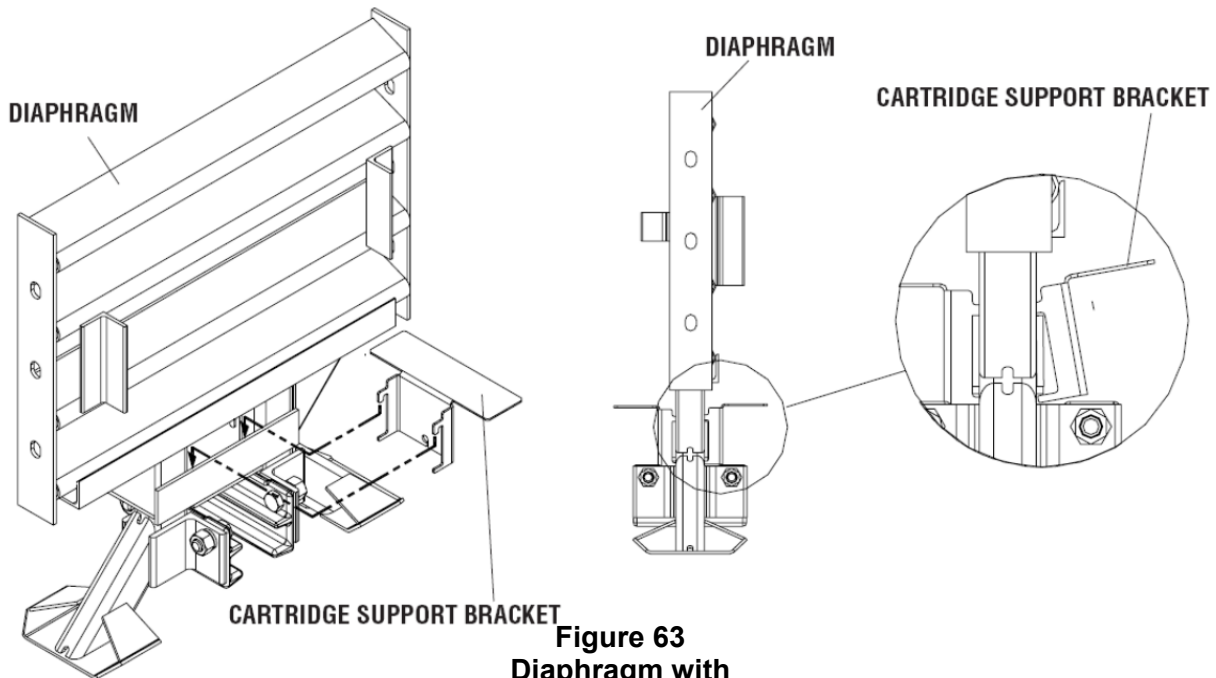


Figure 64
Cartridge Support Bracket
(Tension Strut Backup)

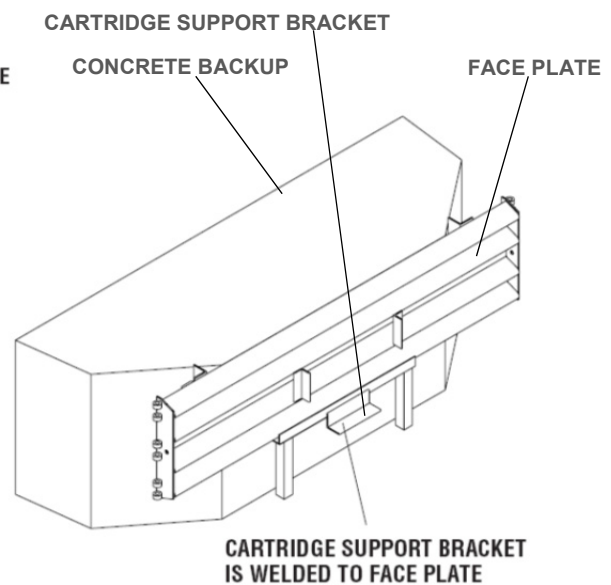


Figure 65
Cartridge Support Bracket
(Concrete Backup)

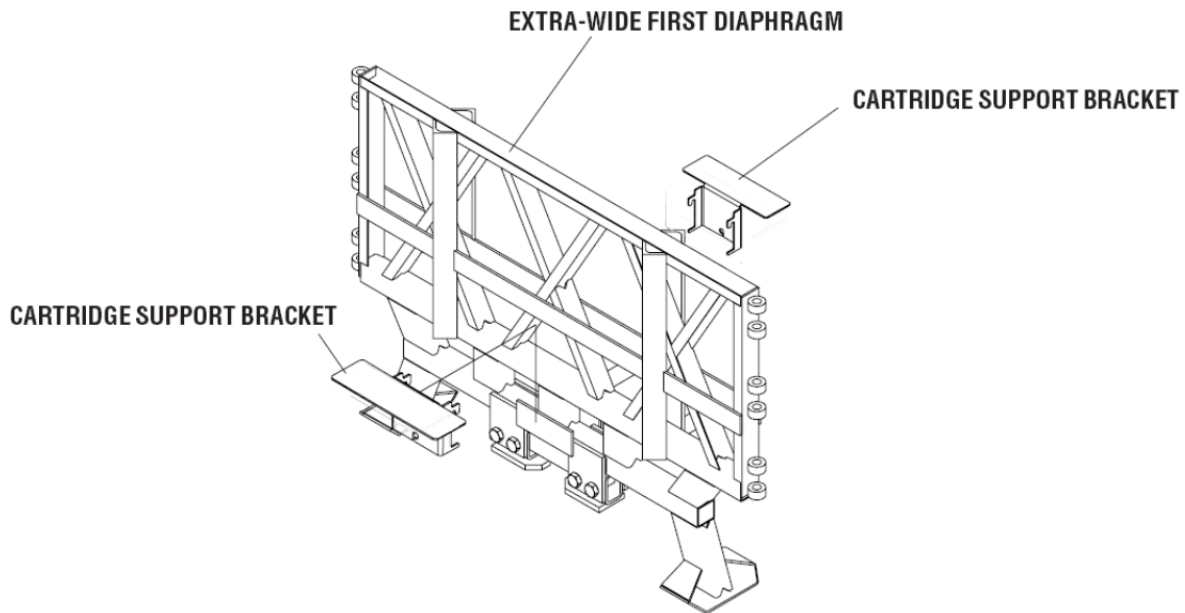


Figure 66
Extra-Wide First Diaphragm With Cartridge Support Bracket
(See Drawing Package)

12) Attach Nose Assembly

See pages 30 and 31 for Nose Assembly instructions.

13) Checking the System Assembly

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



Warning:
Bolt Torque Requirements
Anchor Studs – see Table A, p. 53 May slightly protrude above nuts
Critical Clearances
Anchor Studs above nuts – see Figure 67 Fender Panel Gap Wide – 25 mm [1.00"] see below

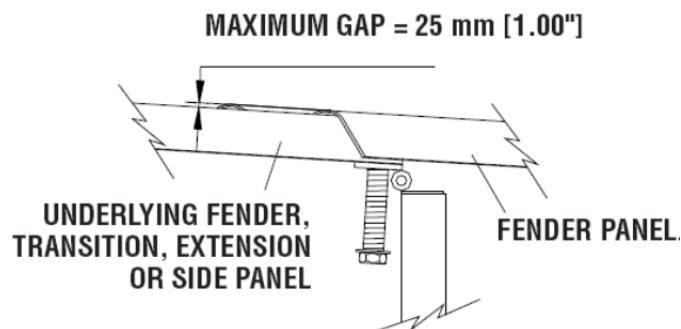


Figure 67
Fender Panel Gap for Wide Systems

14) Cartridge Attachment

Be sure the Adjustable Cartridge Support in the Nose is attached correctly. See “Attach Nose Assembly” in Step 11 on page 30. The top surface of the Nose Cartridge should be horizontal.

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



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

I - TYPE I CARTRIDGE
II - TYPE II CARTRIDGE

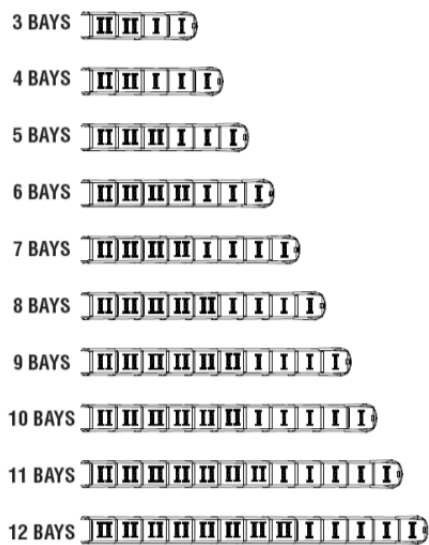


Figure 68
Cartridge Placement

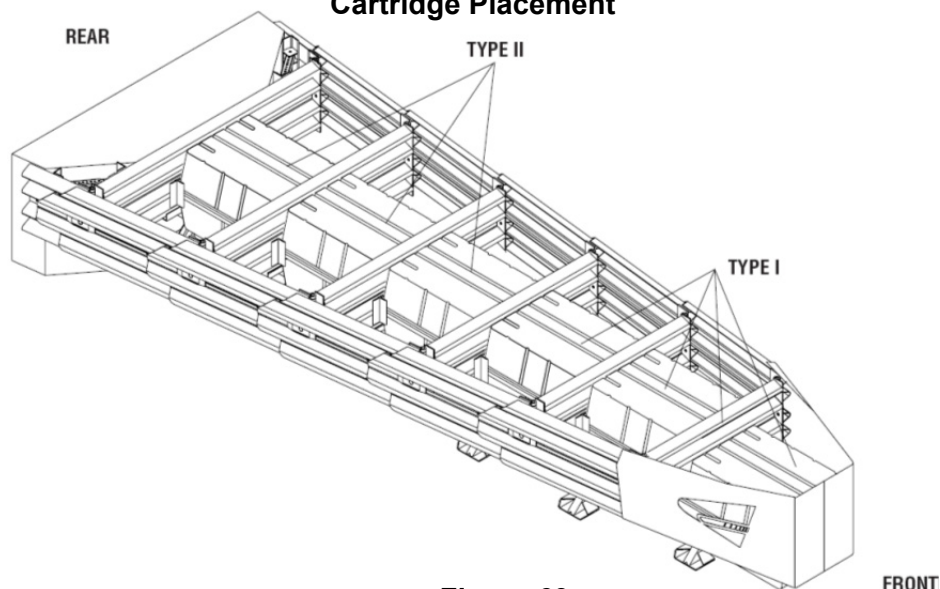


Figure 69
Typical Cartridge Layout (5 Bay System Shown)

MP-3[®] Polyester Anchoring system

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

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

Vertical Assemblies

Note: Read MP-3[®] Instructions before starting.

1) Prepare the Concrete Foundation



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



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

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

2) Drill Holes

Note: Trinity Highway recommends using double-fluted drill bits to achieve optimum tensile strength when applying the MP-3[®] anchoring system.

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

Table A
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 N-m [120 ft-lb]
3/4"x 7"	22 mm [7/8"]	140 mm [5" 1/2"]	165 N-m [120 ft-lb]
3/4"x 18"	22 mm [7/8"]	420 mm [16 1/2"]	15 N-m [10 ft-lb] ⚠



Important: When mounting on asphalt, initial torque shall be as shown in Table A. Due to the instability of asphalt, anchors may loosen over time. For this reason Trinity Highway recommends anchoring to asphalt only at temporary locations. It is recommended to re-torque anchors in asphalt every 6 months to the proper initial torque specified.

3) Clean the Holes

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

4) Mix the Resin and Hardener

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

5) Add Cold Weather Promoter (in Cold Weather)

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



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

6) Pour Grout into Holes

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



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

7) Add the Washers and Nuts

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

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

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



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

9) Torque the Nuts

Once the grout has hardened, torque the nut to the recommended values (see Table A on p. 53).

Table B
Approximate Hardening Times (hours)

Temperature		Hardening Times (hours)	
(C)	(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 Customer Service Department for more information			

Horizontal Assemblies

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

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

1) Thread Dispensing Tip onto Dispenser

Prior to mixing the grout, carefully thread the dispensing tip onto the dispenser.

2) Pour Mixed Grout into Dispenser

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

3) Place Dispenser in Caulking Gun and Dispense Grout

Cut the small end of the dispenser tip off. Place the dispenser into a caulking gun and dispense until MP-3[®] TX grout reaches the tip of the dispenser then release pressure. Push the dispenser tip through the part to the bottom of the hole and dispense while slowly withdrawing the tip.



Caution: Do not overfill or under fill the hole. Fill hole approximately 1/3 to 1/2 full. If the hole is overfilled, there will not be enough grout to use all of the anchor studs/kit. If hole is 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 70).

5) Insert Studs into Holes

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

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

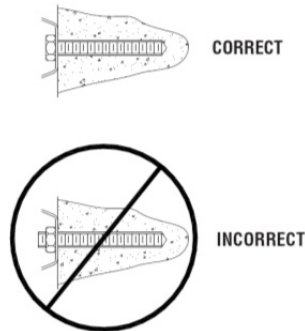


Figure 70
MP-3[®] Horizontal Application



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 N-m [120 ft-lb].

MP-3[®] Assembly Cautions

1) Shelf life

If the shelf life of the MP-3[®] has expired (see MP-3[®] kit for expiration information), mix a small amount of MP-3[®] in the proportions of one part A to two parts B by volume. If the material does not set according to the instructions, contact Trinity Highway for guidance (see p. 3).



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

2) Steel rebar

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

- A) Using a diamond core drill bit 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 bit through rebar without first obtaining permission to do so from the local project engineer.

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

Maintenance and Repair

Inspection Frequency

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

Visual Drive-By Inspection

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



Warning: See Cartridge placement instructions on pages 33 and 52.

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

Walk-Up Inspection

- 1) Clear and dispose of any debris on the site.
- 2) Bolts are tight and rust free.
- 3) Anchor bolts are securely anchored (see Table A, p. 53).
- 4) Ensure Diaphragm Legs are straight.
- 5) 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 74 and 75 on page 60.

- 7) Be sure Cartridges have not been damaged and are properly positioned on their Support Brackets. Replace crushed or sagging Cartridges. To ensure 100% of the intended speed characteristics, partially crushed Cartridges (due to slow speed impacts) shall be replaced.
- 8) Make all necessary repairs as described above. See Post-Impact Instructions on page 58 for more information.
- 9) Note the location and condition of the QuadGuard® II system and any work done in the Impact Attenuator Inspection Logbook under the date of this inspection. If further repair is necessary, note repair request date in logbook. See Post-Impact Instructions on page 58, and the Assembly section on page 17 of this Manual for more information.
- 10) In deciding if a product should be replaced, or is potentially reusable, a trained engineer, experienced in highway products, directed by the DOT, or other appropriate local highway authority, must be consulted.

Post-Impact Instructions



Danger: If either (**wide or narrow**) system is anchored to asphalt, up to 10% of the total anchors may be replaced if damaged. If more than 10% of the anchors are damaged, the system should be relocated to fresh, undisturbed asphalt and redeployed using the 460 mm [18"] threaded rods.

Narrow Systems

- 1) Deploy the appropriate traffic-control devices for protection.
- 2) Check to see that all anchor bolts have remained firmly anchored in the roadway surface. Replace any that are loose, broken, or pulled out.

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

- 3) Clear and dispose of any debris on the site.
- 4) Check the system to be certain that the Mushroom Washer Assemblies holding the Fender Panels together are still intact and that the system has not been deformed in a way that would prevent pulling it back to its original position.
- 5) Be sure that the Diaphragm Support Legs are all properly attached to the Monorail.

Wide Systems

- 1) Deploy the appropriate traffic-control devices for protection.
- 2) Check to see that all anchor bolts have remained firmly anchored in the roadway surface. Replace any that are loose, broken, or pulled out.

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



Caution: QuadGuard® II wide systems should never be anchored to asphalt.

- 3) Clear and dispose of any debris on the site.
- 4) Check the system to be certain that the Mushroom Washer Assemblies holding the Fender Panels together are still intact and that the system has not been deformed in a way that would prevent pulling it back to its original position.
- 5) Be sure that the Diaphragm Support Legs are all properly attached to the Monorail.

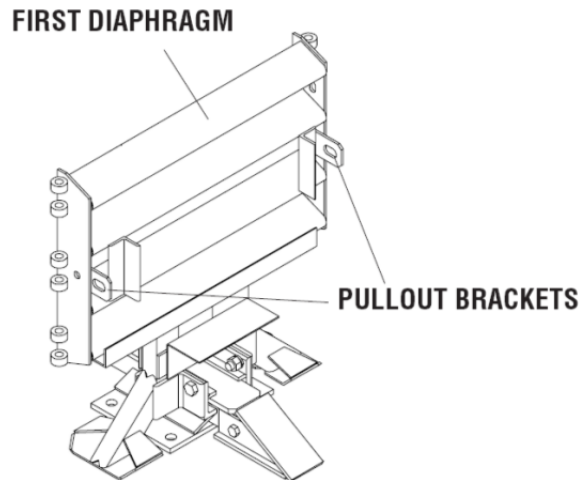


Caution: Use safety goggles and gloves when refurbishing the Mushroom Spring Assembly. Do not place fingers underneath an assembled Mushroom Washer. Parts may suddenly shift and fingers may be pinched. If the spring is still under compression as the nut is nearing the end of the bolt, to prevent injury,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

- 6) Attach chain to Pullout Brackets on first Diaphragm (see Figure 71). Attach both ends of chain to a heavy vehicle (such as a 1 ton pickup).



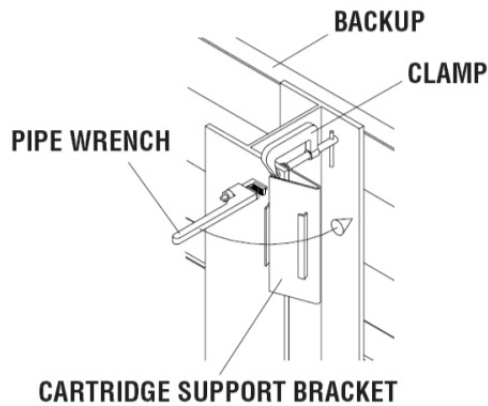
Warning: Stand clear in case chain breaks or becomes disconnected.



**Figure 71
Pullout**

Slowly pull the QuadGuard® II system forward 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 72.



**Figure 72
Straighten Cartridge Support Bracket**

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

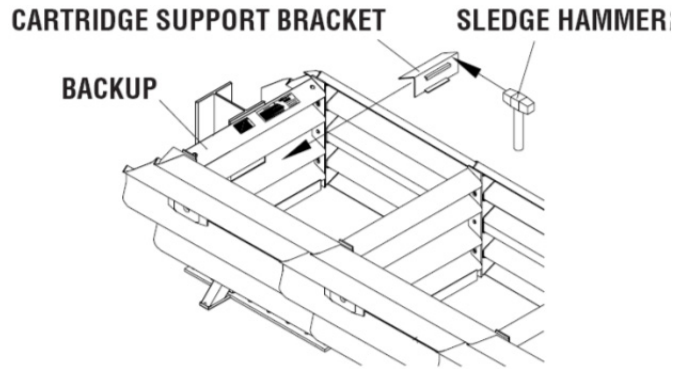


Figure 73
Form Cartridge Support Bracket



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

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

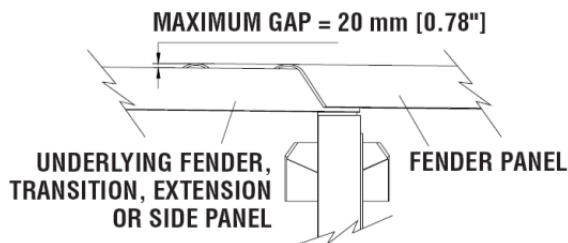


Figure 74
Fender Panel Gap for Narrow Systems

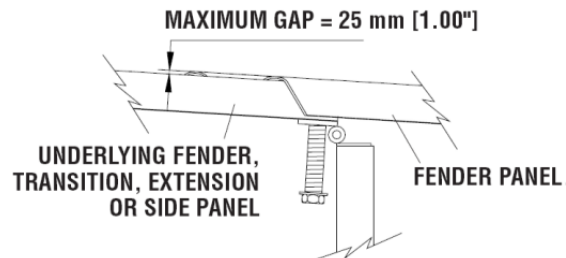


Figure 75
Fender Panel Gap for Wide Systems

- 11) Replace all crushed Cartridges. See Cartridge Placement on pages 33 and 52.
- 12) Remove damaged Nose Assembly. Attach the new Nose to the first Diaphragm, using the six (6) threaded rods and four (4) rail nuts per rod. See pages 30 and 31 for system Nose Assembly.



Table C

Warning:
Bolt Torque Requirements
Anchor Studs – see Table A, p. 53 May slightly protrude above nuts – see Figure 50, p. 41
Critical Clearances
Anchor Studs above nuts – see Figure 18, p. 21 Fender Panel Gap Narrow – 20 mm [0.78”] Fender Panel Gap Wide – 25 mm [1.00”]

13) Check the torque of all bolts on the system (see Table A, p. 53).

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

Parts Ordering Procedure

Make a list of all damaged parts using part descriptions shown on pages 62 and 63 of the system images. Answer the following questions in the spaces provided. This information is necessary to receive the proper parts.

Table D
QuadGuard® II System Ordering Information Chart

Description:	Choices	Fill in this section
What is the width of the system? See “Measuring the Width” on page 14.	610 mm [24”] 760 mm [30”] 915 mm [36”] 1219 mm [48”] 1755 mm [69”] 2285 mm [90”] 3200 mm [126”]	
What is the Number of Bays? See “Counting The Number of Bays” on page 13.	Narrow Systems: 1 through 9 Wide Systems: 3 through 9	
What Type of Backup Does the System Have? See Figures 7 or 8 on page 17.	Concrete Tension Strut	
What Type of Transition Panel? (See “Side Panel and Transition Panel Types” on pages 15 and 16.) Be sure to note right side, left side, both sides (see “How to Determine Left/Right” on page 13) 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 	

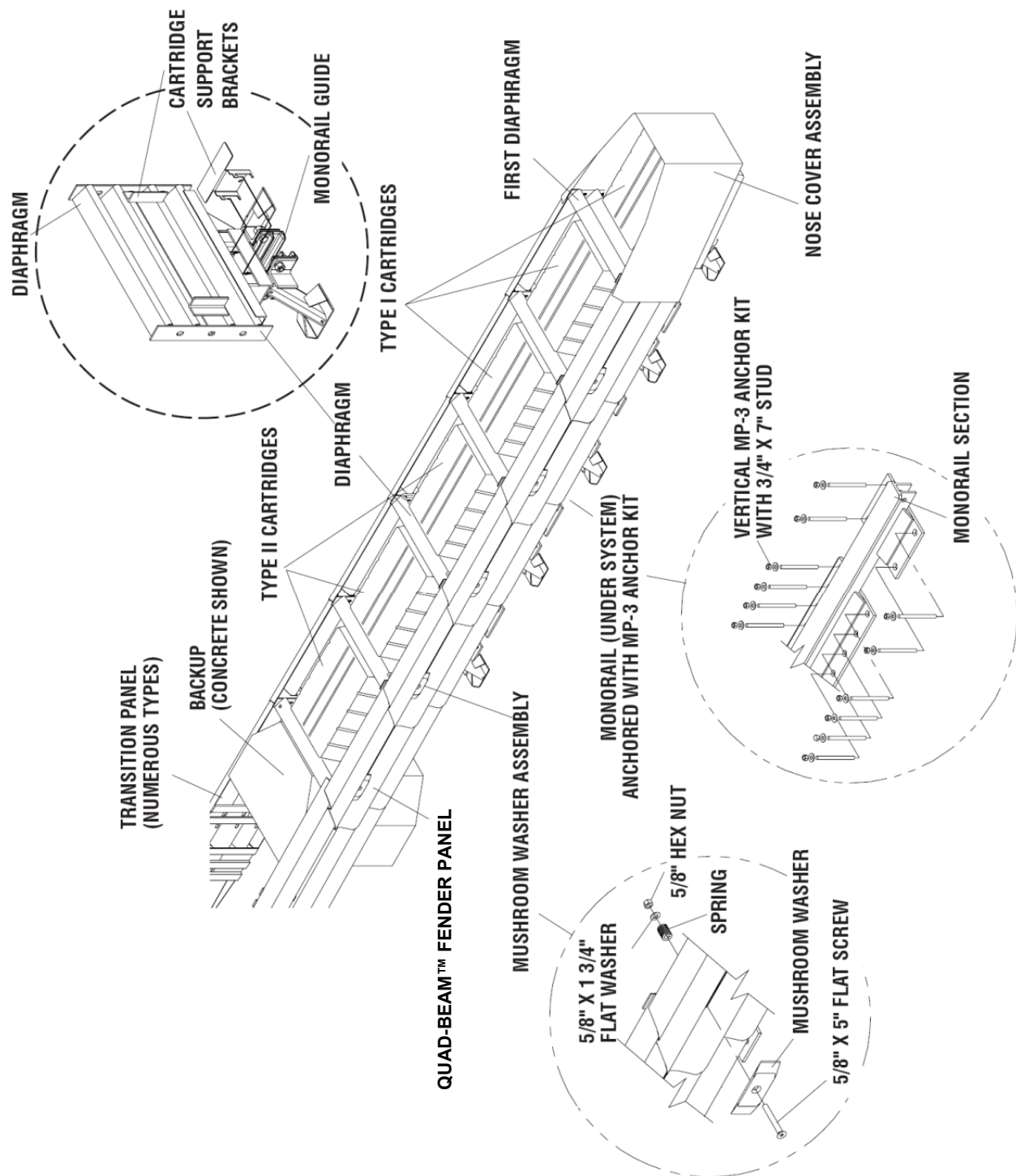


Figure 76
QuadGuard® II for Narrow
Roadside Obstacles

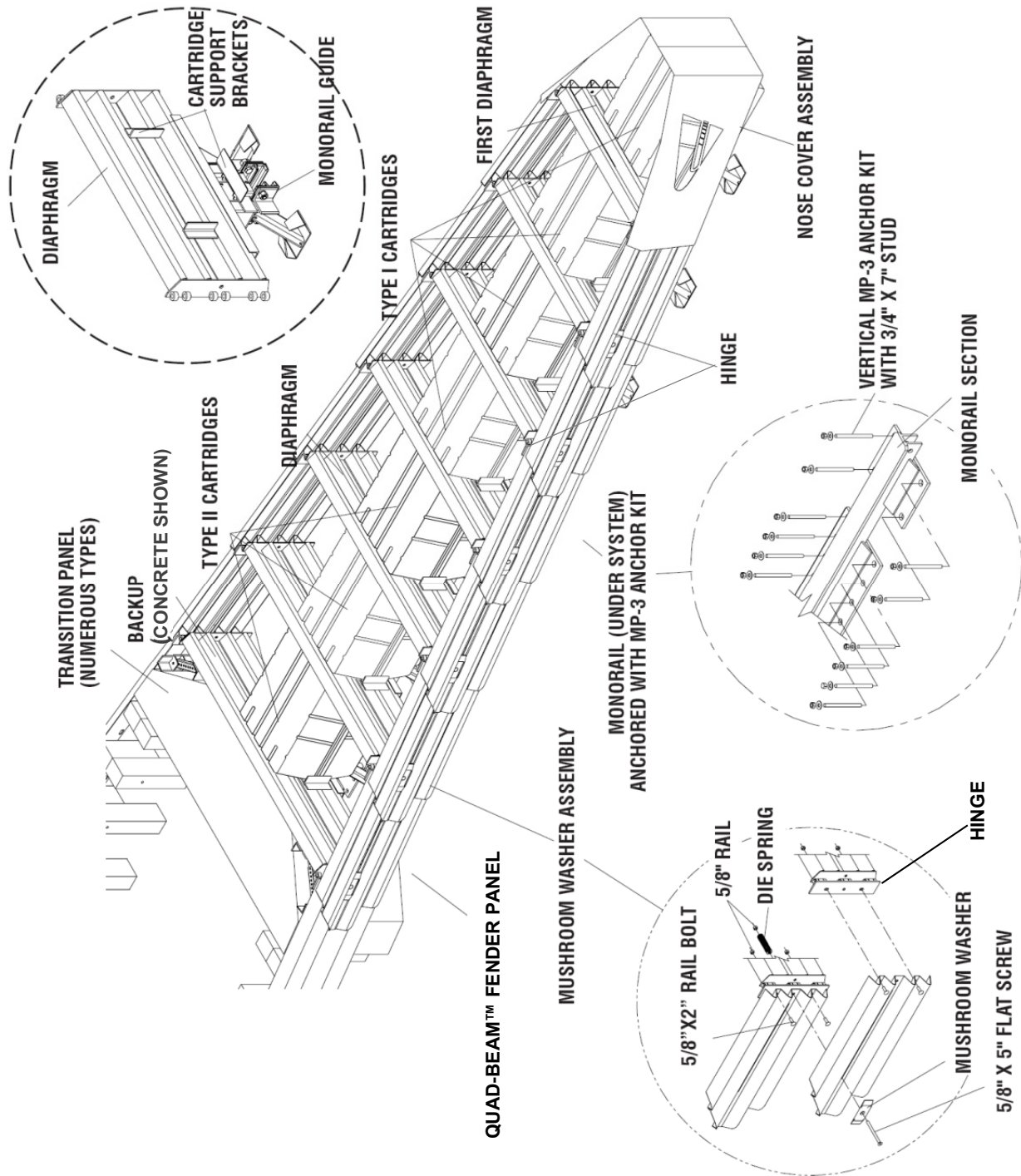


Figure 77
QuadGuard[®] II for Wide
Roadside Obstacles

Notes:

Notes:

Notes:



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